정책연구 99-19

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A Study of IAC's Major R&D Policy and Program Trends and Their Implications for the Diffusion System in Korea

연 구 기 관
과학기술정책연구원

과 학 기 술 부

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과학기술부

제 출 문

과학기술부장관 귀하

본 보고서를 "선진국 주요 연구기관의 연구개발정책 및 연구과제 동향 분석과 국내 활용체제 구축"의 최종보고서로 제출합니다.

1999년 12월 일

○ 연 구 기 관 : 과학기술정책연구원

○ 연 구 기 간 : 1999. 6.11～1999.12.26

○ 주관연구책임자 : 최 영 식

○ 참여연구원

· 이 명 진

· 박 진 서

목 차

표 목 차

그 림 목 차

요　　약

Ⅰ. 제　목

선진국 주요 연구기관의 연구개발정책 및 연구과제 동향 분석과 국내 활용체제 구축

Ⅱ. 연구목적

주요 선진국 연구기관의 연구개발정책 및 핵심연구과제 현황 분석 및 정보의 조사분석을 통해 첫째, 국내 연구자들로 하여금 선진국의 연구결과를 효율적으로 활용할 수 있고 둘째, 정부차원에서 국내 정부출연(연)과 상호협력 가능한 선진국 연구기관의 선정 및 협력과제의 발굴을 위한 정책적 가이드라인으로 활용할 수 있는 기본 데이터를 제공하기 위함.

Ⅲ. 연구내용

○ 주요국의 핵심 연구기관에 대한 profile 정리
【미국(NIST, NSF), 일본(이화학연구소), 독일(프라운호퍼)】

- 개요
  - 구조와 기능의 특징
  - 자금지원체제

- 연구지원체제
- 연구지원 현황 및 성과

○ 핵심 연구과제의 조사·분석 및 협력 연구기관 및 과제 선정 제시
- 과거 3년간 수행과제의 D/B화
- 주요 협력 연구기관 및 연구과제 선정

○ 국내 활용체제 구축에 관한 전략적 방안 제시
- 기반구축 및 정보수집
- 정보 통합관리
- 연구협력 네트워크 구축

Ⅳ. 연구결과

미국의 향후 R&D투자의 추세를 보면 첫째, 클린턴 행정부가 주도하는 21세기 연구기금을 통해 1998년부터 5년간 약 310억 달러 그리고 연방연구투자법(Federal Research Investment Act: FRIA)에 따라 향후 10년간 R&D 예산이 배가될 예정이다. 둘째, 점차 줄어가는 국방 R&D 예산에 비해 비국방 R&D 예산의 증가 추세가 두드러지게 나타났다. 21세기 연구기금에 따르면, 2003년에는 비국방 R&D예산이 현재 예산의 21% 이상 증액될 예정이다. 셋째, 기초과학 예산의 증가로 NSF의 경우 21세기 연구기금을 통해 1999년도 예산이 전년도 대비 약 26%, 기초연구 예산은 10%가 각각 증액되었다.

NSF의 연구과제 지원활동의 특징은 다른 분야에 비해 컴퓨터 및 정보과학기술 분야에 대한 지원의 현격한 증가에서 나타났다. 뿐만 아니라 생명과학, 생명공학 및 환경시스템 등과 같은 미래 지향적 분야에 대한 지속적 지원의 대폭적인 증가는 미래 지식기반사회를 능동적으로 대처하기 위한 미국 정부의 노력을 잘 보여 준다. 특히 학제간 연구분야로 정보의 파악, 수집, 가공, 유통, 활용의 극대화를 위한 Knowledge and Distributed Intelligence(KDI), 환경과 생명에 관한 상호관계의 규명을 위한 Life and Earth's Environment(LEE), 21세기에 부합하는 고급 인력

의 배양을 위한 Educating for the Future(EFF)에 대한 지원의 강화 또한 이를 잘 뒷받침해 주고 있다.

이처럼 정보기술과 생명공학에 관한 집중 지원은 미상무부 NIST의 ATP 지원정책에서도 확인된다. 즉, 1996년부터 1999년까지 ATP의 총 187개 과제 중 생명공학 분야에 가장 많은 54개 과제가 지원되었다. 다음으로 전자/컴퓨터/통신기술에 37개 과제, 정보기술에 34개 과제 등 정보통신 관련 분야에 총 71개 과제가 지원되었다.

연구원의 10% 이상을 외국인에게 개방하고 기초과학과 응용연구의 균형있는 연구수행의 전통을 자랑하는 일본의 RIKEN도 물리, 화학, 엔지니어링, 생물학 등 50여개의 기존 연구실 위주의 연구 중심에서 벗어나 1986년부터 21세기형 과학기술의 획기적인 발전을 위한 핵심기반의 조성사업의 일환으로 기초연구를 강화하기 위해 생물학과 재료분야의 첨단연구주제를 중심으로 Frontier Research Program을 수행하고 있다.

독일 국내외에 산재되어 있는 55개의 연구소에서 재료, 생산기술, 정보통신기술, 전자공학, 센서기술, 공정기술, 에너지 등 다양한 분야에 걸쳐 연구를 수행하는 프라운호퍼 또한 미래 지향적인 정보기술과 환경기술에 대한 연구에 연구개발자원을 집중투자 수행하고 있는 것으로 조사 분석되었다.

미국은 물론 일본의 RIKEN, 독일의 프라운호퍼의 연구과제에 대한 분석에서도 연구개발사업에 뚜렷이 나타난 미래지향적 특성은 우리나라 국가연구개발정책의 재검토를 통한 새로운 방향 설정 및 전략 수립을 위한 정책적 노력에 시사하는 바가 크다.

또한 주요 선진국 연구지원기관 및 수행 연구과제의 조사·분석결과를 바탕으로 개방형 연구기관 및 학제적 산학연협동 연구과제를 중심으로 국내 연구소와 협동연구의 가능성이 높은 연구기관 및 연구과제를 선정·제시했다.

주요 내용을 보면, NSF의 경우 생명과학, 컴퓨터 및 정보과학 등과 같은 주요 분야에서 총 19개의 연구협력기관 및 연구과제가 선정되었고, NIST의 경우는 전자・컴퓨터・통신기술, 생명공학 등의 주요 분야에서 51개의 연구협력기관 및 연구협력과제가 선정되었다. 또한 RIKEN의 경우는 물리 및 재료 15개, 생명과학 22개, 화학 8개, 정보과학 2개 등 47개의 연구협력과제가 선정되고, 프라운호퍼의 경우는 정보・통신기술, 반도체・마이크로시스템기술, 환경 및 의료기술 등 총 48개의 연구협력과제가 선정되었다.

끝으로 이러한 테이터를 보다 효과적이고 체계적으로 활용할 수 있는 국내 체제 구축에 대한 전략적 방안을 아울러 제시했다. 선진국 연구기관의 연구결과를 신속히 소화·흡수하고 상호보완적 협동연구기관 및 연구과제를 선정·발굴 사업을 체계적으로 지원하기 위해 정부는 먼저 국내 연구기관의 특성과 연구수요를 파악하고 가칭 ‘해외과학기술협력센타’를 설치하여 ‘해외과학기술정보망’에 국내외 연구기관의 연구과제 DB를 구축 통합관리하며 협력 대상기관 및 연구과제의 선정에 대한 guideline을 제시하는 등 지원체제를 구축해야 한다. 이와 함께 연구과제 DB의 지속적 갱신, 국내외 연구기관간 효율적 연계를 위한 정책연구 수행, 인력자원 배치 등 제도적 지원이 지속적으로 요청된다.

Summary

Ⅰ. Title

A Study of IAC's Major R&D Policy and Program Trends and Their Implications for the Diffusion System in Korea

Ⅱ. Purposes

The main purpose of this study is to investigate and analyze major changes in the R&D policies and programs of the major industrially-advanced countries(IACs) in order, first, to assist domestic researchers to utilize IACs' R&D results in an efficient manner and secondly, to identify major institutes and programs that are most suitable for a research collaboration with domestic GRIs, industry and academia.

Ⅲ. Contents

○ Profiles of core R&D institutes(NSF, NIST, RIKEN and Fraunhofer) in major advanced countries.

- Characteristics of their structures and functions
- R&D funding systems
- Status and results of major R&D programs

○ Analysis and compilation of their core R&D projects

- Projects during past 3 years

- On-going projects
- Future projects

○ Identification of R&D institutes and programs for joint researches
  - List of R&D institutes for research collaborations
  - List of R&D projects for research collaborations
  - Deduction and presentation of policy suggestion.

○ Strategies for domestic utilization system of foreign research results
  - Identification of domestic need of foreign research results and research collaborations
  - Major systems of collecting, analyzing and distributing updated information on foreign R&D results and joint research projects

Ⅳ. Results

Chief among the major characteristics of the future U.S. R&D budget trend are as follows:

First, R&D funding will increase sharply for the next 5 years beginning 1998. Through "The 21st Century Research Fund" the Clinton Administration will invest about $31 billon during the period, while the Congress passed the Federal Research Investment Act last september, which aims at doubling the current R&D spending for the next ten years up to the year 2010.

Second, non-defense R&D funding will increase drastically in sharp contrast with decreasing defense R&D funding. According to "The 21st Century Research Fund," non-defense R&D spendings will increase to 21% in 2003, outstripping that of defense R&D for the first time in the history of U.S. R&D spendings.

Third, the overall budget for the basic research will sharply increase. For FY 1999 NSF total budget was increased to about 26% and also 10% for the basic research.

The prominent characteristic of supporting activities of NSF can be found in the increase of funding for computer & information science & engineering. A continuous and drastic increase of funding for biological sciences and funding for bioengineering & environmental systems in engineering indeed reflects the continuous U.S. endeavors to prepare for the coming knowledge-based society. For this the support for interdisciplinary researh areas in particular is strengthened: Knowledge and Distributed Intelligence (KDI) strengthening the ability to generate, collect, and diffuse information; Life and Earth's Environment (LEE) designed to foster research on the complex interdependencies among living organisms and their environment: and Educating for the Future (EFF) educating people how to meet the challenges for the 21st Century.

The special attention given to the fields of information technology and bioengineering is also found in NIST-supported ATP projects. Among total 183 projects from 1996 to 1999, 54 projects are awarded in biotechnology. In the areas of information and communication, 71 projects were supported with 37 projects in Electronics/Computer Hardware/Communications and 34 projects in Information Technology respectively.

Known for a well-balance research(basic and applied) the Institute of Physical and Chemical Research(RIKEN), with about fifty intramural laboratories focusing on physics, chemistries, engineering, biology, has shifted in 1986 its research focus by launching "Frontier Research Program" to strengthen a basic research, aimed at developing the 21st century science and technology.

It was also found in the study of its R&D activities that Fraunhofer has been focusing its effort on information and communications technology, biotechnology, and environmental technology in its 47 research institutes operating throughout Germany.

The result of our study indicates us a significant implication for our future R&D policy. We are in need of conducting an overall assessment of our current R&D policy in the direction of focusing on the future-oriented research.

As for the maximization of our effort to overcome the limits of domestic R&D resources by utilizing foreign R&D results, preempting duplicated investment, and improving our research collaboration with the promising R&D institutes in the west, we first should make more strategic investment in the basic research to strengthen domestic research capabilities not only for an efficient utilization of foreign R&D results but also for the enhanced joint research with the western partners.

Second, the roles of the NIS actors(GRIs, industry, university, and government) should be redefined. And R&D policy coordination mechanism should be reinforced.

Finally, it is in need to accumulate and diffuse basic data on the changes in major research institutes and programs in the industrially advanced countries on a continuous base.

제 1 장 서 론

제 1 절 연구의 필요성 및 목적

IMF 이후 과학기술력의 제고를 통한 국가경쟁력 강화가 요청되고 있다. 특히 한정된 과학기술자원의 효율적, 전략적 활용차원에서 국가연구개발을 주도하는 공공연구기관의 효율성 제고가 국가정책의 핵심과제로 부상하고 있다.

주요 선진국의 연구기관들은 효과적 연구개발체제의 구축을 통해 세계경제를 선도하는 많은 선진기술들을 개발하고 있는 상황이다. 따라서 주요 선진연구기관의 연구방향 및 연구과제들의 심층적인 분석을 통해 우리나라의 연구지향점을 모색할 필요성이 제기되고 있다.

그러나 한국의 연구기관 및 기업들은 선진국의 기술보유 기관, 보유기술 현황, 협력절차 및 조건, 접촉창구에 대한 정보부족으로 이를 활용하는데 어려움을 겪고 있는 실정이다. 국내 활용체제의 구축작업을 개별 연구소 차원보다는 정부차원에서 일관성 있고 지속적으로 추진하기 위해 주요 선진연구기관의 연구개발정책 및 연구과제 동향에 관한 연구의 수행이 필요하다.

제 2 절 연구의 목표 및 내용

1. 연구의 목표

주요 선진국 연구기관의 연구개발정책 및 핵심연구과제 현황 및 정보의 분석·확산을 통해 첫째, 연구자들이 선진국의 연구결과를 효율적으로 활용할 수 있고 둘째, 정부차원에서 정부출연(연)과 상호협력 가능한 선진국 연구기관의 선정 및 협력 과제의 발굴을 위한 정책적 가이드라인으로 활용할 수 있는 기본 데이터를 제공한다.

끝으로 조사분석된 연구결과를 국내 연구자가 신속히 활용할 수 있는 체제 구축에 관한 전략적 방안을 제시한다.

2. 연구의 내용

○ 주요 선진국의 핵심 연구기관에 대한 profile 정리

【 미국(NIST, NSF), 일본(이화학연구소), 독일(프라운호퍼)】

- 개요
  - 구조와 기능의 특징
  - 자금지원체제
- 연구지원체제
- 연구지원 현황 및 성과

○ 핵심 연구과제의 조사·분석 및 협력 연구기관 및 과제 선정 제시

- 과거 3년간 수행과제의 D/B화
- 주요 협력 연구기관 및 연구과제 선정

○ 국내 활용체제 구축에 관한 전략적 방안 제시

- 기반구축 및 정보수집
- 정보 통합관리
- 연구협력 네트워크 구축

제 2 장 미국의 연방 R&D 예산 동향

미국은 21세기 지식기반사회를 능동적으로 준비하기 위해 1997년 과학기술정책국(OSTP) 보고서 및 1998년 국가과학기술위원회(NSTC)의 보고서를 통해 21세기 과학기술정책의 목표를 제시하였다.[1]

이러한 미래 지향적 목표의 달성을 위해 미행정부는 "21세기 연구기금(21st Century Research Fund)", 21세기 정보사회에서 정보기술의 대변혁을 통해 세계시장을 선점하기 위한 "21세기 정보기술 이니셔티브(Initiative for Information Technology for the 21st Century(IT2)", 그리고 최근에는 사회생활 전반으로 과학기술의 확산을 통해 폭넓은 지지기반의 구축을 위한 "새로운 과학기술계약론(New S&T Compact)"과 같은 장기 정책을 잇따라 발표하고 있다.

한편, 미의회에서는 상원 '과학기술 우주 소위원회'를 중심으로 향후 10년간 연구개발에 대한 안정적 지원을 보장하기 위한 "연방연구투자법(Federal Research Investment Act)"이 올해 9월에 상원을 통과하였다. 하원에서는 이러한 막대한 연방투자에 대한 "사회적 정당성"의 확보를 통해 국민적 지지의 발판을 마련하기 위해 '과학위원회'가 중심이 되어 국가과학정책연구(National Science Policy Study)의 추진을 통해 "미래를 여는 미국의 새로운 과학정책" 대안을 1998년 9월에 제시하고 현재 제2차 연구를 수행 중에 있다.

미국 연방정부가 주도하는 과학기술정책의 방향과 NSF, NIST 등의 연구개발과제의 배경을 이해하기 위해 본 장에서는 미국 행정부를 중심으로 R&D 예산의 동향을 살펴보고자 한다.

클린턴 대통령의 1998년 연두보고서를 토대로 그 목표를 실현하기 위해 미연방정부는 "21세기 연구기금"의 42%를 기초연구에 집중 투자할 계획이다. 부처별 예산 증가율을 보면, 국립보건원(NIH) 연구예산은 약 50% 증액, 특히 국립암센터(NCI)

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1) 첫째, 세계 최고의 미국 과학기술력의 유지·발전 둘째, 이를 위한 과학기술, 수학 및 교육의 강화 셋째, 급변하는 사회경제적 환경에 능동적으로 대응하기 위한 규제 및 재정적 측면에서 바람직한 연구환경의 구축 넷째, 긴축예산의 시기에도 연구, 교육 및 혁신에 대한 장기적인 투자의 견지 다섯째, 이러한 노력을 연방정부는 물론 민간부문 및 대학을 포함하는 범국가적 차원에서의 추진.

의 연구예산은 65% 증액될 예정이다. 국립과학재단(NSF) 연구예산은 약 26% 증액, 환경청(EPA) 연구예산은 17% 증액될 예정이다(<표 2-1> 참조).

<표 2-1> 향후 5년간 연방 R&D예산 추이

Agency	FY1998 Estimate	FY1999 Budget	FY2000 Projected	FY2001 Projected	FY2002 Projected	FY2003 Projected	%Change FY98-03 Current $	%Change FY98-03 Constant$
NIH	13097	14163	14989	15918	17225	19332	47.5%	32.7%
NASA	9616	9504	9397	9389	9493	9513	-3.1%	-12.8%
Energy Non-defense	3334	3781	3691	3815	3842	3806	14.2%	2.7%
NSF	2568	2857	2946	3038	3131	3229	25.8%	13.1%
Agriculture	1559	1552	1564	1555	1558	1559	.0%	-10.1%
Commerce	1081	1084	1096	1096	1106	1077	-.4%	-10.4%
Interior	609	629	632	624	623	623	2.5%	-7.8%
Transportation	676	775	816	774	727	700	3.6%	-6.8%
EPA	637	631	641	696	725	746	17.1%	5.3%
Other Agencies	1535	1776	1727	1742	1754	1771	15.3%	3.7%
Non-defense R&D	35624	37697	38505	39708	40944	43124	21.1%	8.9%

‘21세기 연구기금’은 미의회와의 마찰에도 불구하고 정부예산의 흑자 전환이라는 배경 속에서 세출위원회를 무난히 통과하였다. 이를 근거로 클린턴 행정부는 미의회와의 마지막 예산협의과정에서 210억 달러의 긴급예산을 확보하게 되었고, 결과적으로 1999년도 연방 R&D예산지원 총액이 최초로 800억 달러를 상회하게 됨으로써 1998년도 예산대비 41억 달러(5.3%)가 증가하게 되었다. 특히 국립보건연구원은 연방 R&D 예산증가액(149억 달러)의 14%인 20억 달러의 예산증가, 에너지부(DOE)는 전년도 대비 11.4%의 예산증가를 각각 기록했다.

특히 기초과학에 가장 많은 예산이 배정되었는데, 기초과학에 1998년도 대비 11.3% 증가(18억 달러)된 175억 달러가 배정되었다. 최고의 예산증액은 14.6%가 증가한 84억 달러의 NIH 기초연구였다. 이로써 국립보건연구원의 기초연구예산은

총 연방기초연구예산의 48%(10년 전에는 37%)를 차지하게 되었다. 그밖에 NSF와 농림부(DOA)의 기초연구 예산은 10%, 10.5%씩 각각 증액됐다.

또한 2000년도 연방예산에 책정된 “21세기 연구기금”은 380억 달러에 달한다. 이는 1999년 대비 3% 증액된 것이다. 이러한 예산증액은 연방연구개발예산의 지속적 증가, 안정성 및 균형적 편성을 도모하기 위한 취지에서 범부처적 성격의 연구분야를 우선시하는 정책이 반영된 것이다. 이러한 취지에서 클린턴 행정부는 본 연구기금을 통해 “21세기 정보기술 이니셔티브”를 제안했다.

<표 2-2> 1999년도 부처별 의회예산안(단위: 백만 달러)

Agency	Fy 98 Estimate	FY 99 Estimate	FY 99 Congress	Change from Request	Request Percent	Change from FY 98	FY 98 Percent
Defense (military)	37,430	37,010	**38,532**	1,522	4.1%	1,102	2.9%
"S&T" 6.1-6.3+Medical	*7,800*	*7,181*	***7,803***	*622*	*8.7%*	*3*	*0.0%*
All other DOD R&D	*29,630*	*29,828*	***30,729***	*900*	*3.0%*	*1,099*	*3.7%*
NASA	9,884	9,504	**9,727**	223	2.3%	-157	-1.6%
Energy	6,288	7,142	**7,002**	-140	-2.0%	714	11.4%
Health and Human Services	13,809	14,888	**15,748**	860	5.8%	1,939	14.0%
NIH	*13,097*	*14,163*	***14,943***	*780*	*5.5%*	*1,846*	*14.1%*
NSF	2,568	2,857	**2,784**	-73	-2.6%	216	8.4%
Agriculture	1,553	1,549	**1,656**	107	6.9%	103	6.6%
Interior	609	629	**627**	-2	-0.4%	19	3.0%
Transportation	676	775	**696**	-79	-10.1%	20	3.0%
EPA	672	657	**692**	36	5.4%	20	3.0%
Commerce	1,081	1,083	**1,076**	-8	-0.7%	-5	-0.5%
NOAA	*580*	*540*	**599**	*58*	*10.8%*	*19*	*3.3%*
NIST	*492*	*532*	***467***	*-65*	*-12.3%*	*-26*	*-5.2%*
Education	209	265	**231**	-34	-12.7	22	10.7%
USAID	150	154	**150**	-4	-2.6%	0	0.0%
VA	608	670	**686**	16	2.4%	78	12.9%
NRC	61	53	**51**	-2	-309%	-10	-16.5%
Smithsonian	146	155	**151**	-4	-2.7%	5	3.3%
All Other	362	343	**361**	18	5.2%	-1	-0.3%
Total R&D	**76,106**	**77,134**	**80,170**	**2,435**	**3.1%**	**4,064**	**5.3%**
Defense R&D	40,409	40,288	**41,823**	1,535	3.8%	1,414	3.5%
Nondefense R&D	35,697	37,446	**38,347**	907	2.4%	2,650	7.4%
Basic Research	15,724	16,917	**17,494**	577	3.4%	1,770	11.3%

‘IT2 이니셔티브’는 대통령 및 부통령의 전폭적인 지지하에 OSTP, NSTC, PCAST 및 여러 연방 관계부처(DOD, DOE, NSF, NOAA, NASA, NIH 등)와의 긴밀한 협조 속에 클린턴 정부의 최우선 정책으로 추진되는 범부처적 프로그램이다.

IT2는 1998년 8월 대통령정보기술자문위원회(President′s Information Technology Advisory Committee: PITAC)가 제시한 정책건의서를 바탕으로 OSTP가 중심이 되어 산학연, 과학기술계 및 미의회의 주요 관계자들과의 협의과정을 통해 철저한 의견수렴과정을 이미 거쳤고, 마침내 1999년 1월 앨 고어 부통령은 정보기술의 획기적인 발전을 도모하기 위해 보다 근본적인 기초과학 중심의 IT2(총 10억 달러 예산)를 제안했다.

IT2는 첫째, 정보기술이 미국 경제성장의 주요인이라는 점, 둘째, 정보기술이 공익 창출의 핵심적인 수단이라는 점, 셋째, 정보기술의 기초연구에 대한 정부투자의 확대는 차세대 정보기술혁신을 주도하는 새로운 아이디어 창출에 절대적으로 필요하다는 점 등에 대한 인식의 배경으로 작용하였으며 첫째, 정보기술의 향상을 위한 기초연구 프로그램의 장기지원 둘째, 컴퓨터 시뮬레이션과 같은 최신 컴퓨팅기술의 활용을 통해 새로운 차원의 과학발전을 도모하고 셋째, 정보기술이 사회에 미치는 법적, 도덕적, 경제적 영향을 평가하는데 그 목표를 두고 있다.

IT2 관련 예산을 살펴보면, 예산의 62%(2억 2천8백만 달러)가 기초연구에 배정되고, 34%는 고등 컴퓨팅에 그리고 나머지는 정보기술에 대한 사회적 영향평가부문에 배정된다. 부처별 예산편성을 보면 최대의 예산(1억 4천6백만 달러: 40%)이 NSF에 배정됐음을 알 수 있다. 나머지 예산 중에 1억 달러(27%)는 DOD에, 7천만 달러(19%)는 DOE에, 3천8백만 달러(10%)는 NASA에, 그리고 6백만 달러(2%)는 NIH와 NOAA에 각각 배정되었다.

<표 2-3> 부처별 IT2 예산(단위: 백만 달러)

	기초정보 기술연구	고성능 연산연구	영향평가연구	총계
국방부	$100	---	---	$100
에너지부	$6	$62	$2	$70
국립우주항공국	$18	$19	$1	$38
국립보건원	$2	$2	$2	$6
기상청	$2	$4	---	$6
국립과학재단	$100	$36	$10	$146
총계	$228	$123	$15	$366

IT2는 기존의 범부처적 연구프로그램들과 연계하여 추진될 예정이다. 따라서 15억 달러의 예산으로 현재 추진 중인 Next Generation Internet(NGI)을 포함한 HPCC 프로그램과 DOE의 Accelerated Strategic Computing Initiative(ASCI)는 IT2로 인해 예산이 증액될 전망이다.

클린턴 정부는 지난 1월 미래 사회에서 모든 미국 시민이 과학기술의 혜택을 누릴 수 있도록 하기 위해 과학기술과 사회간의 새로운 21세기 파트너십의 결성을 제안했다. 이를 위한 첫 단계로 앨 고어 부통령은 과학기술계와 미 행정부가 함께 과학기술의 진보가 사회발전의 중심체가 되도록 공동 노력하기 위한 "新과학기술계약론"을 제안했다. "新과학기술계약론"의 효과적 추진을 위해 NSTC는 연방부처의 임무수행에 대한 과학기술의 기여도를 측정하고, 대통령과학기술자문회의(PCAST)는 일반시민생활의 향상에 대한 과학기술의 역할을 분석・제시할 것이다. OSTP는 이러한 정책을 종합 조정하여 "新과학기술계약론"에 대한 추진전략을 수립할 계획이다.

제 3 장 주요 선진국의 연구개발과제 현황

제 1 절 미국립과학재단(National Science Foundation: NSF)[2]

1. 개 관

가. 설립배경 및 취지

미국립과학재단(NSF)은 2차대전 이후 과학기술의 발전 가능성을 예견하고 국가발전에 있어서 과학기술의 중요성을 강조한 바네바 부쉬 박사의 건의에 따라 1950년 국립과학재단법에 의해 설립된 독립 연방기관이다. NSF는 주로 대학의 연구개발활동과 과학교육의 발전을 위한 제반 사업을 수행하는데, 연간 약 33억 달러를 약 20,000여개의 과학 및 공학분야의 연구 및 교육 프로젝트에 지원하고 있다. 기초연구에 대한 미연방지원에 있어서 현재 NSF는 약 20%의 비중을 차지하고 있으며, 신규과제의 선정은 매년 약 30,000개의 연구과제를 접수받아 이 중 대략 9,000개의 과제를 신규로 승인한다.

나. 주요 기능

국립과학재단의 주요 기능은 첫째, 과학연구의 지원, 둘째, 과학교육의 진흥, 셋째, 과학정보의 교환이다.

다. 조직

국립과학재단은 총재 산하에 생명과학(biological science), 컴퓨터 및 정보과학기술(computer and information sciences & engineering), 교육(education and human resources), 엔지니어링(engineering), 지구과학(geosciences), 수학 및 물리(mathematical and physical sciences), 사회과학(social, behavioral and economic sciences) 등 분야별로 7개의 국(Directorate)을 두고 있으며, NSF의 정책을 결정하는 국립과학평의회

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2) http://www.nsf.gov/

(National Science Board)와 NSF의 연구비 지원을 결정하는 자문위원회(Advisory Committee)가 있다. 그리고 담당 부서와 협의하여 연구사업을 심사하는 사업담당관(Program Officer)이 있으며 현재의 인원은 약 1,300명이다. 구체적인 NSF 조직은 다음 <표 3-1>과 같다.

<표 3-1> NSF의 조직

Office of the Director	
National Science Board	
Office of Equal Opportunity Programs	Directorate for Biological Science
Office of the General Counsel	Directorate for Computer and Information Sciences & Engineering
Office of Inspector General	Directorate for Education and Human Resources
Office of Integrative Activities	Directorate for Engineering
Office of Legislative and Public Affairs	Directorate for Geosciences
Office of Polar Programs	Directorate for Mathematical and Physical Sciences
Office of Budget, Finance and Award Management	Directorate for Social, Behavioral and Economic Sciences
Office of Information and Resource Management	

2. NSF의 연구과제 지원현황[3)]

가. 총괄현황

NSF의 예산은 연구프로젝트지원, 연구설비지원, 교육 및 훈련, 행정관리 등 4개의 주요기능별로 배분된다. 1998년의 경우 연구프로젝트지원은 전년대비 2.7%, 연구설비지원은 3.5%, 교육 및 훈련지원은 3.5% 증가하였고, 1999년에 연구프로젝트지원은 전년대비 12%, 교육 및 훈련지원은 10.7% 증가하였다. 전체적으로 살펴 볼 때 NSF의 연구프로젝트 및 교육, 훈련에 대한 지원이 강화되고 있음을 알 수 있다(<표 3-2> 참조).

3) http://www.nsf.gov/bfa/bud/fy1999/

<표 3-2> NSF의 연도별, 기능별 예산(단위: 백만 달러)

	1996년(추정)	1997년(추정)	1998년(추정)	1999년(추정)
연구프로젝트지원	1,760	1,818	1,898	2,126
연구설비지원	680	684	699	735
교육 및 훈련	630	633	666	737
소계	3,070	3,263	3,263	3,598
행정관리	136	167	167	175
총계	3,206	3,429	3,429	3,773

한편, 신규과제의 경우 NSF에는 매년 3만건 이상의 연구과제가 신청되고 이중 9천여건의 과제가 채택된다. 이를 구체적으로 살펴보면 다음 표와 같다.

<표 3-3> NSF의 연도별 지원확정 건수

Org	FY	Numbers of Awards	Median Annual Size	비고
NSF 전체	2000	73	$64,295	
	1999	9,112	$67,959	
	1998	9,279	$62,404	
	1997	9,864	$57,500	
	1996	9,071	$51,546	
Biological Science (BIO)	2000	3	$110,395	
	1999	1,370	$81,000	
	1998	1,404	$75,000	
	1997	1,416	$72,000	
	1996	1,328	$61,542	
Computer & Information Science (CSE)	2000	1	$103,662	
	1999	759	$79,201	
	1998	706	$75,000	
	1997	731	$67,500	
	1996	647	$53,564	
Engineering (ENG)	2000	15	$35,896	
	1999	809	$74,954	
	1998	1,212	$30,525	
	1997	1,191	$25,873	
	1996	1,326	$26,637	
Mathematical & Physical Science (MPS)	2000	17	$60,000	
	1999	1,891	$69,841	
	1998	1,835	$68,036	
	1997	1,993	$60,000	
	1996	1,817	$52.588	
International (INT)	2000	4	$27,970	
	1999	351	$10,567	
	1998	376	$10,000	
	1997	406	$10,000	
	1996	408	$7,958	

나. NSF의 중점 투자 분야

1999년의 경우, NSF는 Knowledge and Distributed Intelligence(KDI), Life and Earth's Environment(LEE), Educating for the Future(EFF) 등과 같은 분야에 중점적으로 지원하였음을 알 수 있다. 이러한 분야 중 특히 KDI 및 EFF는 2장에서 지적한 '21세기 연구기금' 및 '21세기 정보기술 이니셔티브(IT2)' 등과 관련 있는 분야이다.

① Knowledge and Distributed Intelligence(KDI)

Knowledge and Distributed Intelligence(KDI)는 정보의 파악, 수집, 가공, 유통, 활용과 관련된 영역으로 1999년에 이 분야에 7천8백만 달러가 지원되었다. 이 분야의 중점 연구주제로는 knowledge networking, learning and intelligent systems, new challenges to computation 등이 있으며 각각 3천2백만 달러, 2백만 달러, 천5백만 달러, 3천만 달러가 지원되었다.

② Life and Earth's Environment(LEE)

Life and Earth's Environment(LEE)는 환경과 생물의 상호의존에 대한 광범위한 연구로 1999년에 8천8백만 달러가 지원되었다. 이 분야의 중점 연구주제로는 integrated research challenges, environmental observatories, global change, urban communities, life in extreme environments, engineered systems in the natural environment 등이다.

③ Educating for the Future(EFF)

Educating for the Future(EFF)는 21세기에 부합하는 교육적 요구에 대처하기 위해 설정된 주제로 1999년에 1억7백만 달러가 지원되었다. 이 분야의 중점 연구과제에는 learning and early development, transitions from childhood to the workforce, systemic reform of K-16 education, learning technologies, K-8 mathematics initiative, integration of research and education 등이 있다.

다. 연구프로젝트지원 현황

연구프로젝트지원은 크게 프로젝트 자체에 대한 지원과 연구센터에 대한 지원으로 구분된다. 연도별 지원액은 다음 표와 같다.

<표 3-4> 연도별 연구프로젝트지원 (단위: 백만 달러)

	1996년(추정)	1997년(추정)	1998년(추정)	1999년(추정)
연구프로젝트	1,551	1,616	1,677	1,902
연 구 센 터	209	201	221	224
총 계	1,760	1,818	1,898	2,126

1998년의 경우 프로젝트에 대한 지원은 전년에 비해 5천만 달러(3.1%)가 증가하였으나 1999년 지원액은 전년에 비해 2억2천5백만 달러(13.4%)가 증가된 19억2백만 달러이었다. 특히 1998년, 1999년도에는 KDI, LEE 등에 대한 지원이 두드러진다.

한편, NSF는 연구프로젝트 이외에 다양한 연구센터 및 센터 프로그램을 지원하고 있는데, 각 센터에 대한 지원액은 다음 표와 같다.

<표 3-5> 연도별 센터 및 센터 프로그램 지원현황(단위: 백만 달러)

	Year of Program Initiation	FY 1997 No. of Centers	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate
Engineering Research Centers	1985	19	48	53	56
Science & Technology Centers	1987	24	63	57	52
Industry/University Cooperative Research Centers	1973	53	4	4	5
State Industry/University Cooperative Research Centers	1991	12	4	4	2
Centers of Reserarch Excellence in Science and Technology	1987	12	9	9	9
Plant Genome Centers	1998	NA	NA	18	18
Materials Research Science & Engineering Centers	1994	25	45	48	52
Center for Ecological Analysis and Synthesis	1995	1	2	2	2
Long-Term Ecological Research Sites	1980	20	11	14	15
Earthquake Engineering Research Centers	1988	3	6	6	6
Critical Technologies Institute	1993	1	3	3	3
Other Centers	NA	5	6	5	5
TOTAL		175	$201	$221	$224

3. 분야별 지원 현황

NSF가 지원하는 과학기술 분야는 크게 생명과학, 컴퓨터 및 정보과학, 엔지니어링, 지구과학, 수학 및 물리학 등으로 구분할 수 있다. 앞에서 이미 언급한 바와 같이 NSF는 매년 약 9,000개 이상의 과제를 선정하고 있고 진행중인 과제를 포함하면 매년 지원하는 과제는 1만건 이상이 된다.

그러나 본 보고서에서는 1996년부터 1999년 사이에 과학기술분야에 선정된 과제(awards) 중에서 연구비 총액이 3백만 달러 이상인 과제를 선정하여 연구과제명, 연구기관, 연구기간, 연구요약을 부록에 정리하였다. 이상의 요건에 해당하는 총 과제수는 293개이나 이 중 교육 및 훈련 분야를 제외한 167개 과제에 대한 요약문을 부록에 정리하였다.(부록 1 참조)

본 보고서에서는 생명과학, 컴퓨터 및 정보과학, 엔지니어링, 지구과학, 수학 및 물리학 등의 분야별로 최근의 연구방향과 재정지원 현황을 중심으로 다음과 같이 정리하였다.

가. 생명과학

생명과학 분야의 1998년 지원액은 3억3천만 달러로 전년 대비 3.3% 증가하였으나, 1999년에는 4억1천7백만 달러로 12.7% 증가하였다. 생명과학 분야에서 우선 지원의 대상은 미국 대학의 생명과학 연구이다.(1996년 3억불에서 1999년 4억불)

<표 3-6>에서와 같이 생명과학 분야는 매년 1천3백개에서 1천4백개의 신규 과제가 선정되고 있는데, 1999년의 지원증가는 주로 KDI, LEE, EEF 등에 대한 지원을 강화하기 위해서였다.

KDI 분야 중, knowledge networking 분야의 주 연구과제는 복잡계에 대한 모형의 개발 및 자료 수집, 생물학 데이터베이스의 상호이용가능성, 실시간 시뮬레이션 및 실험제어, 유전자에 대한 데이터베이스 구축 등이며 이 부문에 1천4백만 달러가 지원되었고, learning and intelligent systems에 1백만 달러가 지원되었으며, new challenges in computation 분야에는 9백5십만 달러가 지원되었는데 계산 기법 및 알고리듬 등에 주로 지원되었다.

<표 3-6> 생명과학분야의 신규 awards 건수

Org	FY	Number of Awards	Median Annual Size
Biological Science (BIO) 전체	2000	3	$110,395
	1999	1,370	$81,000
	1998	1,404	$75,000
	1997	1,416	$72,000
	1996	1,328	$61,542
Biological Infrastructure (DBI)	1999	274	$82,982
	1998	290	$58,802
	1997	273	$55,795
	1996	323	$52,011
Environmental Biology (DEB)	2000	1	$27,212
	1999	332	$50,796
	1998	317	$50,012
	1997	326	$53,331
	1996	295	$42,715
Integrative Biology & Meuroscience (IBN)	1999	409	$80,000
	1998	439	$75,000
	1997	458	$71,538
	1996	396	$65,000
Molecular & Cellular Bioscience(MCB)	2000	2	$407,887
	1999	354	$100,000
	1998	358	$100,000
	1997	359	$93,304
	1996	314	$89,786
기 타	1999	1	$300

LEE 분야에서는 life in extreme environments, urban communities, global change, integrated research challenges in environmental biology, environmental observations에 1천3백3십만 달러가 지원되었다.

EFF 분야에는 integration of research and education, learning technologies 등에 5백7십만 달러가 지원되었다.

생명과학 분야의 지원액은 <표 3-7>과 같다. 특히 Integrative Biology & Neuroscience Research 등에 대한 지원증가가 특징적이다.

<표 3-7> 생명과학분야의 분야별 지원액(단위: 천달러)

	FY 1996 ACTUAL	FY 1997 REQUEST	FY 1998 REQUEST	FY 1999 REQUEST
MOLECULAR AND CELLULAR BIOSCIENE				
Molecular & Celluar Biosciences Research Projects	89,568	92,220	94,540	107,910
소계	89,568	92,220	94,540	107,910
INTEGRATIVE BIOLOGY AND NEUROSCIENCES				
Integrative Biology & Neuroscience Research	80,887	84,950	6,280	100,230
소계	80,887	84,950	6,280	100,230
ENVIRONMENTAL BIOLOGY				
Environmental Biology Research Projects	73,425	78,100	78,040	90,630
소계	73,425	78,100	78,040	90,630
BIOLOGICAL INFRASTRUCTURE				
Research Resources	45,656	52,430	54,160	65,150
Human Resources	14,897	18,300	17,800	13,900
소계	60,553	70,730	71,960	79,050
PLANT GENOME RESEARCH				
Plant Genome Research Project	0	0	0	40,000
소계	0	0	0	40,000
총계	304,433	326,000	330,820	417,820

나. 컴퓨터 및 정보과학기술

컴퓨터 및 정보과학기술 분야에 대한 1998년 지원액은 2억9천만 달러로 전년 대비 7.6% 증가하였으며, 1999년에는 3억3천만 달러로 전년에 비해 16.5%가 증가하였다. 특히 컴퓨터 및 정보과학기술 분야에 대한 NSF 지원은 연방지원 중 약 50%를 차지하고 있다.

1999년 컴퓨터 및 정보과학기술에 대한 지원에 있어서 human-centered system research, computing systems research encompassing core fundamental research, convergence of computing and communications에 1천6백만 달러가 지원되었고, 컴퓨터 및 정보과학기술에 대한 지원도 KDI, LEE, EFF에 중점을 두고 있다.

KDI 분야에서는, 차세대인터넷(Next Generation Internet: NGI) 등 knowledge networking에 5백만 달러, 학습기반지능시스템 개발 등 learning and intelligent systems에 3백만 달러, NGI 응용과 같은 new challenges in computation 등에 6백만 달러가 지원되었다.

LEE 분야에서는 극한 환경에서의 원거리 실험 및 데이터 베이스 구축을 위해 2백5십만 달러, EFF 분야에는 2백5십만 달러가 지원되었다.

컴퓨터 및 정보과학기술 분야의 신규 과제 선정규모와 분야별 지원액은 다음 표와 같다. 이 분야에는 매년 6백에서 7백 여건의 과제가 신규로 선정되는데 평균 연구비는 점차 증가하는 추세이다. 한편 세부 분야별 지원액을 살펴보면 advanced networking infrastructure and research 등에 대해 집중적으로 투자하고 있음을 알 수 있다.

<표 3-8> 컴퓨터 및 정보과학기술 분야의 신규 awards 건수

Org	FY	Number of Awards	Median Annual Size
Computer & Information Science (CSE) 전체	2000	1	$103,662
	1999	759	$79,201
	1998	706	$75,000
	1997	731	$67,500
	1996	647	$53,584
Advanced Computational & Infrastructure and Research (ACI)	1999	35	$100,636
	1998	24	$59,774
	1997	42	$44,833
	1996	48	$45,000
Advanced Networking Infrastructre and Research (ABI)	1999	120	$134,870
	1998	129	$119,215
	1997	132	$51,250
	1996	94	$59,437
Computer-Communications Research (CCR)	1999	292	$66,667
	1998	254	$67,319
	1997	259	$58,781
	1996	246	$50,000
Experimental and Integrative Activities (EIA)	1999	141	$66,909
	1998	148	$77,269
	1997	136	$82,000
	1996	125	$67,177
Information and Intelligient Systems (IIS)	2000	1	$107,323
	1999	171	$87,400
	1998	151	$76,019
	1997	162	$81,634

<표 3-9> 컴퓨터 및 정보과학기술의 분야별 지원액(단위: 천달러)

	FY 1996 ACTUAL	FY 1997 REQUEST	FY 1998 REQUEST	FY 1999 REQUEST
COMPUTER AND COMPUTATION RESEARCH				
Computer & Computatution Research Project Support	40,219	43,420	46,420	
소계	40,219	43,420	46,420	67,510
INFORMATION, ROBOTICS AND INTELLIGENT SYSTEMS				
Information, Robotics & Intelligent Systems Research Project Support	32,898	35,570	39,790	
소계	32,898	35,570	39,790	46,740
MICROELECTRONIC INFORMATION PROCESSING SYSTEMS				
Microelectronic Information Processing Systems Research Project Support	26,330	28,440	30,360	
소계	26,330	28,440	30,360	72,150
ADVANCED SCIENTIFIC COMPUTING				
Advanced Computational Infrastructure	72,258	70,560	69,960	
New Technologies	8,174	10,000	10,000	
소계	80,432	80,560	79,960	81,620
NETWORKING AND COMMUNICATION RESEARCH AND INFRASTRUCTURE				
NSFNET	42,233	44,140	47,740	
Networking & Communications Research Project Support	12,803	12,950	14,520	
소계	55,036	57,090	62,260	63,120
CROSS-DISCIPLINARY ACTIVITIES				
CISE Institutional Infrastructure	23,686	22,880	25,870	
CISE Instrumentation	3,832	9,040	9,510	
소계	27,518	31,920	35,380	
총계	262,433	277,000	294,170	331,140

다. 엔지니어링

엔지니어링 분야의 1998년 지원액은 3억6천만 달러로 전년 대비 3.6% 증가하였으며, 1999년에는 11.9%가 증가된 4억 달러를 지원하였다. 엔지니어링 분야에서도 KDI, LEE, EFF에 대한 지원이 두드러진다.

KDI 분야에서는 인터넷을 위한 intelligent agents, artificial systems, multimedia 등에 5백만 달러가 지원되었으며, LEE 분야에 9백5십만 달러, EFF 분야에 1천2백만 달러가 지원되었다.

이와 함께, 엔지니어링 분야에서는 nanotechnology 및 implants, artifical tissues and organs, novel biosensors에 대한 지원을 확대할 예정이다. 엔지니어링 분야의 신규 awards 규모와 분야별 지원액은 다음 표와 같다.

<표 3-10> 엔지니어링 분야의 신규 awards 건수

Org	FY	Number of Awards	Median Annual Size
Engineering (ENG) 전체	2000	9	$199,994
	1999	1,483	$83,026
	1998	1,390	$81,376
	1997	1,573	$78,843
	1996	1,383	$74,516
Bioengineering & Environmental Systems (BES)	1999	128	$73,598
	1998	155	$70,008
	1997	175	$58,664
	1996	108	$63,422
Civil & Mechanical Structures (CMS)	1999	261	$60,110
	1998	252	$58,205
	1997	268	$56,694
	1996	264	$54,180
Chemical & Transport Systems (CTS)	1999	232	$72,465
	1998	221	$68,750
	1997	235	$63,490
	1996	218	$69,897
Design, Manufacture & Industrial Innovation (DMI)	2000	9	$199,952
	1999	522	$198,796
	1998	456	$190,393
	1997	557	$147,714
	1996	493	$135,986
Electrical & Communications Systems (ECS)	1999	234	$66,667
	1998	169	$65,000
	1997	217	$63,503
	1996	204	$58,000
Engineering Education & Centers (EEC)	1999	102	$81,000
	1998	131	$99,997
	1997	117	$63,394
기타	1999	4	$362,500
	1998	6	$149,712
	1997	4	$123,564
	1996	7	$90,000

엔지니어링 분야에서는 매년 1천3백개에서 1천5백여개의 과제가 신규로 선정되고 있다. 한편, 분야별 지원액을 살펴보면 1999년에 bioengineering & environmental systems분야에 전년에 비해 23.8%가 증가된 총 3천5백만 달러를 지원하였는데 생명공학에 대한 NSF의 의지를 엿볼 수가 있다.

<표 3-11> 엔지니어링 분야별 지원액(단위: 천달러)

	FY 1996 ACTUAL	FY 1997 REQUEST	FY 1998 REQUEST	FY 1999 REQUEST
BIOENGINEERING AND ENVIRONMENTAL SYSTEMS				
Bioengineering	18,926	17,020	18,800	
Environmental and Ocean Systems	6,183	8,900	9,540	
소계	25,108	25,920	28,340	35,690
CHEMICAL AND TRANSPORT SYSTEMS				
Chemical and Transport Systems	38,242	41,630	42,130	46,630
소계	38,242	41,630	42,130	46,630
CIVIL AND MECHANICAL SYSTEMS				
Harzard Mitigation	19,609	21,400	21,600	
Civil, Mechanical and Materials Engineering	28,694	30,960	31,500	
소계	48,303	52,360	53,100	59,500
DESIGN, MANUFACTURE, AND INDUSTRIAL INNOVATION				
Design and Manufacturing Systems	31,892	34,850	35,300	50,130
Industry/University Innovation & Liaison	8,584	11,780	10,100	
Small Business Innovation Research	40,449	51,750	54,150	57,650
소계	80,925	98,380	99,550	107,780
ELECTRICAL AND COMMUNICATIONS SYSTEMS				
Electrical and Communications Systems	38,671	42,060	43,470	48,920
소계	38,671	42,060	43,470	48,920
ENGINEERING EDUCATION AND CENTERS				
Development of Human Resoruces	31,521	34,220	34,060	
Engineering Centers	59,932	59,760	59,820	
소계	91,453	93,980	93,880	102,030
총계	322,703	354,330	360,470	400,550

라. 지구과학

지구과학 분야의 1998년 지원액은 4억5천만 달러로 전년 대비 1.5% 증가하였으며 1999년 지원액은 5억7백만 달러로 11.5% 증가하였다. 1999년의 경우, U.S. Weather Research Program, National Space Weather Program, Research Experiences for Undergraduates, U.S. Global Change Research Program 등에 주로 지원되었으며, KDI 분야에 1백7십7만 달러, LEE 분야에 3천4백만 달러, EFF 분야에 1백7십5만 달러가 지원되었다. 지구과학 분야의 지원액중 2/3는 매년 1,000여건의 관련 분야 연구프로젝트에 지원되고 있다.

지구과학 분야의 분야별 지원액은 다음 표와 같다.

<표 3-12> 지구과학 분야별 지원액(단위: 천달러)

	FY 1996 ACTUAL	FY 1997 REQUEST	FY 1998 REQUEST	FY 1999 REQUEST
ATOMOSPHERIC SCIENCES				
Atmospheric Science Research Support	84,301	92,060	90,490	102,440
National Center for Atmospheric	60,094	61,170	60,830	67,780
소계	144,395	153,230	151,320	170,220
EARTH SCIENCES				
Earth Sciences Project Support	57,558	58,800	58,630	65,790
Instrumentation and Facilities	21,064	27,700	28,000	31,410
Continental Dynamics	7,898	9,400	8,500	9,500
소계	86,519	95,900	95,130	106,770
OCEAN SCIENCES				
Ocean Sciences Research Support	106,510	110,180	112,150	127,500
Oceanographic Centers and Facilities	47,476	53,650	52,260	56,960
Ocean Drilling Program	39,594	41,040	41,750	45,930
소계	193,580	204,870	206,160	230,390
총계	424,494	454,000	452,610	507,310

마. 수학 및 물리학

수학 및 물리 분야의 1998년 지원액은 7억1천5백만 달러로 전년 대비 2.8% 증가하였고 1999년에는 7억9천2백만 달러로 10.7% 증가하였다. 1999년에 증가된 지원

액은 주로 fundamental and applied mathematics(6백만 달러), origins of the universe(4백만 달러), quantum realm(9백만 달러), molecular connections(1천만 달러) 등에 지원되었다.

KDI 분야에는 1천5백만 달러, LEE 분야에는 1천만 달러, EFF 분야에는 2천만 달러가 지원되었고, 수학 및 물리 분야의 신규 과제수와 소분야별 지원액은 다음 표와 같다.

<표 3-13> 수학 및 물리 분야의 신규 awards 건수

Org	FY	Number of Awards	Median Annual Size
Mathematical & Physical Science (MPS) 전체	2000	17	$60,000
	1999	1,891	$69,841
	1998	1,835	$68,036
	1997	1,993	$60,000
	1996	1,817	$52,588
Astronomical Science (AST)	1999	133	$74,310
	1998	133	$64,200
	1997	158	$64,000
	1996	107	$66,498
Chemistre (CHE)	1999	389	$105,000
	1998	397	$108,283
	1997	466	$96,333
	1996	417	$98,000
Materials Research (DMR)	2000	11	$78,000
	1999	436	$92,340
	1998	404	$90,000
	1997	411	$85,000
	1996	377	$83,000
Mathematical Sciences (DMS)	2000	6	$23,500
	1999	711	$30,000
	1998	658	$29,274
	1997	710	$27,922
	1996	703	$22,731
Physics (PHY)	1999	220	$72,700
	1998	237	$73,013
	1997	248	$67,000
	1996	211	$65,000
기타	1999	2	$126,268
	1998	6	$50,000
	1996	2	$1,029,914

<표 3-14> 수학 및 물리 분야별 지원액(단위: 천달러)

	FY 1996 ACTUAL	FY 1997 REQUEST	FY 1998 REQUEST	FY 1999 REQUEST
MATHEMATICAL SCIENCES				
Research Project Support	64,482	69,560	74,000	79,100
Infrastructure Support	23,219	22,000	23,000	35,000
소계	87,701	91,560	97,000	114,100
ASTRONOMICAL SCIENCES				
Astronomy Research and Instrumentation	39,594	45,340	46,020	50,880
Facilities	69,068	71,630	72,800	77,110
소계	108,663	116,970	118,820	127,990
PHYSICS				
Physics Research Project Support	94,270	102,660	103,780	114,020
Facilities	37,615	39,600	44,440	57,920
소계	131,885	142,260	148,220	171,940
CHEMISTRY				
Chemistry Research Project Support	111,998	111,740	117,960	123,370
Instrumentation & Infrastructure	15,694	24,900	17,400	24,590
소계	127,692	136,640	135,360	147,960
MATERIAL RESEARCH				
Materials Research Project Support	84,450	92,590	88,440	98,870
Materials Research Science and Engineering Centers	57,281	58,590	58,930	60,730
National Facilities and Instrumentation	33,378	37,890	38,940	40,440
소계	175,108	189,070	186,310	200,040
OFFICE OF MULTIDISCIPLINARY ACTIVITIES				
Research Project Support	29,462	31,500	30,000	30,000
소계	29,462	31,500	30,000	30,000
총계	660,510	708,000	715,710	792,030

4. 분야별 NSF 협력기관 및 협력과제

NSF가 지원하는 주요 연구기관과 연구과제를 국내 연구소와 협동연구의 가능성이 높은 개방형 연구기관 및 학제적 산학연협동 연구과제를 중심으로 다음과 같이 주요 분야별로 선정했다. 생명과학 5개, 컴퓨터 및 정보과학 4개, 엔지니어링 8개, 재료과학 2개 등 총 19개 협력과제에 대한 연구기관 및 연구과제는 다음과 같다.

가. 생명과학

주관기관 : 아리조나대학교
과 제 명 : 식물스트레스 내성에 대한 게놈연구
참여기관 : 퍼듀대학교, 오클라호마주립대학교

주관기관 : 러트거스대학교
과 제 명 : 거대분자구조의 데이터베이스
참여기관 : NIST, 캘리포니아주립대학교(샌디아고)

주관기관 : 스탠포드대학교
과 제 명 : 옥수수 유전자의 발견, 시컨싱 및 표현형 분석
참여기관 : Virginia Walbot, 아리조나대학교, 캘리포니아주립대학교(버클리, 샌디아고), 일리노이대학교, 로와주립대학교

주관기관 : 스탠포드대학교
과 제 명 : Arabidopsis의 게놈 시컨싱
참여기관 : 펜실바니니아대학교, 캘리포니아주립대학교(버클리)

주관기관 : 캘리포니아주립대학교(데이비스)
과 제 명 : 생물다양성 - 탄소 및 영양물 이동에 있어서 mycorrhizal fungi, 식물 및 토양의 상호역할
참여기관 : 남오레곤대학교

나. 컴퓨터 및 정보과학

주관기관 : 캘리포니아주립대학교(오클란트)
과 제 명 : 캘리포니아 연구 및 교육 네트워크 구축
참여기관 : Oak Ridge National Lab, Rice, Argonne National Laboratory, Los Alamos National Laboratory, 시라큐스대학교, 테네시대학교, 텍사스대학교

주관기관 : 캘리포니아주립대학교(버클리)
과 제 명 : 학술정보의 확산과 활용 구축
참여기관 : 캘리포니아주립대학교(산타바바라), 스탠포드대학교

주관기관 : 캘리포니아주립대학교(산타바바라)
과 제 명 : Alexandria Digital Earth Prototype
참여기관 : 캘리포니아주립대학교(버클리), 스탠포드대학교

주관기관 : 스탠포드대학교
과 제 명 : 스탠포드 인터넷도서관 관련 기술
참여기관 : 캘리포니아주립대학교(버클리, 산타바바라)

다. 엔지니어링

주관기관 : 뉴욕대학교(New York University)
과 제 명 : 도시인프라시스템 연구소
참여기관 : 코넬대학교, 남가주주립대학교, 뉴욕폴리테크닉대학교

주관기관 : 코넬대학교
과 제 명 : 국립 나노조합(nanofabrication) 사용자 네트워크
참여기관 : 스탠포드대학교, 캘리포니아주립대학교(산타바바라), 하워드대학교, 펜실바니아주립대학교

주관기관 : 조지아공대
과 제 명 : living tissues 공학 연구센터
참여기관 : 에모리의대

주관기관 : 버지니아폴리텍, 버지니아주립대학교
과 제 명 : Power Electronics Systems 센터
참여기관 : 위스콘신대학교(메디슨), RPI, North Carolina A&T State University, 푸에르트리코대학교

주관기관 : 크렘슨대학교
과 제 명 : 첨단 공학 섬유 및 필름 센터
참여기관 : MIT

주관기관 : 하와이대학교(Manoa)
과 제 명 : Marine Bioproducts 공학 센터

참여기관 : 캘리포니아주립대학교(버클리)

주관기관 : 존스홉킨스대학교
과 제 명 : 컴퓨터통합 외과 시스템 및 기술 공학센터
참여기관 : 카네기멜론대학교, Shadyside Hospital, MIT, Brigham & Women's Hospital

주관기관 : Texas Engineering Exp Sta
과 제 명 : Foundation Engineering Education Coalition
참여기관 : 알라바마대학교, 아리조나주립대학교, rose-Hulman Institute of Technology, 텍사스 A&M 대학교, College Station, 메사추세츠대학교(다트모스), 위스콘신대학교(메디슨), Maricopa Community College District, 텍사스여자대학교, 피츠버그대학교, 텍사스대학교(엘파소), South Dakota Schools of Mines and Technology, Instituto Technologico y de Estudios Superiores de Monterrey(멕시코), Universidade Federal de Sant Catarina(브라질)

라. 재료과학
주관기관 : 시카고대학교
과 제 명 : 재료 과학 및 공학 센터
참여기관 : 시카고 과학기술박물관

주관기관 : 스탠포드대학교
과 제 명 : 폴리머 인터페이스 및 거시분자집합 연구센터
참여기관 : 캘리포니아주립대학교(데이비스), IBM Almaden Research Center

제 2 절 국립표준기술원
(National Institute of Standards and Technology : NIST)[4]

1. 개 관

가. 연혁

국립표준기술원(NIST)은 미상무부(U.S. Department of Commerce : DOC)의 주요부서로서, 1901년 3월 3일 미국립표준국(National Bureau of Standards : NBS)으로 설립되었다. 그 후 1988년 8월 23일 레이건 행정부의 “종합무역 및 경쟁력 제고법”에 의거 NIST로 개편되었는데 특히 1993년 1월 21일 클린턴 행정부의 “국가경쟁력법”에 의거 중소제조기업 지원을 통한 미국 경제의 경쟁력 회복을 주도할 과학기술 개발 및 기술이전의 중추적 국가 연구기관의 임무를 부여받았다.

나. 설립 목적

NIST의 설립목적은 첫째, 미국 산업의 국제경쟁력 향상 촉진, 둘째, 국가표준기관으로서의 전통적 기능 유지 등으로 교역, 기술진보, 제품의 신뢰성 및 제조기술 향상, 공공안전의 기반이 되는 측정, 교정, 품질보증 기술 및 서비스를 제공하는 것이다.

NIST는 이러한 목적을 수행하기 위해 세계시장에서 미국 산업계의 경쟁력 회복과 강화를 위해 미국 산업계의 품질 향상, 제조공정의 첨단화, 제품의 신뢰성・제조능력・기능성・비용효과의 확보와 새로운 과학적 발견에 근거한 제품의 보다 신속한 상업화 촉진에 요구되는 기술 및 공정의 개발에 대한 지원을 담당하고 있다. 이와 함께 국가측정표준의 개발 및 유지, 국가측정표준의 국제적 호환성 확립, 산업계와 정부에 대하여 과학 및 기술적 문제에 관한 자문 등을 하고 있다.

다. 조직

NIST는 8개의 연구소, 기술지원부서, 관리부서로 구성되어 있는데 다른 연방정부소속 연구기관과는 달리 1990년부터 Advanced Technology Program(ATP)을 진행중이다.

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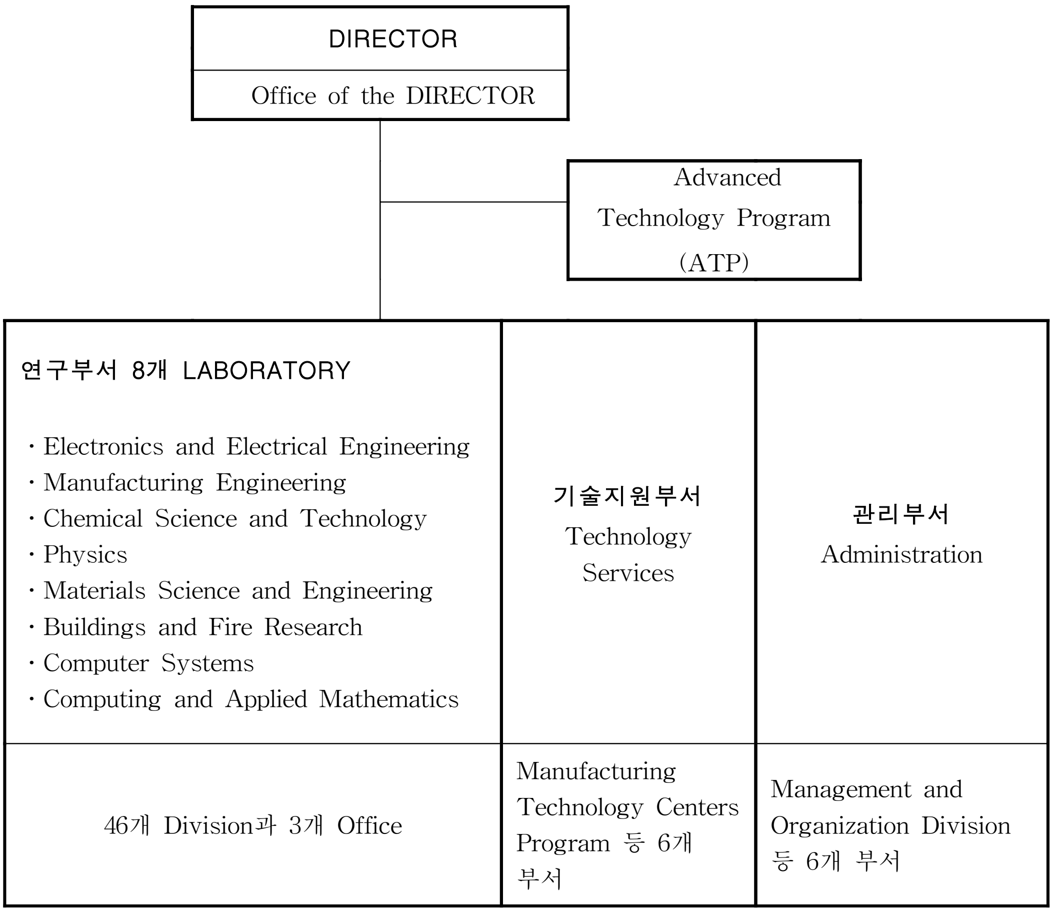
4) http : //www.atp.nist.gov/

<그림 3-1> NIST 조직도



2. Advanced Technology Program(1996-1999) 현황

가. ATP 개요

ATP는 경제적으로 잠재적인 이득이 크나 리스크가 높은 기술의 발전을 가속화하기 위해 1990년부터 민간기업을 지원하고 있다. 1994년 이전까지는 모든 기술영역을 포괄하는 'general competitions'만 지원을 하였으나, 1994년 이후 'focused programs'을 통해 특정 기술영역에 대한 지원을 병행하고 있다.

나. 지원현황

본 보고서가 다룬 1996년부터 1999년까지의 지원과제는 총 187 과제이나 4 과제는 자료가 누락되었다. 따라서 본 보고서에서는 183 과제를 조사분석하고 이들에 대한 개요는 부록에 정리하였다.(부록 2 참조) 연도별 과제수는 다음과 같다.

① 1996년 (총 6개 과제)

- General Competitions : 6개 과제

② 1997년 (총 63개 과제)

- General Competitions : 18개 과제
- Information Infrastructure for Healthcare : 6개 과제
- Component-Based Software : 6개 과제
- Motor Vehicle Manufacturing Technology : 10개 과제
- Digital Data Storage : 1997년 5개 과제
- Technologies for the Integration of Manufacturing Applications : 6개 과제
- Tissue Engineering : 12개 과제

③ 1998년 (총 77개 과제)

- General Competitions : 23개 과제
- Tools for DNA Diagnostics : 7개 과제
- Digital Video in Information Networks : 4개 과제
- Catalysis and Biocatalysis : 4개 과제
- Photonics Manufacturing : 10개 과제
- Premium Power : 13개 과제
- Microelectronics Manufacturing Infrastructure : 9개 과제
- Selective-Membrane Platforms : 5개 과제
- Adaptive Learning Systems : 2개 과제

④ 1999년 (총 37개 과제)

- General Competitions : 37개 과제

다. 지원분야

ATP가 지원하는 기술의 영역은 크게 생명공학(Biotechnology), 제조기술(Manufacturing), 전자/컴퓨터/통신기술(Electronics/Computer Hardware/Communications), 첨단재료 및 화학(Advanced Materials/Chemicals), 정보기술(Information Technology) 등 5개 영역이다. 각 영역은 다음과 같은 세부 분야로 구성되어 있다.

- Biotechnology
  - Animal & Plant Biotechnology
  - Biomolecular & Biomimetic Materials
  - Bioprocessing/Biomedical Engineering
  - Bioinformatics
  - Diagnostic and Therapeutic Biotechnology
  - Marine Biology
  - Other Biotechnology

- Manufacturing(Discrete)
  - Automobile Manufacturing
  - Aircraft Manufacturing
  - Other Transportation Manufacturing
  - Intelligent Control
  - Machine Tools
  - Materials Handling
  - Intelligent Manufacturing
  - Avionics
  - Other Discrete Manufacturing
  - Energy Conversion
  - Energty Generation/Distribution

- Electronics/Computer Hardware/Communications
  - Semiconductors
  - Electronics

- Systems
- Microelectromechanical Technology
- Computer Hardware
- Microelectronic Fabrication Technology
- Communication for Date, Voice, Video
- Electronic Instrumentation/Sensors & Control Systems
- Optics & Photonics
- Other Electronics

• Advanced Materials/Chemicals
  - Abrasives, Adhesives, Ceramics, Coatings, and Composites
  - Computer-Based Design of Chemical/Materials
  - Polymers Synthesis & Polymer Fabrication Technologies
  - Metals & Alloys
  - Building/Construction Materials
  - Other Materials
  - Separation Technology
  - Catalysis/Biocatalysis
  - Food Processing and Preservation
  - Other Continuous Manufacturing
  - Energy Resources/Petroleum
  - Energy Storage/Fuel Cell, Battery/Environmental Technologies

• Information Technology
  - Computer Systems and Software Applications
  - Computer-Aided Design and Testing Systems
  - Imaging & Image Processing
  - Cognitive Systems
  - Pattern Recognition
  - Internet Infrastructure
  - Security & Biometrics

- Other Information/Computers/Entertainment

- Technology Area Not Listed Above

1996년부터 1999년까지 ATP에서 지원한 연구분야는 다음과 같다.

- Abrasives, Adhesives, Ceramics, Coatings, and Composites
- Advanced Materials/Chemicals
- Animal and Plant Biotechnology
- Automobile Manufacturing
- Bioinformatics
- Bioprocessing/Biomedical Engineering
- Catalysis/Biocatalysis
- Computer Hardware
- Computer Systems and Software Applications
- Diagnostic and Therapeutic Biotechnology
- Electronic Instrumentation/Sensors and Control Systems
- Electronics/Computer Hardware/Communications
- Energy Resources/Petroleum
- Energy Resources/Petroleum
- Energy Resources/Petroleum
- Energy Storage/Fuel Cell, Battery
- Imaging and Image Processing
- Information Technology
- Intelligent Manufacturing
- Manufacturing(Discrete)
- Metals and Alloys
- Microelectronic Fabrication Technology
- Optics and Photonics
- Other Continuous Manufacturing(Pulb/Paper, Textiles)
- Other Information/Computers/Entertainment

- Polymers Synthesis & Polymer Fabrication Technologies
- Semiconductors
- Separation Technology

라. 기술분야 및 연도별 ATP 과제 현황

1996년부터 1999년까지 ATP의 지원과제를 기술분야별로 구분하면 <표 3-15>와 같다. 전체 과제 중 생명공학 분야가 54개로 29.5%를 차지하고 있으며 다음으로 첨단재료 및 화학 분야가 41개로 22.4%, 전자/컴퓨터/통신기술 분야가 37개로 20.2%, 정보기술 분야가 34개로 18.6%, 마지막으로 제조기술 분야가 17개로 9.3%의 비중을 차지하고 있다.

대학연구에 초점을 맞춘 NSF의 엔지니어링 분야에서도 알 수 있듯이 산업계에 초점을 맞춘 ATP의 지원과제에 있어서도 생명공학 분야에 대한 비중이 확대되고 있음을 알 수 있다.

마. 기술분야 및 연도별 ATP 지원금 현황

분야별 지원액을 살펴보면 1996년부터 1999년까지 전자/컴퓨터/통신기술 분야에 총 1억5천만 달러(29.2%), 생명공학 분야에 1억2천만 달러(23.2%), 첨단 재료 및 화학 분야에 1억1천6백만 달러, 정보기술 분야에 8천9백만 달러, 제조기술에 3천8백만 달러가 지원되었다.(<표 3-16> 참조) 현재 진행중인 1999년의 경우를 제외하더라도 매년 지원액이 큰 폭으로 증가하고 있음을 알 수 있다.

<표 3-15> 기술분야별 ATP 지원과제 수

기 술 분 야		연도별 과제수				총 계
		96년	97년	98년	99년	
Biotechnology	Animal and Plant Biotechnology		5	3		8
	Bioinformatics		2	1		3
	Bioprocessing/Biomedical Engineering		6	4		10
	Diagnostic and Therapeutic Biotechnology	2	7	10		19
	Biotechnology				14	14
	소계	**2**	**20**	**18**	**14**	**54 (29.5%)**
Manufacturing (Discrete)	Automobile Manufacturing		1	1		2
	Intelligent Control		1			1
	Intelligent Manufacturing			1		1
	Manufacturing(Discrete)		9		4	13
	소계	**0**	**11**	**2**	**4**	**17 (9.3%)**
Electronics/ Computer Hardware/ Communication	Computer Hardware		3			3
	Electronic Instrumentation/Sensors and Control Systems	1	2	2		5
	Microelectronic Fabrication Technology		1	7		8
	Optics and Photonics	1		2		3
	Semiconductors			3		3
	Electronics/Computer Hardware/Communications			8	7	15
	소계	**2**	**6**	**22**	**7**	**37 (20.2%)**
Advanced Materials/ Chemicals	Abrasives, Adhesives, Ceramics, Coatings, and Composites	1		3		4
	Catalysis/Biocatalysis		1	3		4+
	Energy Resources/Petroleum			3		3
	Energy Storage/Fuel Cell, Battery			10		10
	Environmental Technologies		1			1
	Metals and Alloys			1		1
	Polymers Synthesis & Polymer Fabrication Technologies			2		2
	Separation Technology	1		6		7
	Other Continuous Manufacturing(Pulb/Paper, Textiles)		1			1
	Advanced Materials/Chemicals		2		6	8
	소계	**2**	**5**	**28**	**6**	**41 (22.4%)**
Information Technology	Computer Systems and Software Applications		4	2		6
	Imaging and Image Processing			1		1
	Other Information/Computers/Entertainment		1	4		5
	Information Technology		16		6	22
	소계	**0**	**21**	**7**	**6**	**34 (18.6%)**
합계		**6**	**63**	**77**	**37**	**183**

<표 3-16> 기술분야별 ATP 지원액(단위 : $)

기술분야		연도별 지원금				총계
		96년	97년	98년	99년	
Biotechnology	Animal and Plant Biotechnology		11,198,404	5,361,542		16,559,946
	Bioinformatics		3,974,693	1,642,000		5,616,693
	Bioprocessing/Biomedical Engineering		11,318,500	6,782,123		18,100,623
	Diagnostic and Therapeutic Biotechnology	4,000,000	13,407,677	32,592,246		49,999,923
	Biotechnology				29288773	29288773
	소계	**4,000,000**	**39,899,274**	**46,377,911**	**29,288,773**	**119,565,958 (23.2%)**
Manufacturing (Discrete)	Automobile Manufacturing		1,998,782	3,000,000		4,998,782
	Intelligent Control		1,997,150			1,997,150
	Intelligent Manufacturing			1,378,908		1,378,908
	Manufacturing(Discrete)		19,693,841		10,395,540	30,089,381
	소계		**23,689,773**	**4,378,908**	**10,395,540**	**38,464,221 (7.5%)**
Electronics/ Computer Hardware/ Communication	Computer Hardware		16,521,923			16,521,923
	Electronic Instrumentation/Sensors and Control Systems	5,958,748	2,601,998	10,444,578		19,005,324
	Microelectronic Fabrication Technology		1,297,677	49,798,714		51,096,391
	Optics and Photonics	1,800,000		4,736,781		6,536,781
	Semiconductors			5,395,597		5,395,597
	Electronics/Computer Hardware/Communications			36,321,166	15,259,987	51,581,153
	소계	**7,758,748**	**20,421,598**	**106,696,836**	**15,259,987**	**150,137,169 (29.2%)**
Advanced Materials/ Chemicals	Abrasives, Adhesives, Ceramics, Coatings, and Composites	687,283		5,050,482		5,737,765
	Catalysis/Biocatalysis		1,722,200	6,327,106		8,049,306
	Energy Resources/Petroleum			6,252,942		6,252,942
	Energy Storage/Fuel Cell, Battery			26,391,437		26,391,437
	Environmental Technologies		1,367,714			1,367,714
	Metals and Alloys			1,769,428		1,769,428
	Polymers Synthesis & Polymer Fabrication Technologies			3,909,832		3,909,832
	Separation Technology	2,000,000		11,671,027		13,671,027
	Other Continuous Manufacturing(Pulb/Paper, Textiles)		1,979,777			1,979,777
	Advanced Materials/Chemicals		15,963,080		31,771,346	47,734,426
	소계	**2,687,283**	**21,032,771**	**61,372,254**	**31,771,346**	**116,863,654 (22.7%)**
Information Technology	Computer Systems and Software Applications		6,353,944	3,877,800		10,231,744
	Imaging and Image Processing			1,569,999		1,569,999
	Other Information/Computers/Entertainment		1,859,669	7,006,286		8,865,955
	Information Technology		45,649,785		23,162,996	68,812,781
	소계		**53,863,398**	**12,454,085**	**23,162,996**	**89,480,479 (17.4%)**
합계		**14,446,031**	**158,906,814**	**231,279,995**	**109,878,642**	**514,511,482**

3. 분야별 NIST 협력기관 및 협력과제

생명공학 10개, 제조기술 10개, 전자 · 컴퓨터 · 통신기술 11개, 첨단재료 및 화학 10개, 정보기술 10개 등 총 51개 협력과제의 연구기관 및 연구과제는 다음과 같다.

가. 생명공학(Biotechnology)

○ 주관기관 : Isis Pharmaceuticals
과 제 명 : 약품 발견을 위한 신전략
참여기관 : 캘리포니아주립대학교(샌디아고, 어빈), Protogene(Palo Alto), IonSpec(Irvine)

○ 주관기관 : Automated Cell Technologies, Inc.
과 제 명 : 조합세포양식 : 도구개발 및 인간세포성장에 대한 응용
참여기관 : 피츠버그의대, 카네기멜론대학교

○ 주관기관 : Ethicon, Inc. (Johnson & Johnson)
과 제 명 : 생물조직 공학을 위한 3차원 섬유질 골격
참여기관 : 엘러게이니대학병원, Drexel 대학교, Applied Product Development, Inc.(Bristol)

○ 주관기관 : Kent SeaTech Corporation
과 제 명 : Superfingerlings : 농업사용을 위한 첨단 생명공학기술, 유전자조작 및 동물경작 기법의 개발
참여기관 : 캘리포니아주립대학교(샌디아고), 코네티컷대학교(Storrs), 북캐롤라이나주립대학교(Raleigh), Institut de Biologie Moleculaire et Cellulaire(프랑스)

○ 주관기관 : PE-Biosystems (formerly Perkin-Elmer)
과 제 명 : 유전자분석을 위한 마이크로샘플 조제시스템
참여기관 : 3M BioSystems(St. Paul.), Monsanto(St. Louis), Millennium Pharmaceuticals, Inc.(Cambridge)

○ 주관기관 : Tissue Engineered Heart Valve Prostheses
과 제 명 : Tissue를 이용한 심장판막 보철물
참여기관 : 미네소타대학교(Minneapolis), 피츠버그대학교(Pittsburgh), 위싱턴 대학교(시애틀)

○ 주관기관 : THM Biomedical, Inc.
과 제 명 : 관절연골 교정 및 재생을 위한 3차원 폴리머 주입
참여기관 : Hospital for Joint Diseases Orthopaedic Institute(New York), Malcolm and Dorothy Coutts Institute for Joint Reconstruction and Research(San Diego)

○ 주관기관 : CytImmune Sciences Inc.
과 제 명 : Colloidal Gold as a Targeted Drug/Gene Delivery System
참여기관 : National Cancer Institute(Bethesda), EntreMed, Inc.(Rockville)

○ 주관기관 : Reprogenesis, Inc.
과 제 명 : Perivascular Endothelial Cell Implants 개발
참여기관 : 하버드/MIT Biomedical Engineering Center(Cambridge)

○ 주관기관 : Cell Based Delivery, Inc.
과 제 명 : BioArtificial Muscle Implants For Sustained Protein Delivery
참여기관 : 브라운대학교, Rhode Island Hospital, Miriam Hospital

나. 제조기술(Manufacturing)

○ 주관기관 : Superior Graphite Company, Inc.
과 제 명 : A Non-intrusive Method for Intelligent Process Control of the Densification of Powder Preforms During Electroconsolidation
참여기관 : Bio-Imaging Research Inc., Argonne National Laboratory, 노스웨스턴대학교

○ 주관기관 : Lamb Technicon Machining Systems
과 제 명 : 차세대 Agile Fixturing System

참여기관 : Chrysler, Ford, General Motors

○ 주관기관 : Automated Powertrain Assembly Consortium)
과 제 명 : Flexible Robotic Assembly for Powertrain Applications (FRAPA)
참여기관 : Ford Motor Company, Perceptron Inc.(Plymouth), Progressive Tool and Industries Company(Southfield), MicroDexterity Systems (Memphis), National Center for Manufacturing Sciences(Ann Arbor)

○ 주관기관 : Stewart Automotive Research, LLC
과 제 명 : Low Cycle Time Liquid Molding Process for Automotive Structural Components
참여기관 : Computational Mechanics Co., 라이스대학교

○ 주관기관 : Cummins Engine Company
과 제 명 : Sub-Micron Precision Grinding of Advanced Engineering Materials
참여기관 : Goldcrown Machinery(Cincinnati), Cincinnati Milacron(Cincinnati)

○ 주관기관 : Sanders Prototype, Inc.
과 제 명 : Motor Vehicle Rapid Toolmaker
참여기관 : 미시간대학교, 펜실바니아주립대학교

○ 주관기관 : Montronix, Inc.
과 제 명 : 차세대 Intelligent Monitoring System
참여기관 : 일리노이대학교(Urbana/Champaign)

○ 주관기관 : STEP Tools, Inc.
과 제 명 : Model Driven Intelligent Control Of Manufacturing
참여기관 : Allied Signal(Kansas City), Bridgeport Machines, Inc.(Bristol), Center for Automation Technologies at RPI(Troy)

○ 주관기관 : SunPower Corporation
과 제 명 : Photovoltaic Micro-Concentrator Systems
참여기관 : Institute of Solar Energy at the Polytechnic University of

Madrid(스페인), Advanced Thermal Systems

○ 주관기관 : Rechargeable Battery Corporation
과 제 명 : 고성능 재충전 알칼리 전지
참여기관 : Yardney Technical Products, Superior Graphite Co., 텍사스대학교(Austin), Lawrence Berkeley National Laboratories(Berkeley)

다. 전자/컴퓨터/통신기술(Electronics/Computer Hardware/Communications)

○ 주관기관 : National Storage Industry Consortium (NSIC)
과 제 명 : Multiple Optical Recording Enhancements (MORE)
참여기관 : Calimetrics, Inc., Energy Conversion Devices, Inc., Polaroid Corporation

○ 주관기관 : Wilcoxon Research, Inc.
과 제 명 : Smart Piezoelectric-Based MEMS Accelerometers with Wireless Interface for Industrial Applications
참여기관 : 펜실바니아주립대학교(University Park)

○ 주관기관 : Lightwave Microsystems
과 제 명 : 저비용 WDM Devices and Systems를 위한 광학 폴리머 및 제조공정
참여기관 : 알라바마대학교(Birmingham), 켄트주립대학교(Kent)

○ 주관기관 : SDL, Inc.
과 제 명 : 포토닉스 제조를 위한 첨단 공정
참여기관 : Adept Technology, Inc.(San Jose), RSoft, Inc.(Ossining), Newport Corp.(Irvine)

○ 주관기관 : Motorola, Inc.
과 제 명 : Wafer-Scale Applied Reworkable Fluxing Underfill for Direct Chip Attach
참여기관 : Jabil Circuit(San Jose), Loctite Corp.(Rocky Hill), 어번대학교, 코넬대학교

○ 주관기관 : Epion Corporation
과 제 명 : 차세대 반도체 장비를 위한 가스-클러스터 이온-빔 제조기법
참여기관 : SEMATECH(Austin), 텍사스대학교(Austin), 북캐롤라이나주립대학교, 휴스턴대학교

○ 주관기관 : National Semiconductor Corporation
과 제 명 : Novel High-Performance Wafer-Level Reworkable Underfill Materials for Flip-Chip Packaging
참여기관 : National Starch and Chemical(Bridgewater)

○ 주관기관 : Picolight Incorporated
과 제 명 : Ultra-Compact Packaging Technology For Telemedicine, Telecommunications And Next Generation I/O (NGIO)
참여기관 : 남가주대학교(LA), Digital Optics Corp.(Charlotte), 알라바마대학교 (Birmingham)

○ 주관기관 : ATMI, Inc.
과 제 명 : Integrated MEMS Reactor Gas Monitor Utilizing Novel Thin Film Chemistry For The Closed Loop Process Control And Optimization Of Plasma Etch And Clean Reactions In The Manufacturing Of Microelectronics
참여기관 : MIT, IntelliSense Corp.(Wilmington)

○ 주관기관 : Ion Optics, Inc.
과 제 명 : MEMS에 기반한 적외선 마이크로 센서
참여기관 : 캘리포니아공대

○ 주관기관 : General Electric Company Corporate Research and Development
과 제 명 : Bulk GaN And Homoepitaxial Device Manufacturing
참여기관 : 코넬대학교

라. 첨단재료 및 화학(Advanced Materials/Chemicals)

○ 주관기관 : Ovonic Battery Company (ECD)
과 제 명 : 첨단 마그네슘 합금 제조공정
참여기관 : Oak Ridge National Laboratory, Colorado School of Mines, 로와주립대학교

○ 주관기관 : Seaward International, Inc.
과 제 명 : 복합 철도 침목
참여기관 : 조지아공대, Norfolk Southern Corp.(Roanoke)

○ 주관기관 : Ebert Composites Corporation
과 제 명 : 3차원 섬유침전 공정 : The Development of Near-Isotropic Composite Bar Stock
참여기관 : W. Brandt Goldsworthy & Associates, Inc.(Torrance), Cincinnati Milicron(Cincinnati), 캘리포니아주립대학교(San Diego)

○ 주관기관 : PowerStor Corporation
과 제 명 : 고전압 · 저임피던스 Aerogel Ultracapacitor
참여기관 : Ocellus, Inc.(Alameda), Covalent Associates Incorporated(Woburn), Rockwell Science Center(Thousand Oaks)

○ 주관기관 : US Nanocorp, Inc.
과 제 명 : Nanostructured Active Materials에 기반한 비대칭 Supercapacitor
참여기관 : JME, Inc.(Shaker Heights), Florida Atlantic University(Boca Raton), Eveready Battery Co.(Westlake)

○ 주관기관 : Maxwell Energy Products, Inc.
과 제 명 : Advanced Materials and Processes for Cost-Effective High-Power Ultracapacitor Modules
참여기관 : Sandia National Laboratories, Tennessee Center for Research and Development(Knoxville)

○ 주관기관 : Ultralife Batteries, Inc.

과 제 명 : 첨단 리듐 고체폴리머 전지 개발
참여기관 : Eagle-Picher Industries, Inc.(Joplin), Lockheed Martin Missiles & Space Co.(Sunnyvale), Sandia National Laboratories

○ 주관기관 : Praxair, Inc.
과 제 명 : High-Temperature Hydrogen Selective Membrane Platforms
참여기관 : Innovative Membrane Systems, Inc.(Norwood.), Walter Juda Associates (Needham,), 터프대학교(Medford),

○ 주관기관 : Praxair, Inc.
과 제 명 : Facilitated Transport Membrane Platforms
참여기관 : Innovative Membrane Systems(Norwood), 뉴멕시코대학교 (Albuquerque), 뉴욕주립대학교(Buffalo).

○ 주관기관 : Engelhard Corporation
과 제 명 : Application Of Molecular Gate Technology To Oxygen Enrichment Of Air Streams And Simplified Purification Of Natural Gas
참여기관 : 클레버랜드주립대학교(Cleveland), 남알라바마대학교(Mobile), 메사추세츠대학교(Amherst)

마. 정보기술(Information Technology)

○ 주관기관 : Athena Group, Inc.
과 제 명 : 디지틀 신호처리를 위한 고성능 ASIC 기술
참여기관 : VLSI Technology Inc.(San Jose)

○ 주관기관 : CHIME-Inc.
과 제 명 : RxInfo : Data Mining Tools for Assessing the Impact of Pharmaceutical Therapies on Population Based Healthcare Outcomes
참여기관 : 예일대학교

○ 주관기관 : Searle
과 제 명 : Virtual Reality Telecollaborative Integrated Manufacturing Environment (VRTIME)
참여기관 : 일리노이대학교(시카고)

○ 주관기관 : Advanced Micro Devices
과 제 명 : Agent-Enhanced Manufacturing System Initiative
참여기관 : ObjectSpace Inc.(Austin)

○ 주관기관 : Commerce One, Inc.
과 제 명 : Component-Based Commerce : The Interoperable Future
참여기관 : BusinessBots(San Francisco), CommerceNet(Palo Alto), Tesserae Information Systems, Inc.(Palo Alto)

○ 주관기관 : Language Systems, Inc.
과 제 명 : A Spoken-Language Forms Translator for Information Transactions
참여기관 : Eloquent Technology, Inc.(Ithaca, N.Y.), 남가주대학교(LA)

○ 주관기관 : DemoGraFX
과 제 명 : Integrated Layered Compression System Prototype
참여기관 : Mercury Computer(Chelmsford)

○ 주관기관 : General Electric Corporate R & D
과 제 명 : 디지틀 TV 방송의 수신율 개선
참여기관 : NBC, Thomcast Communications, Inc.(Southwick), Thomson Consumer Electronics(Indianapolis)

○ 주관기관 : College.com (formerly Real Education)
과 제 명 : Real Adaptive Intelligent Learning Systems (RAILS)
참여기관 : Thomas K. Landauer Usability, Inc.(Boulder)

○ 주관기관 : Ohio Aerospace Institute
과 제 명 : The Federated Intelligent Product Environment (FIPER)

참여기관 : BFGoodrich Aerospace Aerostructures Group(Chula Vista), Engineous Software, Inc.(Morrisville), General Electric Aircraft Engines(Cincinnati), GE Corporate Research and Development(Niskayuna), 오하이오대학교(Athens), Parker Hannifin Corp.(Mentor)

제 3 절 일본 이화학연구소(RIKEN)[5)]

1. 개 관

가. 소 속

창조적인 첨단 연구와 기초 및 응용 부문의 균형적인 연구를 목적으로 하는 일본 이화학연구소(RIKEN)는 일본과학기술부(STA)의 지원을 받는 대표적인 비영리 연구기관 중의 하나이다.

나. 연혁

1917년 RIKEN의 전신인 민간 과학재단이 설립되었다. 1948년 3월, 2차대전의 종전과 함께 운영이 중단되고 KAKEN(Scienctific Research Institute Ltd.)으로 재조직되었는데 1958년 비영리조직으로 전환하였다. RIKEN은 1966년에서 1976년까지 모든 시설을 도쿄에서 사이타마(Saitama)로 이전하였고, 1984년 쯔구바에 분소를 설립하였으며 1986년 Frontier Research Program을 착수하였다.

다. 조직

RIKEN은 물리, 화학, 엔지니어링, 생물학 분야의 약 50개 연구소와 지원 기관으로 구성되어 있으며, 필요시에 RIKEN은 학제적 성격이 강한 연구의 경우 그룹연구소(group laboratories)를 조직한다. 1986년부터는 미래지향적인 21세기 과학기술 부문의 기초 연구를 위해 Frontier Research Program을 운영하고 있고, 1992년부

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5) http : //www.riken.go.jp/eng/index.html

터는 연구소의 프로그램 및 관리 시스템을 평가하기 위해 세계의 저명한 과학자로 구성된 자문위원회(RIKEN Advisory Council : RAC)를 운영하고 있다.

<표 3-17> RIKEN의 조직도

President, Executive Directors		
Wako	Planning Office	
	General Affairs Div.	Public Relations Sec. General Affairs Sec. Documentation Sec. Welfare Sec. Personnel Sec.
	Finance Div.	Account Sec. Financial Sec.
	Finance Div.	Account Sec. Financial Sec
	Research Administration Div.	Research Coordination Sec. Patent Sec. Library and Publication Sec. Dissemination Sec.
	Facilities and Utilities Div.	Facility Sec. Construction Sec.
	International Cooperation Center	
	Contract Management Div.	Planning Sec. General Affairs Sec.
	Div. of SPring-8 Project Strage	Ring R&D Sec. Beam Line R&D Sec.
	Safety Center	
	Dept. of Microbial Systematics and Culture Collection	Div. of Culture Collection Div. of Microbial Systematics
	Dept. of Research Fundamentals Tech.	Div. of Research Instruments Development Div. of Extreme Conditions Engineering Div. of Super Sensors Engineering Div. of Surface Characterization Div. of Molecular Characterization Div. of Chemical Analysis Div. of Biomolecular Characterization Div. of Laboratory Animal Research Div. of Radioisotope Technology
	Computer Imformation Center	
	Institute Laboratories (49)	
	Frontier Research Program	
	Brain Science Institute	
Tsukuba Life Science Center	Life Science Promotion Div.	General Affairs Sec. Research Planning Sec. Finance Sec
	Institute Laboratories (6)	
	Div. of Experimental Animal Research	
	RIKEN GENE BANK	

2. 분야별 RIKEN 협력과제

RIKEN의 협력과제는 물리 및 재료 15개, 생명과학 22개, 화학 8개, 정보과학 2개 등 총 47개이며 개별 협력과제의 연구주제는 다음과 같다.

가. 물리 및 재료 : 15개

○ 기 관 명 : Atomic Physics Laboratory(원자물리연구실)
연구주제 : 원자, 분자, 클러스터, 표면, 크리스탈과 multiply charged ions의 상호작용 / antiprotonic atoms과 antihydrogen의 생산과 분광

○ 기 관 명 : Cosmic Radiation Laboratory(우주방사선연구실)
연구주제 : 고에너지 과도전류 실험 / X-ray 원천의 실측 연구

○ 기 관 명 : Cyclotron Laboratory(사이클로트론연구실)
연구주제 : Accelerator Physics / 핵물리학 실험 및 이론 연구

○ 기 관 명 : Laser Technology Laboratory(레이저기술연구실)
연구주제 : 초단파 고강도 레이저 기술 / Coherent Soft-X-ray 방출

○ 기 관 명 : Linear Accelerator Laboratory(선형가속기연구실)
연구주제 : Nuclei Far from the Stability의 구조 / 핵 천체물리학 / Cluster Formation after the Heavy-Ion Collisions

○ 기 관 명 : Magnetic Materials Laboratory(자성물질연구실)
연구주제 : Magnetic Phase Transitions의 실험 연구 / Magnetic Materials by Means of X-ray and g-ray Spectroscopes 연구

○ 기 관 명 : Materials Fabrication Laboratory(재료조합연구실)
연구주제 : 신공정기술 개발 / elasto-plastic solids의 역학 및 수치 모델링

○ 기 관 명 : Microwave Physics Laboratory(극초단파물리학연구실)
연구주제 : Coherent Nonlinear Optics의 응용 / 고분해 및 고감도 레이저 / Coherent X-Ray Optics

○ 기 관 명 : Muon Science Laboratory(중간자연구실)
연구주제 : Construction of a new muon facility at ISIS/RAL and development of new muon science program.

○ 기 관 명 : Optical Engineering Laboratory(광공학연구실)
연구주제 : Interferometry / Speckle 계측학 / 실시간 이미지 처리 및 홀로그래피

○ 기 관 명 : Plasma Physics Laboratory(플라즈마연구실)
연구주제 : Accelerator Physics과 관련 기술 / 플라즈마 물리학 및 처리의 기초 연구

○ 기 관 명 : Radiation Laboratory(방사연구실)
연구주제 : 핵물리학, Radiation Science

○ 기 관 명 : Semiconductors Laboratory(반도체연구실)
연구주제 : 영자구조의 신조합기법의 개발

○ 기 관 명 : Surface and Interface Laboratory(표면 및 계면 연구실)
연구주제 : Solid Surfaces and Interfaces의 물리 및 화학적 성질

○ 기 관 명 : Synchrotrons Radiation Center(SPring-8 Project)(싱크로트론방사센터)
연구주제 : high brilliance X-ray storage ring의 설계와 개발 / accelerator physics 발전

나. 생명과학 : 22개

○ 기 관 명 : Antibiotics Laboratory(항생물질연구실)
연구주제 : Screening of novel bioprobes / Chemistry and biology of bioprobes

○ 기 관 명 : Animal and Cellular Systems Laboratory(동물 및 세포시스템연구실)
연구주제 : 당단백질의 Intracellular Translocation / 당단백질의 기능

○ 기 관 명 : Biochemical Systems Laboratory(생화학연구실)
연구주제 : Bioprocess Engineering, 게놈 분석, 로보틱스

○ 기 관 명 : Bioorganic Chemistry Laboratory(생물유기화학연구실)
연구주제 : Action mechanism of cytokines with multiple functions

○ 기 관 명 : Biophysical Chemistry Laboratory(생물물리화학연구실)
연구주제 : Structure and Function of Hemoproteins

○ 기 관 명 : Biophysics Laboratory(생물물리학연구실)
연구주제 : 생물 거대분자의 구조와 기능간의 관계

○ 기 관 명 : Biopolymer Physics Laboratory(바이오폴리머연구실)
연구주제 : Organic Thin Films / 강유전체 폴리머

○ 기 관 명 : Cellular and Molecular Biology Laboratory(세포 및 분자생물학연구실)
연구주제 : 이체동형 유전자 결합의 분자메커니즘과 유전자조정

○ 기 관 명 : Cellular Physiology Laboratory(세포생리학연구실)
연구주제 : 염색체 복제 메커니즘 / Cell Cycle Regulation,

○ 기 관 명 : Cellular Signaling Laboratory(세포신호전달연구실)
연구주제 : Stable Isotope-labeling Multidimensional NMR Spectroscopic Studies on Proteins

○ 기 관 명 : Genome Science Laboratory(게놈과학종합연구센터)
연구주제 : Development of High Speed Technology for Genome Analysis / RLGS-based Technique을 사용한 Functional Gene의 탐색

○ 기 관 명 : Microbial Toxicology Laboratory(미생물독성연구실)
연구주제 : Studies on Regulation of Genes in Plant-Pathogen Interaction

○ 기 관 명 : Microbiology Laboratory(미생물학연구실)
연구주제 : Microbial and Molecular Studies on Microbes under Extreme Conditions

○ 기 관 명 : Molecular Cell Science Laboratory(분자세포학연구실)
연구주제 : Friend virus / Studies on cytokine receptor-mediated signal transduction

○ 기 관 명 : Molecular Entomology and Baculovirology Laboratory(곤충분자생물학 및 간상체바이러스학연구실)
연구주제 : Molecular mechanisms of baculovirus replication in insect cells

○ 기 관 명 : Molecular Genetics Laboratory(분자유전학연구실)
연구주제 : Nuclear Oncogene Products and Supressor Oncogene Product as a Transcriptinal Regulator

○ 기 관 명 : Molecular Membrane Biology Laboratory(세포생물학연구실)
연구주제 : Functions of Small GTPases in the Secretory Pathway -- Sar/Arf and Rab/Ypt Families

○ 기 관 명 : Molecular Oncology Laboratory(종양학연구실)
연구주제 : 종양 및 종양억제 유전자의 생리적 기능

○ 기 관 명 : Molecular Photochemistry Laboratory(분자광화학연구실)
연구주제 : Magnetic Field Effects on Chemical Reactions in Condensed Phases,

○ 기 관 명 : Plant Molecular Biology Laboratory(식물분자생물학연구실)
연구주제 : Functional analysis of plant genes induced by drought stress

○ 기 관 명 : Regulation of Plant Functions Laboratory(식물기능통제연구실)
연구주제 : Regulatory Mechanisms of Plant Functions / Survey of New Plant Functions

○ 기 관 명 : Synthetic Cellular Chemistry Laboratory(합성세포화학연구실)
연구주제 : Reconstruction of Functional Domains of Glycoconjugates

다. 화학 : 8개

○ 기 관 명 : Applied Laser Chemistry Laboratory(응용레이저화학연구실)
연구주제 : Applied cluster science / Laser isotope separation of nranium and silicon

○ 기 관 명 : Chemical Dynamics Laboratory(화학다이너믹스연구실)
연구주제 : Chemical Dynamics of Photoreactions 연구

○ 기 관 명 : Inorganic Chemical Laboratory(무기화학연구실)
연구주제 : Excited Atoms and Molecules의 레이저 분광학

○ 기 관 명 : Nuclear Chemistry Laboratory(핵화학연구실)
연구주제 : Multitracer Technique의 개발과 응용

○ 기 관 명 : Organometallic Chemistry Laboratory(유기금속화학연구실)
연구주제 : Ruthenium catalyzed transformations of alkynes and alkenes and their mechanisms.

○ 기 관 명 : Polymer Chemistry Laboratory(고분자화학연구실)
연구주제 : Polyesters의 생합성과 유전공학, ② Depolymerases 효소의 기능과 속성

○ 기 관 명 : Surface Chemistry Laboratory(표면화학연구실)
연구주제 : Solid Surfaces의 화학공정에 대한 기초연구

○ 기 관 명 : Synthetic Organic Chemistry Laboratory(합성유기화학연구실)
연구주제 : Development of New Synthetic Methods and Strategies

라. 정보과학 : 2개

○ 기 관 명 : Computational Science Laboratory(컴퓨터과학연구실)
연구주제 : Large Scale Numerical Simulations with the Vector-Parallel Super-Computer, VPP-500.

○ 기 관 명 : Information Science Laboratory(정보과학연구실)
연구주제 : 뇌에서의 정보처리에 대한 연구

제 4 절 독일 프라운호퍼 연구협회 (The Fraunhofer-Gesellschaft)[6]

1. 개 관

가. 연 혁

독일의 공공연구기관인 프라운호퍼는 1949년 3월 26일, 2차 대전후 황폐화된 독일의 재건을 목표로 1949년 뮨헨에 설립된 응용연구분야의 선두조직으로서 국내에 47개 연구소, 미국에 5개 연구자원센터, 아시아에 3개의 지사를 두고 있다.

독일 국방부는 1963년 프라운호퍼를 자율적인 독립된 연구소로 인정하였고, 독일 과학기술처는 1960년 중반 과학 기술 관련 연구소들을 독립적인 연구소로 인정하게 되었다. 1973년 독일 정부가 내린 결정으로 프라운호퍼 연구소들은 계약제 연구를 우선으로 하되 기본 연구에 필요한 연구비는 사회 기관에서 보조받을 수 있다는 '프라운호퍼 모델'이 정착되었다.

나. 설립 목적

프라운호퍼의 연구는 기본적으로 상업적 성공을 위한 연구(산・연협동)[7]를 지향하며 정보의 확산을 촉진한다. 이를 위해 프라운호퍼 연구소를 모든 기업이 외부의 연구기관 혹은 실험실 및 컨설턴트로서 이용할 수 있도록 하고 있다.

다. 주요 연구활동

중소기업에 대한 일일자문, 회사직원 교육, 타당성연구(feasibility research), 동향분석, 공동저술 등 다양한 방법으로 지원활동을 펴고 있다. 프라운호퍼 연구원의 평균연령은 37세이다. 연구 경력이 5~8년 되면 연구원의 다수가 기업체, 정부의 간

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6) http : //www.fhg.de/english.html. 프라운호퍼(1787~1826)는 연구가, 발명가, 기업가로서 유리 용해기술을 발명하고 정밀광학기기 제조 등에서 큰 업적을 남긴 인물로 연구소의 명칭은 그의 이름을 따서 'guiding light'라는 의미로 불리게 되었다.

7) 막스플랑크연구회가 순수기초연구, 헬름호르츠 대형연구센터가 문제 지향적 및 목표 지향적 기초연구, 블루리스트연구기관이 과업 지향적 연구와 인문과학연구 그리고 독일연구협회가 공공연구와 기업간의 협력을 구체적인 프로젝트의 형태로 지원하는 업무를 담당하고 있는 반면 프라운호퍼연구회는 응용연구 및 산업연구를 담당하고 있다.

부직으로 이동하게 되며 “전문가 자신의 이동에 의한 전문성 이전(Transfer of expertise through experts themselves)”으로 자연스럽게 기술이전이 이루어진다. 1971년~1990년 사이에 180명의 과학자중 2/5는 기업체 고위간부, 1/5은 제조회사 집행위원, 1/10은 대학교수, 회사창업, 컨설팅회사 사장으로 이동하여 근무하고 있다. 한편, 기업에 대한 지원 이외에도 프라운호퍼는 정부와 밀접한 접촉을 통해 신기술개발에 대한 영향평가는 물론 연방의회 기술평가단에도 자문하고 있다.

라. 조직

1999년 현재 프라운호퍼는 47개의 연구소와 9,000여명의 연구인력을 보유하고 있다.

<표 3-18> 분야별 연구소 현황

연구분야	산하 연구기관
소재기술・부품	LBF(부재강도연구소) / FEP(전자빔・플라즈마연구소) / IFAM(응용재료연구소) / WKI(목재연구그룹 「빌헬름・글라우디츠연구소」) / IKTS(세라믹기술・소결재료연구소) / EMI(나노세컨드물리연구소) / ILT(레이저기술연구소) / IST(층표면기술연구소) / ISC(규소연구소) / IWM(가공소재역학연구소) / IWS(소재물리・층기술연구소)
제품기술・제조공학	IFF(공장경영자동화연구소) / IML(로지스틱연구소) / IPK(생산설비설계연구소) / IPA(생산기술자동화연구소) / IPT(생산기술연구소) / TEG(기술개발그룹) / IWU(공작기계프레스기술연구소)
정보・통신기술	IAO(노동경제조직연구소) / IESE(실험소프트웨어공학연구소) / IGD(화상처리연구소) / IITB(정보처리연구소) / ISST(소프트웨어・시스템연구소)
반도체・마이크로 시스템기술	IAF(응용고체물리연구소) / IFT(고체기술연구소) / IIS(집적회로연구소) / IMS(전자회로시스템연구소) / ISIT(실리콘기술연구소) / IZM(전자부품신뢰성연구소)
센서시스템・검증기술	IOF(응용광학정밀기계연구소) / IBMT(바이오메디칼기술연구소) / IPM(물리측정연구소) / IZFP(비파괴검사기술연구소)
프로세스기술	IAP(응용폴리머연구소) / ICT(화학기술연구소) / IGB(계면바이오프로세스연구소) / UMSICHT(환경・안전・에너지기술연구소) / IVV(식품・기호연구소)
에너지 및 건축기술・환경 및 의료연구	IFU(대기환경연구소) / IBP(건축기술연구소) / ISE(태양에너지시스템연구소) / ITA(독성학에어로졸연구소) / ATU(독물학・환경의학연구소) / IUCT(환경과학・독성학연구소)
기술 및 경제연구・정보이전	IRB(도시계획건축정보센터) / INT(자연과학・기술트렌드연구소) / PST(특허센터) / ISI(시스템기술이노베인션연구소) / FhM(연구회경영)

마. 연구예산 및 인력

독일 연방정부의 연구개발비는 최근 2년간 약 8% 감소하여 98년에는 162억 마르크 정도였는데, 이러한 감소는 연구개발비를 억제 한다기 보다는 국방연구비 감소와 민간기업에 대한 기관조성금제도 폐지 등이 주된 원인이다. 그 대신 정보기술, 생명과학, 환경분야의 연구개발비는 향후 연평균 7% 증가할 예정으로 알려져 있다.

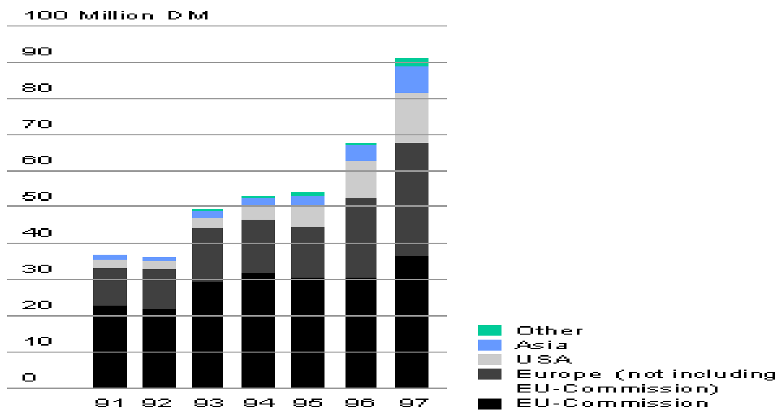
이러한 맥락에서 정보기술 관련 응용 분야 연구를 담당하고 있는 프라운호퍼 연구회 역시 매년 연구 예산의 증가로 98년 약 13억 마르크에서 99년 연구사업 예산은 47개 연구소 운영에 약 14억 마르크가 책정되었다.

본 연구 예산 총액에서 정부의 기관 지원금이 차지하는 비율은 40%로서 나머지 60%는 기업 보조금, 공공부분관련 위탁연구비 및 프로젝트 지원금 등으로 충당되고 있으며, 기관 지원금에 있어서는 전체 지원금의 90%는 연방정부의 교육과학연구기술부(BMBF)가, 10%는 주정부가 부담하고 있다. 특히 1997년 산업계의 계약 중에서 50%는 중소기업으로부터 이루어졌다.

위탁연구에 의한 수입은 매년 6~10%의 비율로 증가하여 98년 수입은 97년 6억8천만 마르크에서 6% 증가한 약 7억 2천만 마르크에 달했다. 이 수입의 상당수는 민간기업으로부터의 수탁연구 증가에 기인한 것으로 정부의 프로젝트 지원금을 크게 초과하고 있으며 민간기업의 경우 500인 이하 규모의 중소기업으로부터 받은 연구개발 위탁 건수가 전체 2/3에 달했다.

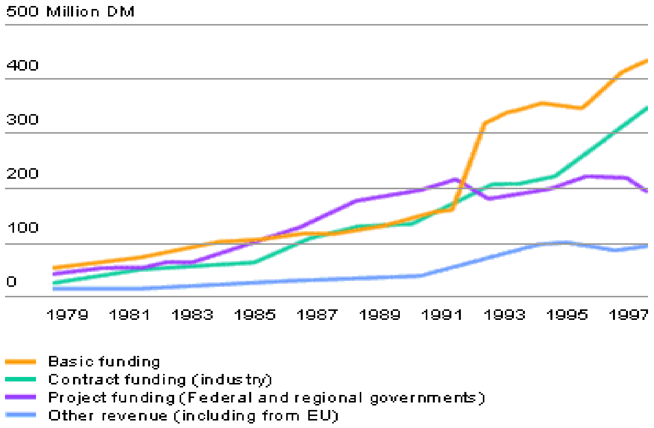
해외로부터의 수익은 1997년 9천만 마르크로 점차 증가하고 있는 추세이다.(<그림 3-2> 참조)

<그림 3-2> 해외로부터의 수익



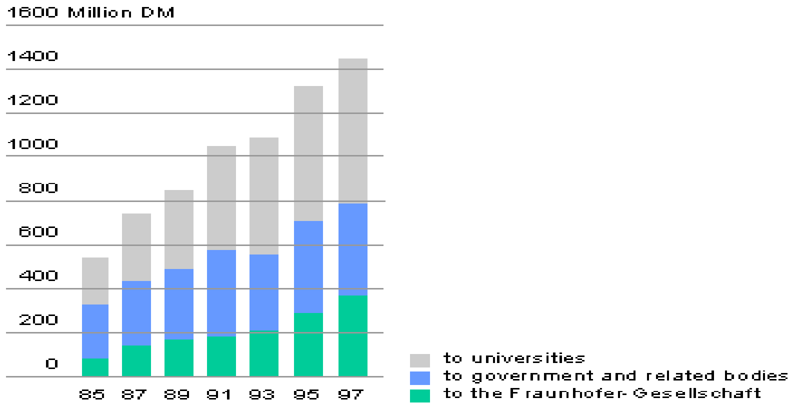
계약연구의 현황을 살펴보면, 1990년 이후 산업계와의 계약연구와 기초연구가 증가하고 있고 정부로부터의 지원이 점차 둔화되고 있음을 알 수 있다.(<그림 3-3> 참조)

<그림 3-3> 계약연구 현황



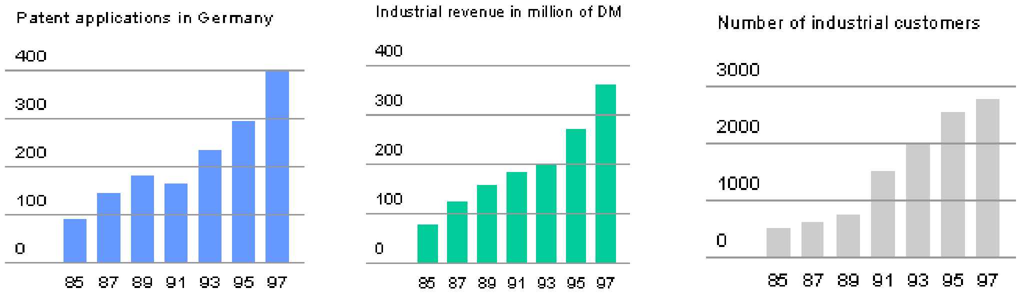
외부 연구개발 지출을 살펴보면 대학에 대한 비중이 점차 커가고 있음을 알 수 있다.(<그림 3-4> 참조)

<그림 3-4> 외부 연구개발 지출



프라운호퍼의 경제적 성과를 살펴보면 특허수와 산업의 편익이 계속 증가하고 있으며 특히 산업계의 고객이 90년대 들어 3,000개 기업에 육박할 정도로 비약적으로 증가하고 있다는 점이 두드러진다.

<그림 3-5> 프라운호퍼의 경제적 성과



연구 인력을 살펴보면 97년 기준으로 독일 전역에 소재하고 있는 47개 연구소에 약 6,773명의 직원이 고용되어 있고, 이 중 2,821명이 과학자에 해당한다. 99년 현재는 약 9,300명의 직원이 고용되어 있으며 연구회의 본부는 뮌헨에 위치해 있다.

2. 분야별 프라운호퍼 협력과제

프라운호퍼의 협력과제는, 소재기술・부품 11개, 제품기술・제조공학 7개, 정보・통신기술 5개, 반도체・마이크로시스템기술 5개, 센서시스템・검정기술 4개, 프로세스기술 5개, 에너지 및 건축기술・환경 및 의료연구 6개, 기술 및 경제연구・기술이전 5개로 총 48개이다. 개별 협력과제의 연구주제는 다음과 같다.

가. 소재기술・부품(Materials technology, component behaviour) : 11개

○ 연구소명 : LBF(부재강도연구소)

연구과제 : Component-Related Material Behavior - Strength hypotheses and life prediction, optimization and fatigue life proof of components

○ 연구소명 : FEP(전자빔 · 플라즈마연구소)
연구과제 : 열처리

○ 연구소명 : IFAM(응용재료연구소)
연구과제 : Powder Technology - Forming of powdered metals, thermal compression in the manufacture of ultra-dense sintered materials

○ 연구소명 : WKI(목재연구그룹 「빌헬름 · 글라우디츠연구소」)
연구과제 : Process Engineering Wood / Wood Materials - 생산자동화

○ 연구소명 : IKTS(세라믹기술 · 소결재료연구소)
연구과제 : Powder Technology, Development of Processes and Prototypical Components

○ 연구소명 : EMI(나노세컨드물리연구소)
연구과제 : 추진공정 - Interior and transition and exterior ballistics, ignition and combustion processes in solid and fluid propellants

○ 연구소명 : ILT(레이저기술연구소)
연구과제 : 가스레이저 - 가스레이저 개발, transistorize power supplies 개발, testing and customized modification of lasers;

○ 연구소명 : IST(층표면기술연구소)
연구과제 : Industrial Processes and Coating Applications - 증기 및 진공침전에 의한 코팅

○ 연구소명 : ISC(규소연구소)
연구과제 : 유리개발 및 유리기술, 유리부식

○ 연구소명 : IWM(가공소재역학연구소)
연구과제 : New Applications of Materials - Properties for service of technical ceramics, composites, polymers, steel and light weight alloys, materials testing and qualification, welded joints

○ 연구소명 : IWS(소재물리・층기술연구소)

연구과제 : 고속 코팅 – Technology and system development to deposition of thin films

나. 제품기술・제조공학(Production technology, manufacturing engineering) : 7개

○ 연구소명 : IFF(공장경영자동화연구소)

연구과제 : Enterprise strategy, market-oriented enterprise structuring, enterprise management, enterprise cooperations

○ 연구소명 : IML(로지스틱연구소)

연구과제 : 품질관리 및 조직시스템 – Quality management and software

○ 연구소명 : IPK(생산설비설계연구소)

연구과제 : 제어기술(로보틱스 및 CNC) – 로봇 및 플랜트 제어기술

○ 연구소명 : IPA(생산기술자동화연구소)

연구과제 : Organization Development

○ 연구소명 : IPT(생산기술연구소)

연구과제 : 공정기술 – 표준 생산공정의 개선(high power cutting, precision processing, 5-axes milling)

○ 연구소명 : TEG(기술개발그룹)

연구과제 : Product Planning 및 Business Processes – Methods-based product planning, Management systems, Technology management and patents, Method-based product management

○ 연구소명 : IWU(공작기계프레스기술연구소)

연구과제 : Metal Forming Technologies – Process development, stage planning, tool design and manufacturing

다. 정보・통신기술(Information and communications technology) : 5개

○ 연구소명 : IAO(노동경제조직연구소)

연구과제 : Technology Information Systems, Rapid Product Development, Software-Technology, Virtual Reality, Knowledge Transfer

○ 연구소명 : IESE(실험소프트웨어공학연구소)

연구과제 : Methods and tools for the elicitation, analysis and specification of software requirements

○ 연구소명 : IGD(화상처리연구소)

연구과제 : Document Imaging - Document processing and document communication integration of prepress, press and post press (CIP3)

○ 연구소명 : IITB(정보처리연구소)

연구과제 : 생산제어시스템 - Object-oriented monitoring and control of production

○ 연구소명 : ISST(소프트웨어・시스템연구소)

연구과제 : Internet/intranet Technologies and Management - Design, development, implementation and operation of intranets and distributed applications.

라. 반도체・마이크로시스템기술(Microelectronics, microsystems technology) : 5개

○ 연구소명 : IAF(응용고체물리연구소)

연구과제 : High Frequency Devices and Circuits - Design, simulation (CAD), and test of integrated circuits based on the III-V compound semiconductors GaAs and InP.

○ 연구소명 : IIS(집적회로연구소)

연구과제 : Integrated Circuit Design Analog Systems - RF-ICs, Sensor signal processing, Analog-to-Digital-Converters

○ 연구소명 : IMS(전자회로시스템연구소)

연구과제 : Microsensor technology, micro structure technology, micromechanics, wafer bonding, Chemical Mechanical Polishing

○ 연구소명 : ISIT(실리콘기술연구소)

연구과제 : Silicon Process Technology, Development and testing of single processes, process modules and complete processes for all relevant fields of the semiconductor technology

○ 연구소명 : IZM(전자부품신뢰성연구소)

연구과제 : Mechanical reliability in micro technology - Mechanical/thermal simulation

마. 센서시스템・검정기술(Sensor systems, testing technology) : 4개

○ 연구소명 : IOF(응용광학정밀기계연구소)

연구과제 : 광학코팅 - Development of optical technologies (high-precision electron beam techniques, plasma-enhanced technologies, sputtering, coatings on plastics)

○ 연구소명 : IBMT(바이오메디칼기술연구소)

연구과제 : Sensor systems, Microsystems, Biosystems

○ 연구소명 : IPM(물리측정연구소)

연구과제 : 광분광학 - Spectrometer systems for quantitative chemical gas analyses

○ 연구소명 : IZFP(비파괴검사기술연구소)

연구과제 : Quality assured performance of measurement and testing by certified inspection personnel in an accredited testing laboratory and in-situ.

바. 프로세스기술(Process technology) : 5개

○ 연구소명 : IAP(응용폴리머연구소)

연구과제 : 합성 폴리머 – Technology of synthesis and optimization of processes, amino resins, retard delivering systems, microenca-psulation, environmentally friendly plastics, water soluble polymers, flocculating agents, water purification, polymeric surfactants, optimization of melt polycondenzation processes, polymer dispersions, communication polymers.

○ 연구소명 : ICT(화학기술연구소)

연구과제 : Energetic Materials – Analysis, synthesis and development of energetic materials

○ 연구소명 : IGB(계면바이오프로세스연구소)

연구과제 : Surface Technology and Interfacial Engineering – Process development for non-polluting methods for surface treatment, cleaning and coating by means of plasma processes serving the improvement of the technical and biotechnical performance of materials and devices

○ 연구소명 : UMSICHT(환경・안전・에너지기술연구소)

연구과제 : 환경친화적 공정 – particle technology, crystallization processes, carbon adsorbents, reactions/separation under specific conditions

○ 연구소명 : IVV(식품・기호연구소)

연구과제 : Product safety and analytical methods – Analytical examination of packagings and articles

사. 에너지 및 건축기술・환경 및 의료연구

(Energy and building technology, environmental and health research) : 6개

○ 연구소명 : IFU(대기환경연구소)

연구과제 : Biogenic VOC Emissions – Quantification of the emission of volatile organic compounds (VOCs) by plants

○ 연구소명 : IBP(건축기술연구소)

연구과제 : 건물 음향학 – Airborne and impact sound insulation of component parts, sound absorption, elastic properties of materials, sound insulation of walls and shieldings, silent water supply installations, sanitary facilities and installation systems, structure-borne sound-insulating pipe fixing and wrappings, testing and development of building components

○ 연구소명 : ISE(태양에너지시스템연구소)

연구과제 : 광전자 시스템 및 측정 기술 – Photovoltaic applications for accessible markets

○ 연구소명 : ITA(독성학에어로졸연구소)

연구과제 : Inhalation Toxicology

○ 연구소명 : ATU(독물학・환경의학연구소)

연구과제 : 유해물질 및 환경 분석 – Registration of harmful substances in water, soil, air and living matter

○ 연구소명 : IUCT(환경과학・독성학연구소)

연구과제 : Environmental Analysis and Technology : Organic and inorganic environmental analyses (industrial chemicals, hazardous substances, pesticides, biocides), inherent substance data (e.g., hydrolysis, photolysis, volatilization);

아. 기술 및 경제연구・기술이전

(technical and economic studies, information transfer) : 5개

○ 연구소명 : IRB(도시계획건축정보센터)

연구과제 : ARCONIS Information Consulting – Individual services, database investigations, market analyses, further enquiries, mediation of literature

○ 연구소명 : INT(자연과학・기술트렌드연구소)

연구과제 : 기술 모니터링 및 예측 – Technology monitoring, trends, forecasting, assessment

○ 연구소명 : PST(특허센터)

연구과제 : Intellectual property law, licence law, employees′ inventor law, central management of all patent activities of the Fraunhofer Gesellschaft

○ 연구소명 : ISI(시스템기술이노베인션연구소)

연구과제 : Innovation Services and Regional Development – Innovation financing and new technology based firms, innovation services

○ 연구소명 : FhM(연구회경영)

연구과제 : 프로그램 개발 및 평가

제 4 장 국내 활용체제의 구축 방안

우리나라는 21세기에 전개될 지식기반 사회에서 경제성장을 뒷받침할 수 있는 과학기술지식의 내부축적이 부족한 상황이다. 이러한 점을 감안할 때 우리나라 국내 핵심 기술역량의 확보 노력과 함께 이를 보완할 수 있도록 해외 과학기술자원에 대한 out-sourcing 전략이 중요한 의미를 갖는다. 해외 연구자원의 out-sourcing 전략의 일환으로서 해외 선진연구기관의 연구방향과 연구과제를 분석하는 것은 우리나라 연구기관이 미래 연구 방향을 설정하고 공동연구의 대상기관을 선정하는 데 있어 의미 있는 시사점을 줄 수 있다. 우선 선진 연구기관의 연구방향과 연구과제를 분석하여 그 연구결과를 우리나라 기술혁신체제에서 효율적으로 활용할 수 있는 방안을 마련할 수 있다. 선진 연구기관의 선행 연구를 우리나라에서 불필요하게 중복 수행하지 않도록 관련 정보를 모니터링할 필요가 있다. 또한 외국 연구기관이 수행하거나 이미 수행하였던 연구결과를 분석하여 우리나라 연구기관의 연구방향을 설정하고, 우리나라 연구기관과 공동연구 등 연계가 필요하고 가능한 대상 외국 연구기관을 선정하고, 선정된 외국 연구기관과 국내 연구기관이 공동연구를 추진할 수 있다. 개별 연구소 차원보다는 정부 차원에서 일관성 있게 지속적으로 추진하면서 선진국의 기술보유 기관, 보유기술 현황, 협력절차 및 조건 등에 대하여 연구기관 및 기업에게 정보를 제공할 필요가 있다. 다음에서는 국내외 연구기관간 연계과정을, 기반구축, 정보 통합관리, 국내외 연구기관간 네트워크 구축의 3단계로 나누어 살펴보았다(그림 4-1 참조).

제 1 절 기반구축 및 정보수집

1. 국내 연구기관의 특성, 수요 파악

국내외 연구기관간 공동연구 모색 등 연구개발 협력 네트워크를 구축하기 위한

첫 번째 단계는 국내 연구기관의 특성과 연구수요 파악이다. 즉 출연(연) 등 공공부문 연구기관의 인력구조, 연구예산 확보계획 등 특성 파악, 단기 중장기 기획에 의한 연구 지향점 도출 및 필요 연구수요 파악을 포함한다. 국내연구기관의 이러한 특성은 해외 연구기관의 연구과제와의 비교분석을 통하여 자체연구 추진분야와 연구 out-sourcing 대상분야 등 연구수요를 파악하는 기본 자료가 된다.

2. 국내 연구기관의 연구과제 DB 구축

국내외 연구기관간 연계를 위한 기초정보로서 국내 연구기관의 연구과제 DB를 구축한다. 동 DB를 개별 연구기관이 자체적으로 구축하도록 정부 등 공공부문이 지원한다. 연구과제 DB에는 예산, 기간, 책임자, 참여자, 참여기관 등을 포함하여 국내외 관련 연구기관이 접근할 수 있도록 공개한다. 동 DB는 외국 연구기관과의 공동연구를 제의할 때 국내 연구기관의 연구역량, 관심 연구영역 등을 설명하는 정보 source가 된다. 동 단계에서 해외 연구기관은 자체적으로 연구를 기획하고 연구과제 DB를 구축할 것으로 가정한다.

3. 정보수집 거점 확보

해외 주요 연구기관의 연구개발 정책 및 연구과제 동향 등 연구과제 관련 정보를 수집하기 위하여 주요 지역별 정보수집 거점을 확보할 필요가 있다. 제반 정보가 internet 등을 통하여 원거리에서도 접근이 가능한 현실을 감안할 때 동 거점은 반드시 물리적 현지 건물의 형태일 필요는 없다.[8] 그럼에도 불구하고 문서상의 정보가 갖는 한계를 극복하고 개인에게 체화된 암묵적 지식(tacit knowledge)을 획득하기 위해서는 지리적으로 접근이 가능한 위치에 물리적 거점을 확보하여 인적 network을 활용할 수 있도록 하는 것이 바람직하겠다. 기존에 설치되어 있는 미국내 한미과학협력센타(KUSCO), 독일내 KIST-Europe 연구소 등을 활용할 수 있다. 상기 기관에서 이미 시행하고 있는 현지 교포 과학자들의 참여를 적극 유도하고

8) 기존에 구축된 DB에 접근하기 위하여 별도의 활용계약이 필요한 경우도 있다 (예, 미국 RAND 연구소가 구축한 미국 연구개발 DB인 RaDiUS).

체계화한다. 동 거점에는 정부기관, 출연(연), 관련 해외지사 등을 집역화 시킴으로써 정보의 공유성 향상 및 긴밀한 네트워크 구축 등의 효과를 기대할 수 있다.

4. 정보관리자

물리적 거점을 효과적으로 활용하기 위한 선결 요건은 정보의 모니터링, 선택적 수집, 분석, 확산 등을 담당할 관리자의 확보이다. 이를 위하여 가칭 기술관(technical attache) 제도를 도입할 수 있다. 전문분야별로 기술을 이해하고 필요정보에 접근이 가능한 연구 전문인력을 선발하여 주요 거점에서 정보관리자의 역할을 담당하게 한다. 현재 주요국에 주재하고 있는 과학관이나 국내외 연구기관의 연구원이 이를 담당할 수 있다. 관련 정보의 모니터링과 수집을 촉진하기 위하여 현지에 주재하는 외교관, 기업 주재원, 유학생, 교포 과학기술자, 재외 한국인 과학자협회 등을 대상으로 정보제공에 대한 인센티브를 부여하는 시스템을 활용할 수 있다.

제 2 절 정보 통합관리

1. 정보의 통합 관리

주요 거점별로 수집된 정보를 종합적으로 관리하기 위한 가칭 '해외과학기술정보센타'의 구축을 검토할 수 있다. 동 센타는 기본적으로 국내 연구기관의 연구과제 DB, 해외 연구기관의 연구과제 DB를 통합 관리한다. 동 센타는 기술과학관의 관리하에 해외공관 및 지사, 출연(연) 해외사무소 등을 유기적으로 연계시켜 정보를 수집 분석하고 그 결과를 정부부처, 연구기관, 산업계에 확산시키는 등 정보를 통합관리하는 역할을 수행한다. 동 센타의 기능은 물리적 건물을 사용하지 않는 virtual 센타에서도 충분히 수행 가능하다. 예컨대 기존의 연구개발정보센타(KORDIC)내에 부설 virtual center로 구축할 수 있다.

2. 국내외 연구과제 DB 구축

해외 연구기관의 연구개발 현황, 내용, 특성을 파악할 수 있는 1차 자료는 해외 연구기관이 수행한 개별 연구과제의 내용을 수록한 DB이다. 가칭 '해외과학기술정보센타'는 동 DB에 수록할 대상 연구기관과 대상 정보의 선정과 관련하여 수요자인 국내 연구기관의 수요를 파악한다. 동 센타는 해외 연구기관 중 국내 연구기관의 제안을 바탕으로 선정한 연구기관과 기술분야를 대상으로 해외 연구기관이 자체적으로 구축한 연구과제 DB에 접근하여 가칭 '해외과학기술정보망'에 이들 정보를 올려 활용할수 있도록 한다. 해외 연구기관이 국내 연구기관과의 연계 여부를 판단하기 위한 기본 정보로서 국내 연구기관의 연구과제 DB도 동 정보망에 함께 올린다. 개별 연구과제 현황에 관한 정보는 지속적으로 갱신되어야 그 효과가 있다는 것은 주지의 사실이다. 해외 연구기관의 연구결과 현황에 대한 기존 연구는 '96까지의 자료를 제시하고 있다. 이에 본 연구는 '96 이후 최근 3년간 자료를 대상으로 하였으며 같은 이유로 향후 지속적 갱신을 위한 후속 연구가 필요하다.

제 3 절 연구협력 네트워크 구축

1. 연계 방법

취합된 통합정보의 활용 방안을 국내 연구기관과의 공동연구 추진이라고 한정할 때, 국내 유관기관과의 연계방법으로서 정부주도의 top-down 방식과 개별 연구기관/연구자가 주도하는 bottom-up 방식이 있을 수 있다. 국내 출연(연)의 경우 대학과 기업이 보유하지 못한 연구설비를 보유하고 있다는 특성을 살려 interdisciplinary 분야를 주요 공동연구 대상으로 할 수 있다. 국내 개별 연구기관/연구자가 주도하는 bottom-up 방식은 취합된 해외 연구기관의 연구개발 과제 정보를 국내 연구기관/연구자가 개별적으로 접근하고 판단하여 공동연구 등 후속조치를 개별적으로 추진하는 것이다.

2. 대상기관의 선정

'해외과학기술정보센타'는 이를 효과적으로 추진하기 위하여 해외 주요연구기관의 선정, 연구개발 과제 정보 내용 등 가칭 '해외과학기술정보망'에 올려진 정보의 적정성, 범위, 정보 확산 방법 등에 대하여 수요자인 국내 연구기관/연구자의 의견을 파악하여 국내외 기관간 연계를 지원한다. 정부주도의 top-down 방식으로서는 기술분야의 선정, 특정 기준에 의한 대상 해외연구기관의 선정, 국내 유관기관과의 연계 지원 등으로 추진할 수 있다. 개별 기술분야별로 우리나라 연구기관과 연계할 수 있는 최적 대상기관을 선정하기 위해서 '해외과학기술정보센타'는 특정 기준에 따라 대상기관을 추천할 수 있다. 예컨대 연구지원기관(예 : NSF)으로부터 지원받는 과제와 해당 기관을 분석하여, 일정액 이상의 지원을 받은 기관, 일정기간 이상 지원을 받은 기관, 다수의 참여기관과 공동으로 과제를 수행하는 기관, 해외기관(특히 우리나라와 유사한 중진국의 연구기관)과 공동연구 경험이 활발한 기관 등을 기준으로 삼아 대상기관을 좁혀갈 수 있다. 이러한 정부의 지원과 guideline을 바탕으로 국내 연구기관은 해외 연구기관과의 연계를 추진하게 된다.

3. 제도적 지원

국내외 연구기관간 연계의 주체는 개별 연구기관이며 정부는 이러한 과정에서 지원자의 역할을 수행한다. 정부는 국내외 연구기관의 연구과제 DB 구축 등 연계기반을 구축하고 대상 연구기관 선정에 대한 객관적 guideline을 제시하는 등 전반적 과정을 지원한다. 동 guideline은 해외 연구기관이 수행한 연구결과의 활용 극대화, 불필요한 중복 연구 방지, 국내 연구기관과 공동으로 수행할 연구과제 및 대상 연구기관 선정을 고려하여 그 원칙과 기준을 설정한다. 연구과제 DB의 지속적 갱신, 국내외 연구기관간 연계추진을 위한 제도적 지원, 연계 추진 효율화를 위한 정책연구 지원 등도 정부 및 관련 공공기관의 역할이다.

<그림 4-1> 국내외 연구기관 협력 체제 구축

추진기관 구축단계	해외과학기술정보센타	국내연구기관	정부지원
기반구축 및 정보수집	- 현지거점 확보 (기존 KUSCO, KIST-Europe등 활용) - 정보수집 대상 해외연구기관 선정 및 정보수집 - 정보수집 incentive 제공 (현지 공관원, 교포 과학자 등 대상)	- 연구기획 - 연구과제 DB 구축 - 현지거점의 정보관리자 제안 - 정보수집 대상 해외연구기관 제안	- 국내 연구기관의 특성 파악 - 정보수집 거점 확보를 위한 재정적, 제도적 지원 - 정보관리자 선정, 파견
정보 통합 관리	- '해외과학기술정보망' 설치 및 국내외 연구기관 연구과제 DB 구축, 가공 - DB를 국내외 연구기관에 확산 - DB의 지속적 갱신	- 연구과제 DB 제공 - '해외과학기술정보망'의 연구과제 DB 접근 - DB 확산방법 제안	- '해외과학기술정보센타' 설립 - DB 구축, 가공, 확산에 관한 국내외 연구기관의 제안사항 종합
협력네트워크 구축	- 필요시 국내외 연구기관간 연계 지원 - 사후관리	- 연구 Out-sourcing 수요 도출 - 연계대상 해외연구기관 선정 - 해외 연구기관과 협력 네트웤 구축	- 연계대상 해외 연구기관 선정을 위한 guideline 제시 - 연계추진 제도적 지원 (funding, 인력, 환경조성) - 연계추진 효율화를 위한 정책연구 추진

제 4 절 주요 선진국연구기관과 국내연구기관과의 연계방안(예시)

이러한 국내 활용체제의 구축을 전제로 주요 선진국 연구기관과 국내 연구기관과의 연계방안을 살펴보고자 한다.

국내 연구기관과 선진국 연구기관의 협력이 실질적 성과를 거두기 위해서는 "상호 호혜적" 협력 기반이 조성되어야 한다. 그러나 우리나라는 현재 이러한 상호 호혜적 협력의 추진을 위한 인프라가 제대로 구축되어 있지 못한 상태이다. 따라서 단기적으로는 이러한 상황을 고려하여 인프라 구축에 도움이 되는 유형의 협력(인력 및 정보교류, R&D 상업화 연수, 전담 위탁 등)을 추진하고, 나아가 장기적으로 대등한 차원의 공동연구로 발전하는 현실적 접근이 바람직 할 것이다.

이러한 현실적 접근을 바탕으로 국제협력의 성과를 극대화하기 위해서는 중장기

적 국내기술개발정책 방향과 연계하여 추진하는 협력전략이 필요하다. 즉 정부가 추진하는 국책연구개발사업 특히 과기부가 추진하는 '21세기 프론티어사업,' '중소기업 애로기술지원사업' 등과 연계하여 국내외 연구기관간의 연계방안을 모색하고자 한다.

또한 선진국 연구소와 국내 연구소와의 협력을 어렵게 하는 배경 중에는 문화적 차이 또는 개도국에 대한 편견 등의 규정외적인 문제가 있다. 이를 해소하기 위한 일환으로 재외 한인과학기술자가 주도적으로 참여하는 연구소들을 중심으로 연계를 추진하는 전략적 방안을 예시하고자 한다.

1. 한·일 연구기관간의 연계 방안

우선 우리나라와 가장 많은 공동연구를 수행하는 일본과는 21세기에 가장 유망한 산업으로 떠오르는 생명공학분야에서 개방적 연구활동을 추구하는 RIKEN의 게놈과학종합연구센터(Genome Science Center)와 한국의 과학기술부가 추진하는 '21세기 프론티어 연구개발사업 게놈기능분석을 이용한 신유전자기술 개발 사업'을 주도적으로 수행하는 생명공학연구소(KRIBB; 별첨 2 참조)와 연계 협력을 추진하는 것이 바람직하다.

양국간 생명공학발전의 수준차이, 생명공학의 급발전, 양국의 공통적 니드를 고려할 때 양기관간의 협력은 다음과 같이 단계적으로 추진해나가는 것이 바람직 할 것이다.

첫째, 생명공학기술이 상용화가 되기 위해서는 아직도 "스핑크스의 침묵"기간(약 20-30년)이 필요하다. 게다가 인프라 구축을 위한 막대한 초기투자는 물론 투자에 대한 회수율(return rate) 또한 낮고, 오랜 기간을 요한다. 따라서 우선 단기적으로 양기관간 연구인력 및 정보교류의 추진을 기능성 유전자연구에 집중하고 나아가 중장기적으로는 인간게놈에 대한 공동연구사업을 위한 기반을 점진적으로 구축해 나가는 것이 바람직 할 것이다.

둘째, 보다 용이한 접근을 위해 RIKEN의 게놈과학종합연구센터(별첨 1 참조)에서 인간게놈연구를 주도하는 재일한인과학자 박홍석 박사와의 접촉을 통해 우리가 필요로 하는 연구(차세대 게놈연구 SNP 등)를 전담 위탁하고 이를 발판으로 양 기관간의 연구인력 및 정보교류를 점차 활성화해 나가는 것이 바람직 할 것이다.

셋째, 이러한 협력활동을 바탕으로 양국 간의 정보시스템(DB) 구축을 통해 동양인 유전자 지도를 완성하기 위한 공동연구를 추진하고 나아가 양국의 공동 관심사인 한국인과 일본인의 유전체 데이터에 대한 비교분석을 위한 대등한 차원의 공동연구로 협력의 수준을 높여 나가야 할 것이다.

2. 한·미 연구기관간의 연계 방안

미국 연구기관과의 연계는 우선 미상무부 NIST 주관으로 중소기업 경쟁력 제고를 위한 프로그램(ATP)에 참여하는 연구기관과 국내 연구기관을 연계하여 미국의 상업화 경험을 전수 받기 위한 단기 상업화 연수프로그램을 적극 추진할 필요가 있다. 앞에서 이미 제시한 바와 같이 ATP에 참여하는 연구기관은 생명공학분야에 10개, 제조기술분야에 10개, 전자·컴퓨터·통신기술 11개, 첨단재료 및 화학분야에 10개, 정보기술분야에 10개 등으로 총 51개이다.

특히 과학기술부가 중소기업의 애로를 타개하기 위해 국책연구개발사업으로 추진하려는 '중소기업 애로기술지원사업'을 앞으로 전담 수행할 국내 연구소(특히, 중소기업연구소를 중심으로)를 선정하여 주요 ATP 공동 참여 연구기관들(특히, DNA 시퀀싱 및 기술개발 센터, Oak Ridge National Laboratory, 샌디아고 슈퍼컴센터, Research Collaboratory for Structural Bioinfomatics, Center for Biomedical Engineering, National Semiconductor Corporation 등; 별첨 1 참조)과 서로의 상업화 경험을 상호 교류하도록 정부는 적극 지원해야 할 것이다.

둘째, 문화적 차이 또는 개도국에 대한 편견 등의 규정외적인 문제를 해소하기 위한 방안으로 재미과학기술자가 주도적으로 참여하는 연구소들과의 연계 전략을 생각해 볼 수 있을 것이다.

예를 들면, 오클라호마 州로부터 "송진주의 날"을 지정 받을 정도로 광전자분야에 권위 있는 송진주(Jin-Joo Song) 교수가 소장으로 있는 레이저 및 광전자연구센터(Center for Laser and Photonics Research, Oklahoma State University; 별첨 1 참조)에 광전자에 대한 연구를 전담 위탁하여 이를 고리로 우리나라의 한국전기연구소와 연구원인력·정보교류를 추진하고 점차적으로 공동연구를 모색하는 단계적인 협력이 바람직할 것이다.

또한, 최근 Science지에 반도체 집적도를 1만 배 높일 수 있는 초미세 회로기술을 개발·발표하여 화제를 불러모았던 홍승훈 박사가 소속해 있는 나노분자연구센터(Center for Nanofabrication and Molecular Self-Assembly, Northwestern University; 별첨 1 참조)와 과학기술부가 추진하는 21세기 프론티어 연구개발사업의 '나노기능소자개발사업'을 앞으로 전담 수행할 국내 연구소(추후 선정예정)와 공동연구의 추진을 모색하는 것이 바람직 할 것이다.

3. 한·독 연구기관간의 연계 방안

독일의 프라운호퍼 연구회는 기업가정신(entrepreneurship)의 특성을 지닌 공공연구기관으로서 새로운 첨단기술의 혁신잠재력을 조기에 찾아내어 중장기적 연구과정을 통해 획기적 연구결과를 도출하여 신속히 상업화함으로써 독일 중소기업의 경쟁력 제고에 있어 핵심적인 역할을 하고 있다. 이는 우리나라의 최근 중소기업의 상업화 프로그램(벤처자본의 육성, 기술이전법의 제정, 연구원의 창업지원 등)과 상호협력의 가능성을 크게 해 주고 있다.

미국의 ATP와의 협력방안에서 이미 제시한 바와 같이 과학기술부가 중소기업의 애로를 타개하기 위해 추진하려는 '중소기업 애로기술지원사업'을 전담 수행할 국내 연구소들(추후 선정예정)을 주요 프라운호퍼 연구소들과 연계하여 서로의 상업화 경험을 상호 교류하는 프로그램을 적극 추진하는 것이 바람직 할 것이다. 프라운호퍼의 연구과제 및 기관은 소재기술·부품 11개, 제품기술·제조공학 7개, 정보·통신기술 5개, 반도체·마이크로시스템기술 5개, 센서시스템·검정기술 4개, 프로세스기술 5개, 에너지 및 건축기술·환경 및 의료연구 6개, 기술 및 경제연구·기술이전 5개로 총 48개이다.

특히, 21세기 디지털경제 시대의 핵심인 정보기술 인프라(전자상거래, 기업커뮤니케이션, 소프트웨어공학 등)에 대한 컨설팅을 주로 연구하는 프라운호퍼 연구회 산하의 소프트웨어·시스템연구소(ISST : Fraunhofer Institute for Software and Systems Engineering; 별첨 1 참조)와 우리나라 전자부품연구원 산하의 시스템IC 연구센터(별첨 2 참조) 및 전자통신연구소 산하의 컴퓨터·소프트웨어기술연구소와 상호인력·정보교류 및 공동연구를 모색함이 바람직 할 것이다.

제 5 장 결론

제 1 절 미국의 연구개발정책 추세

미국의 향후 R&D투자의 추세를 보면 첫째, 클린턴 행정부가 주도하는 21세기 연구기금을 통해 1998년부터 5년간 약 310억 달러 그리고 연방연구투자법(Federal Research Investment Act : FRIA)에 따라 향후 10년간 R&D 예산이 배가될 예정이다. 둘째, 점차 줄어가는 국방 R&D 예산에 비해 비국방 R&D 예산의 증가 추세가 두드러지게 나타났다. 21세기 연구기금에 따르면, 2003년에는 비국방 R&D예산이 현재 예산의 21% 이상 증액될 예정이다. 셋째, 기초과학 예산의 증가로 NSF의 경우 21세기 연구기금을 통해 1999년도 예산이 전년도 대비 약 26%, 기초연구 예산은 10%가 각각 증액되었다.

제 2 절 주요 분석결과 및 정책적 시사점

NSF의 연구과제 지원활동의 특징은 다른 분야에 비해 컴퓨터 및 정보과학기술 분야에 대한 지원의 현격한 증가에서 나타났다. 뿐만 아니라 생명과학, 생명공학 및 환경시스템 등과 같은 미래 지향적 분야에 대한 지속적 지원의 대폭적인 증가는 미래 지식기반사회를 능동적으로 대처하기 위한 미국 정부의 노력을 잘 보여 준다. 특히 학제간 연구분야로 정보의 파악, 수집, 가공, 유통, 활용의 극대화를 위한 Knowledge and Distributed Intelligence(KDI), 환경과 생명에 관한 상호관계의 규명을 위한 Life and Earth's Environment(LEE), 21세기에 부합하는 고급 인력의 배양을 위한 Educating for the Future(EFF)에 대한 지원의 강화 또한 이를 잘 뒷받침해 주고 있다.

이처럼 정보기술과 생명공학에 관한 집중 지원은 미상무부 NIST의 ATP 지원정책에서도 확인된다. 즉, 1996년부터 1999년까지 ATP의 총 187개 과제 중 생명공학 분야에 가장 많은 54 과제가 지원되었다. 다음으로 전자/컴퓨터/통신기술에 37 과제, 정보기술에 34 과제 등 정보통신 관련 분야에 총 71개 과제가 지원되었다.

연구원의 10% 이상을 외국인에게 개방하고 기초과학과 응용연구의 균형있는 연구수행의 전통을 자랑하는 일본의 RIKEN도 물리, 화학, 엔지니어링, 생물학 등 50여개의 기존 연구실 위주의 연구 중심에서 벗어나 1986년부터 21세기형 과학기술의 획기적인 발전을 위한 핵심기반의 조성사업의 일환으로 기초연구를 강화하기 위해 생물학과 재료분야의 첨단연구주제를 중심으로 Frontier Research Program을 수행하고 있다.

독일 국내외에 산재되어 있는 55개의 연구소에서 재료, 생산기술, 정보통신기술, 전자공학, 센서기술, 공정기술, 에너지 등 다양한 분야에 걸쳐 연구를 수행하는 프라운호퍼 또한 미래 지향적인 정보기술과 환경기술에 대한 연구에 연구개발자원을 집중투자 수행하고 있는 것으로 조사 분석되었다.

미국은 물론 일본의 RIKEN, 독일의 프라운호퍼의 연구과제에 대한 분석에서도 연구개발사업에 뚜렷이 나타난 미래지향적 특성은 우리나라 국가연구개발정책의 재검토를 통한 새로운 방향 설정 및 전략 수립을 위한 정책적 노력에 시사하는 바가 크다.

또한 주요 선진국 연구지원기관 및 수행 연구과제의 조사·분석결과를 바탕으로 개방형 연구기관 및 학제적 산학연협동 연구과제를 중심으로 국내 연구소와 협동연구의 가능성이 높은 연구기관 및 연구과제를 선정·제시했다.

주요 내용을 보면, NSF의 경우 생명과학 5개, 컴퓨터 및 정보과학 4개, 엔지니어링 8개, 재료과학 2개 등 총 19개의 연구협력기관 및 연구과제가 선정되었고, NIST의 경우는 생명공학 10개, 제조기술 10개, 전자・컴퓨터・통신기술 11개, 첨단재료 및 화학 10개, 정보기술 10개 등 총 51개의 연구협력기관 및 연구협력과제가 선정되었다.

또한 RIKEN의 경우는 물리 및 재료 15개, 생명과학 22개, 화학 8개, 정보과학 2개 등 47개의 연구협력과제가 선정되고, 프라운호퍼의 경우는 소재기술・부품 11개, 제품기술・제조공학 7개, 정보・통신기술 5개, 반도체・마이크로시스템기술 5개, 센서시스템・검정기술 4개, 프로세스기술 5개, 에너지 및 건축기술・환경 및 의

료연구 6개, 기술 및 경제연구・기술이전 5개 등 총 48개의 연구협력과제가 선정되었다.

선정과제의 특성을 보면, NSF 및 NIST의 연구과제들은 대부분 파급효과가 큰 학제적 또는 산학연간의 공동연구 중심이고, RIKEN의 연구과제들은 생물학과 재료과학 등 미래 지향적인 기초과학 중심이고, 프라운호퍼의 연구과제들은 산업계 요구에 부응하기 위한 산연협동의 중심 과제들이다.

이러한 테이터를 보다 효과적이고 체계적으로 활용할 수 있는 국내 체제 구축에 대한 전략적 방안을 아울러 제시했다. 국내 R&D자원의 한계를 극복하기 위한 취지에서 선진국 연구기관의 연구결과를 신속히 소화‧흡수하고 상호보완적 협동연구기관 및 연구과제를 선정‧발굴 사업을 체계적으로 지원하기 위해 정부는 먼저 국내 연구기관의 특성과 연구수요를 파악하고 가칭 ‘해외 과학기술협력 센터’를 설치하여 ‘해외과학기술정보망’에 국내외 연구기관의 연구과제 DB를 구축 통합관리하며 협력대상기관 및 연구과제의 선정에 대한 지침서를 제시하는 등 지원체제를 구축해야 한다. 이와 함께 연구과제 DB의 지속적 갱신, 국내외 연구기관간 효율적 연계를 위한 정책연구 수행, 인력자원 배치 등 제도적 지원이 지속적으로 요청된다.

끝으로 이러한 국내 활용체제의 구축을 전제로 중장기, 단기적 유형의 협력을 통해 한・미, 한・일, 한・독 연구기관간의 네트워크를 국내 국책연구개발사업과 연계하여 구축함으로써 협력연구활동의 성과를 극대화하는 전략적 방안을 제시했다.

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[별첨 1] 국내외 연구기관간의 협력네트워크 예시

<주요 선진국 협력대상 연구기관의 프로파일과 협력 현황>

가. 일본 게놈과학 종합연구 센터(Genome Science Center, RIKEN)

① 센터의 연구조직

일본 이화학연구소의 부설기관인 게놈과학종합연구센터는 소장 산하에 5개의 연구그룹(유전자구조・기능, 단백질구조・기능, 게놈구조정보, 동물게놈구조정보, 식물게놈구조정보)과 각 연구그룹 산하에 15개 팀으로 구성되어 있다.

② 센터의 주요 연구분야 및 과제

유전자구조・기능연구그룹(Genome Exploration Research Group)의 주 연구과제는 고속게놈해석시스템의 개발(고속시컨스개발, 시컨스기술개발, 고분리능 Gel 개발), 마우스 엔사이크로피디아 작성(完全長cDNA 라이브러리 작성, 엔사이크로피디아에 기초한 유전적 접근 확립), 인포메틱스(단백질의 기능예측, 轉寫單位예측, 엔사이크로피디아 데이터베이스 작성) 등이다.

단백질구조・기능연구그룹(Protein Research Group)의 주 연구과제는 단백질 기능영역의 DNA 레벨에서 추정 및 발현, 단백질 기본구조에 대한 신규성 유무의 체계적 예측, 고속・고성능의 단백질 기능 스크리닝계의 확립, NMR에 의한 단백질 영역의 입체구조해석 등이다.

게놈구조정보연구그룹(Human Genome Research Group)의 주 연구과제는 인간 염색체의 전체구조(염기배열)의 결정과 규칙적으로 발견되는 유전자의 기능 및 발현 제어계의 연구, 게놈구조에 기초한 복제제어, 재조합등의 염색체 기능 연구, 미지 게놈의 지도제작 및 연구자원화에 관한 기술개발, 대규모 게놈 시컨스 결정을 위한 고도기술개발 연구, 인간 게놈의 기능단위 예측시스템 개발, 마우스 등과의 비교 게놈기술에 의한 새로운 게놈기능영역의 발견, 게놈배열에 내재한 규칙성과 일반법칙의 발견 등이다.

나. 미국 레이저 및 광전자연구센터
(Center for Laser and Photonics Research, Oklahoma State University)

오클라호마주립대학교 부설 레이저 및 광전자연구센터는 한국인인 송진주 박사가 소장을 맡고 있는데 송진주 박사는 하이테크산업의 발전에 기여한 공로로 동 대학으로부터 '송진주 교수의 날'을 지정받을 만큼 큰 신뢰를 보여 주고 있다. 1989년 설립된 연구센터는 특히 광전자에 대한 첨단 연구를 수행하여 왔다. 레이저와 물질에 대한 기초연구에서 나노기술에 대한 장치개발까지 광전자와 관련된 모든 분야의 연구를 포괄하고 있다.

① 센터의 임무의 목표

오클라호마주와 오클라호마주립대학의 경쟁력을 강화시키는 첨단 기술을 개발하는 것으로 연구센터의 목표는 첫째, 현재의 레이저 및 광전자 연구를 통해 레이저, 광전자물질, 장치, 응용 등과 관련된 세계적 수준의 연구센터로 발전하고, 둘째, 오클라호마의 산업 및 연구소에 레이저 및 광전자기술을 지원하며, 셋째, 오클라호마에 우수한 과학자, 공학자, 의사를 유치하고 우수 학생들을 통해 레이저 및 광전자 과학기술에 첨단의 교육을 제공하고, 넷째, 새로운 첨단기술을 통해 오클라호마주와 오클라호마주립대학의 경쟁력을 강화시키고 이를 통해 오클라호마주립대학의 교육, 연구, 확장에 기여하는 것이다.

② 연구인력

현재, 오클라호마주립대학의 화학 및 물리학과, 컴퓨터전자공학부, Veterinary Medicine 대학에서 약 50여명의 연구인력이 참여하고 있다.

소장(director)은 송진주(Jin-Joo Song) 박사가 맡고 있으며 송박사는 1987년 오클라호마주립대학교의 교수로 부임하였으며 1993년 동센터의 임시소장을 맡고 1994년 소장으로 취임하였으며 양자광전자물질 및 장치가 주 관심영역이다. 참여교수는 다음과 같다.

- Dr. Bruce Ackerson : Department of Physics, Colloidal Physics
- Dr. Donna Bandy : Department of Physics, Optical Device Modeling
- Dr. Kenneth Bartels : College of Veterinary Medicine, Veterinary Medicine

Surgical Laser Applications

- Dr. Daniel Grischkowsky : School of Electronic and Computer Engineering, THz Optoelectronics and Ultrafast Laser Science
- Dr. Edward Knobbe : Department of Chemistry, Preparation and Laser Processing of Optical Materials
- Dr. Nicholas Kotov : Department of Chemistry, Nanotechnology, Surface Probe Microscopy, Magnetic Thin Films, Optical and Electrical Properties of Nanoparticles and Thin Films
- Dr. Jerzy Krasinski : School of Electronic and Computer Engineering, Laser and Nonlinear Systems
- Dr. David Peakheart : Department of Physics, Solid State Laser Materials for Remote Sensing Applications
- Dr. Albert Rosenberger : Department of Physics, Nonlinear, Coherent, Resonant Optical Physics
- Dr. James Wicksted : Department of Physics, Optical Properties of Materials

연구센터 홈페이지에 공지된 연구원중, Dr. Seon-Ju Hwang, Dr. Yong-Hwan Kwon, Dr. Gil-Han Park, Dr. Sang Kee Shee 등은 한국인으로 추정된다.

③ 고등 광전자학위 프로그램(Photonics Advanced Degree Program)

오클라호마주립대학교의 레이저 및 광전자연구센터는 물리학과, 화학과, 전자컴퓨터공학과의 협력을 통해 Photonics Advanced Degree Program을 운영하고 있다. NSF-IGERT Photonics Program의 일환으로 물리학과, 화학과, 전자컴퓨터공학부에서는 오클라호마주립대학의 광전자 박사프로그램에 등록한 학생들을 대상으로 NSF의 지원을 받는 IGERT(Integrated Graduate Education and Research Training) 프로그램을 운영하고 있다.

다. 미국 나노분자연구센터(Center for Nanofabrication and Molecular Self-Assembly, Northwestern University)

① 개관

나노분자연구센터는 노스웨스턴대학교 부설 연구센터로 박사후 연수과정에 있는 홍승훈 박사가 최근 Science지(1999년 10월)에 반도체의 집적도를 지금보다 1만배까지 높일 수 있는 초미세 회로기술을 개발하여 발표하여 화제가 되었었다.

동 센터는 세계적인 화학자, 물리학자, 재료과학자, 공학자들을 결집하여 나노기술 연구를 목적으로 NIH, NSF, ARO(Army Research Office), ONR, AFOSR, DOE의 지원을 받고 있다. 나노기술은 전자공학, 컴퓨터, 진단연구, 보건산업에 큰 영향을 미치는 기술이다.

현재 물리학, 화학, 재료과학, 생명공학 및 의학분야의 인력들로 구성되어 있다.

② 주요 프로젝트

현재 나노분자연구센터의 주요 프로젝트로는 Atomic Cluster-derived Materials (ACM) 프로젝트가 있다. 이 프로젝트는 원자의 군집과 군집배열의 합성 및 특성에 대한 연구로 생체재료, 광촉매, 광발광군집, 비선형광학물질, 자기나노입자, 나노입자배열 등을 포함하고 있는데 노스웨스턴대학교의 물리학과 및 화학과 이외에도 외부기관의 연구인력이 참여하고 있다(조지아공대, 루센트, 시카고주립대, Naval Research Lab 등). 진행중인 세부과제로는 1) DNA/금속 나노입자 바이오센서, 2) 광촉매군집, 3) 광발광군집, 4) 비선형 광학군집배열, 5) 자기 나노입자, 6) 나노입자의 전자동학에 대한 이론 연구, 7) 비선형광학물성에 대한 분자궤도연구 등이 있다.

라. 독일 실험소프트웨어공학연구소(IESE)

① 개괄

1996년 1월 1일 설립된 프라운호퍼 산하의 실험소프트웨어공학연구소의 공식명칭은 Fraunhofer Institute for Experimental Software Engineering(Fraunhofer IESE)으로 현재 소장은 Dieter Rombach 박사가 맡고 있다.

연구소는 네 지역에 나누어져 있는데 각각의 위치는 다음과 같다.

- Fraunhofer Institute for Experimental Software Engineering, Kaiserslautern
- IESE Contact Office at the University of Kaiserslautern
- Competence Center for Software Technology and Training, Kaiserslautern
- Fraunhofer Center for Experimental Software Engineering, College Park, Maryland, USA

1999년 9월 기준으로 인력현황을 살펴보면 정식직원이 78명, 학생 및 계약직이 58명, 방문과학자 3명으로 구성되어 있다.

② 주요 협력활동

IESE의 협력 파트너는 크게 국가연구기관, 국제연구조직으로 구분되어진다. 현재까지 주 협력기관은 다음과 같다.

먼저 국가연구기관으로는 Software Engineering Research Group(University of Kaiserslautern), Special Research Area (SFB 501) "Development of large systems with generic methods", Center of Learning Systems and Applications(LSA), Institute of Computer Science(University of Stuttgart) 등이 있다.

본 연구의 주된 국제연구파트너는 호주, 스페인, 미국, 브라질, 이탈리아, 스웨덴, 노르웨이, 핀란드, 영국, 일본, 캐나다 등 주로 유럽을 중심으로 하고 있다. 주요 연구파트너는 다음과 같다.

- Center for Advanced Empirical Software Research (CAESAR), University of New South Wales, Sydney, Australia (formal affiliation agreement)
- Centre de Recherche Informatique de Montreal (CRIM), Montreal, Canada
- European Software Institute (ESI), Bilbao, Spain (formal affiliation agreement)
- Experimental Software Engineering Group of the University of Maryland (UMD/ESEG), College Park, Maryland, USA (formal affiliation agreement)
- Federal University of Santa Catarina, Florianopolis, Brazil
- Georgia Tech University, Atlanta, Georgia, USA

- Carleton University - School of Computer Science, USA (formal affiliation agreement)
- Istituto per la Ricerca Scientifica e Technologica (IRST), Trento, Italy
- Universita 'degli Studi di Roma "Tor Vergata", Italy
- Norwegian University of Science and Technology (NTNU)
- Software Engineering Institute (SEI), Carnegie Mellon University, Pittsburgh, Pennsylvania, USA (formal affiliation agreement)
- Swedish Institute of Production Engineering Research (IVF), Molndal, Sweden
- Software Engineering Laboratory (SEL), NASA/Goddard Space Flight Center, Greenbelt, Maryland, USA
- Software Technology Transfer Finland, Espoo, Finland
- University of Oulu, Oulu, Finland
- University of Tennessee, Knoxville, Tennessee, USA
- Universita 'degli Studi di Bari, Italy
- University of Strathclyde, UK
- Nara Institute of Science and Technology (NAIST), Japan
- VTT Electronics, Oulu, Finland
- Software Productivity Consortium NFP, Herndon, USA
- Georg Mason University, Fairfax, Virginia, USA
- National Research Council of Canada, Institute for Information Technology, Ottawa, Canada (formal affiliation agreement)
- BOOTSTRAP Institute, Oulunsalo, Finland (formal affiliation agreement)
- University of Florence, Dept. of Systems and Informatics, Florence, Italy

③ 연구분야

IESE의 주 연구분야는 소프트웨어 개발, 프로젝트 관리, 자산관리 등이다.

◦ 소프트웨어 개발

- 예측가능하고 보증할 수 있는 소프트웨어 개발
- 광범위한 소프트웨어 재사용

◦ 소프트웨어 프로젝트 관리
◦ 소프트웨어 자산관리
  - 소프트웨어 공정 및 제품 평가
  - 협력 학습의 가속화
  - 교육 및 훈련

마. 독일 소프트웨어·시스템연구소(ISST)

① 개괄

1992년 설립된 소프트웨어・시스템연구소의 공식명칭은 Fraunhofer-Institute for Software and Systems Engineering으로 현재 Herbert Weber 박사가 소장을 맡고 있으며 통합 IT 인프라의 설계, 수행, 도입, 운영에 대한 민간 및 공공부문에 대한 컨설팅(전자상거래, 기업커뮤니케이션, 소프트웨어공학 등)이 주 연구목적이다.

이를 위해 민간 및 공공부문의 다양한 프로젝트에서 혁신적인 개념, 신개념, 신기술 개발, 산업으로 기술이전, 실용적 목적을 위한 시험시스템 개발, 학제간 협동 지원 등의 서비스를 수행하고 있다.

② 조직 및 인력

ISST는 베를린의 본부가 있고 도르트먼트에 분소가 있다. 현재 51명의 과학자와 11명의 비과학인력 71명의 학생으로 구성되어 있으며 인터넷/인트라넷 기술 및 관리, 공정관리, 정보서비스, 정보관리, 신뢰시스템, 품질관리 등의 부서가 있다.

③ 주요 협력기관

ISST의 주요 협력기관은 과학계, 산업계, 공공기관으로 나누어 보면 다음과 같다.

◦ **과학계**

Computer Science Dept. / Computer Science Faculty / Department for 'Computing and Society' / Fraunhofer institutes / GMD-FIRST / IBM Deutschland Informationssysteme GmbH, European Center for Network

Research, Heidelberg / Institute for Business Computing / Institute for Open Communications Systems / Joanneum Research, Graz/Austria / Society for Mathematics and Data Processing, Institute for Integrated Publication Systems, Bonn / Technische Universitat Berlin

◦ **산업계**

AUCOTEAM Automation and computer engineering / Cap debis / Carl Zeiss Werke / CEC Karlsruhe / Daimler-Benz AG / DHL Worldwide Express GmbH / Digital Equipment GmbH / DQS : Deutsche Gesellschaft zur Zertifizierung von Qualitatsmanagementsystemen mbH (Certification of quality management systems) / EDS Scicon, England / Elektronik, Service & Vertrieb (ES&V) GmbH / Fischer Holding / Support for the intermediate software industry in Berlin and Brandenburg / GUS : Gesellschaft fur Unternehmensberatung und Softwareentwicklung AG & Co (Business consultancy and software development) / ICL / Leopold Schafer GmbH / PSI AG / Rembold und Holzer GmbH / R+V Versicherung / SFGL, Emeraude/Frankreich / Siemens Nixdorf Informationssysteme GmbH / Softlab / SYSTEM CONSULT Gesellschaft fur Datenverarbeitung und Informationstechnik mbH / Xaver Fendt

◦ **공공기관**

Berlin Regional IT office / Landesamt fur Informationstechnik Berlin (LIT) (Berlin Regional IT Office)

④ 주요 서비스

ISST는 연구활동은 크게 계약연구와 특정연구를 통해 이루어진다. 계약연구에는 주로 산업 및 공공부문, 국제협력을 통한 계약연구를 통한 컨설팅, 기업커뮤니케이션, 전자상거래, 소프트웨어공학에 있어서의 기술이전 등을 목적으로 하고 있으며 특정연구(Target Group)는 대규모 사용자를 위해 기업특화적인 개발환경을 연구를 중점적으로 진행하고 있다.

⑤ 주요 프로젝트

현재 진행중인 프로젝트는 다음과 같다.

- Adecco Job Shop : extension of the distributed kiosk system for employment agencies
- ASPIRE : Advanced modeling and specification of distributed information systems
- Data-based publishing,
- Deutsche Bank AG community kiosk system
- DIS : Development of a 팙usiness data information system
- ESPRESS : Engineering of safety-critical embedded systems
- ESPRESS-DBAG : Putting formal methods and techniques into practise
- ESPRESS-BOSCH : Developing embedded systems. Step-by-step optimization of the industrial development process for safety-critical control systems.
- FloraVision : Database for professinal image management
- GIF : Integrating architectural and behavioral modeling in object-oriented systems engineering
- ICOMA : Configuration management platform for telecooperation applications
- Intranet for Deutsche Bahn AG (German Railways)
- MO : Dynamic virtual online museum
- VE(BMBF-Funding No. : 01 HB 9606/1) : Improvement of business processes with flexible workflow management systems
- Planning and development of the DB (German Railways) intranet, development of distribution infrastructure, and development of reference applications
- Support during ISO9000 certification in the development dept. of the North Rhine-Westphalian State Office for Data Processing and Statistics (LDVZ)

- Testing results from the MOVE project in the context of an intermediate haulage company
- Testing results from the MOVE project in the logistics sector
- VHDBS : Distributed, heterogeneous database system
- WFM Seminar : seminar on workflow management
- Workflow management for the North Rhine-Westphalian Mining Authorities

1998년 완료된 프로젝트는 다음과 같다.

- Development of a graphical user interface and maintenance components for the Dresdener Bank's REPTIL system
- Eurocontrol : Consultancy for the use of object-oriented analysis methods in Air Traffic Control
- Evaluation of the software situation regarding the Year 2000 problem
- GeoFlow GFZ : a workflow system (modelling) to support geo-scientific work processes
- Geo-Los : Model procedure for the introduction of geo-information processing systems
- InfoPool consulting : systematic consulting for the design of the InfoPool system for the Saxony-Anhalt regional administration
- Software production environment for small and intermediate businesses a cooperative project focussing on model procedure and developer environment
- SPU : Software production environment for small and intermediate businesses

바. 미국 Oak Ridge National Laboratory

① 개 괄

1943년 맨하탄 프로젝트 수행을 위해 설립된 ORNL은 미국 에너지부 산하기관으

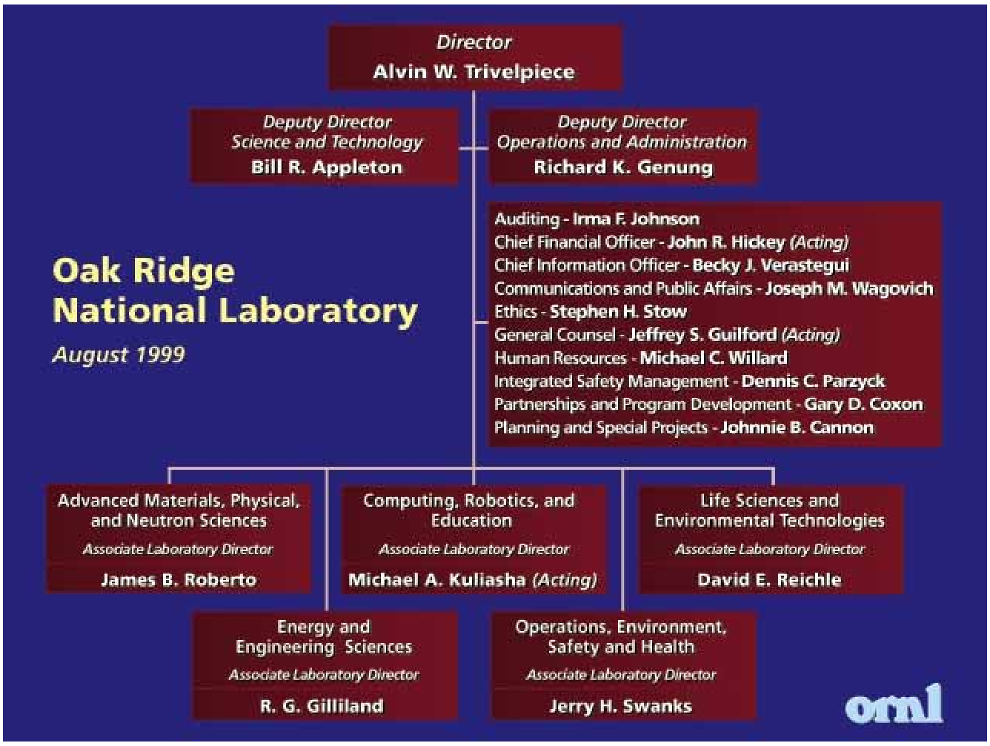
로 에너지 관련 연구 수행, Lockheed Martin Energy Research Corporation가 감독을 하고 있다.

주 연구분야는 기초 에너지 과학, 에너지 효율성, 환경과학 및 기술, 핵물리학, 생명과학 등이며 현재 약 5,000명의 인력 중 1500여명이 과학자 및 공학자이다. 대부분의 재정을 에너지부에서 지원 받으며 방문연구자는 연간 약 4,000명에 이르고 이중 1/4은 산업계이다.

② 조 직

ORNL의 조직은 다음과 같다.

<그림> ORNL의 조직도



③ 핵심적인 연구개발활동

ORNL의 연구개발활동은 크게 과학기술, 에너지 및 자원, 환경, 국가안보로 나누어진다. 각 분야의 주 연구개발 과제는 다음과 같다.

◦ **과학과 기술**

- 재료과학 및 공학(특히 세라믹, 금속, 합금, 표면, 박막, 중합체, 초전도체 등)
- 분석화학, 화학공정, 환경모니터링, 지구화학, 표면과학, 재료화학, 분광학, 방사선 등)
- 환경과학, 환경생물학, 환경화학, 생태계, 지구과학, 수문학, 환경평가 등
- 플라즈마, 자기, 핵물리학 등
- 측정 과학 및 기술
- 핵물리학, 고에너지 핵천체물리학
- 중성자
- 생명과학(게놈학, 단백질학 등)
- 정보학, 고성능계산
- 에너지 및 환경문제와 관련한 사회과학

◦ **에너지 자원**

- 효율적인 에너지 기술
- 생체에너지
- 화석에너지
- 핵기술 및 안전

◦ **환 경**

- 환경관리과학
- 환경기술개발
- 생명주기분석 및 보건 및 환경리스크 평가

◦ **국가안보**

- 무기관련 핵물질의 관리 및 처리
- 국제적인 핵 안정성 확보
- 안전한 비축양에 대한 전략적 계산

④ 협 력

ORNL의 연구협력은 CRADAs, 방문연구, 장비활용 등으로 구분할 수 있다.

Cooperative Research and Development Agreements(CRADAs)는 에너지부 연구기관과 민간기업 혹은 대학과의 협력을 목적으로 기술인력의 교환, 방문연구, 정보공유 등을 통해 이루어진다. 이를 위해서는 연구소에 프로포잘을 제출하고 Lockheed Martin Energy Systems의 승인을 받아야 한다.

Office of Science and Technology Partnerships는 1989년 설립되었는데 연구소의 방문연구자에 대한 지원(외국학자 포함)을 담당하고 있다.

한편 연구소 외부의 대학, 산업에 개방된 사용자프로그램을 통해 다음의 주요 시설을 활용할 수 있다; Atomic Physics EN Tandem Accelerator / Bioprocessing Research Facility / Buildings Technology Center (BTC) / Californium User Facility / Computational Center for Industrial Innovation (CCII) / High Flux Isotope Reactor (HFIR) / Small Angle Neutron Scattering Facility (SANS) / Neutron Scattering Research Facility (NSRF) / High Temperature Materials Laboratory (HTML) / Holifield Radioactive Ion Beam Facility (HRIBF) / Metals Processing Laboratory User Center (MPLUS) / Metrology Research and Development Laboratory (MRDL) / Mouse Genetics Research Facility (MGRF) / Laboratory for Comparative and Functional Genomics / Oak Ridge Centers for Manufacturing Technology (ORCMT) / Oak Ridge Electron Linear Accelerator (ORELA) / Oak Ridge National Environmental Research Park / Walker Branch Watershed / Shared Research Equipment Program (SHaRE) / Surface Modification and Characterization (SMAC) 등. 이를 위해서는 사용자의 프로포잘의 검토와 승인이 필요하며 사용자가 속한 기관과 Lockheed Martin Energy Research Corporation과 협정을 체결해야 한다.

사. 미국 DNA 시퀀싱 및 기술개발 센터
(Stanford DNA Sequencing and Technology Development Center)

① 개 관

스탠포드대학교의 DNA 시퀀싱 및 기술개발센터(SDSTC)는 1993년부터 NIH 게놈센터 중 하나로 생화학과 교수인 Ronald W. Davis 박사가 센터 소장을 맡고 있다. SDSTC는 원래 다음의 두 가지 즉 첫째, 작업처리량을 증가시키고 DNA 시퀀싱 및 게놈분석의 비용절감을 위한 새로운 기술과 방법을 설계하고, 둘째, model eukaryote 및 yeast Saccharomyces cerevisiae 시퀀스를 완성하기 위한 국제적인 노력에 참여하는 것 등의 임무를 목적으로 지원을 받고 있다.

② 기술개발그룹

스탠포드대학교의 DNA 시퀀싱 및 기술개발센터에서 기술개발그룹(Technology Development Group)은 작업처리양을 감소시키고 DNA 시퀀싱 및 분석 비용의 감소시키는 기술개발을 담당하고 있다.

③ 인포메틱스 프로젝트(Informatics Projects)

스탠포드대학교의 SDSTC에서 인포메틱스 그룹은 대사경로데이터의 처리를 위한 샘플 편성, 로보틱스 소프트웨어, 생물실험을 담당하고 있다. 인포메틱스 그룹의 세부 과제는 다음과 같다.

- 시스템 그룹
- 샘플 트래킹 데이터베이스(Sample Tracking Database) 및 서버자동화 소프트웨어
- 주요 시퀀스 프로세싱(Main Sequence Processing)
- 로보틱스 프로그래밍(Robotics Programming)
- Functional Genomics
- Miscellaneous Biochemistry Research

④ 현재 진행중인 시퀀싱 프로젝트

현재 진행중인 시퀀싱 프로젝트는 다음과 같다.

◦ Sequencing of the Arabidopsis thaliana Genome
◦ Malaria Genome Project
◦ Sequencing of Candida Albicans
◦ Maize Gene Discovery, DNA Sequencing and Phenotypic Analysis
◦ Human Sequencing
◦ Cryptococcus neoformans Demonstration Project

⑤ 완료된 시퀀싱 프로젝트

◦ Chlamydia Sequencing
◦ Saccharomyces;

아. 미국 샌디아고 슈퍼컴센터 (SDSC; San Diego Supercomputer Center)

① 센터 개관

샌디아고 슈퍼컴센터(SDSC)는 캘리포니아주립대학(샌디아고)의 연구소로 조직되었으며 약 250명의 인력으로 구성되어 있고 이들의 전공은 생물학, 생의학, 바이오인포테틱스, 화학, 환경과학 등 다양하다.

SDSC는 첨단 컴퓨팅 기술의 개발 및 응용을 통해 지식 진보를 선도해 나가는 것을 임무로 설립되었다. 이러한 임무를 달성하기 위해 SDSC는 다음의 세부 목표를 설정하고 있다.

- 국가의 메타컴퓨팅 인프라를 구축하기 위해 NPACI(National Partnership for Advanced Computational Infrastructure)를 선도
- NPACI의 성공보장
- 첨단 컴퓨팅 기술개발
- 과학연구 수행
- 교육, 외부연구, 훈련을 통해 컴퓨팅 과학 및 엔지니어링 지식의 확산
- 탁월성과 협력에 적합한 연구환경 유지

② 주요 연구활동

- ◦ 고성능 컴퓨터
- ◦ 기록파일저장(Archival File Storage)
- ◦ 과학적 구상(Scientific Visualization)

③ 파트너쉽

SDSC는 NPACI를 구축하기 위해 다양한 파트너와 협력을 하고 있다. 주요 협력 프로그램은 다음과 같다.

- ◦ NPACI
- ◦ Intel Technology for Education 2000
- ◦ Science and Technology Outreach
- ◦ DoD HPC Modernization Program;
- ◦ San Diego Bay Interagency Water Quality Panel;
- ◦ CONNECT; 기술창업프로그램

④ 주요 연구그룹 및 관련 프로젝트

- ○ Data-intensive Computing
  - Digital Library Interoperability
  - MIX: Mediating Information with XML
  - NARA: Persistent Archives and Electronic Records Management
  - DOCT: Distributed Object Computation Testbed
  - SRB: The Storage Resource Broker
  - SEA: The SDSC Encryption/Authentication System
- ○ Scientific Visualization
  - Computational Fluid Dynamics: Characterization of Small-scale Turbulence by Direct Numerical Simulation
  - Turbulent Flow:
- ○ Networking & Security
  - Squid; The popular open-source Web caching software.

- Hierarchy; Hierarchical caching service; includes statistics, log files, and documentation.
- Web Polygraph; The de-facto standard benchmarking package for Web caches.
- Bake-offs; Semi-annual Web caching benchmarking events.

이외에 NLANR Measurement and Operations Analysis Team, Security 등에 대한 연구도 진행중이다.

○ Computational Science Research

○ Scientific Computing
- Scientific Computing Services
- programming and usage issues on production/allocated systems
- consulting, including industrial support and NUPOC
- documentation/information, including HotPage, PCOMP, and SCAN training
- Parallel Applications & Architectures Projects
- allocations process
- HPC architectures evaluations, including "friendly user evaluations"
- clusters evaluations
- applications software
- benchmarking and performance modeling
- Parallel Tools & Environments
- NPACI PTE support
- NPACI Alpha project (Wheeler/Saltz) participation
- evaluations and support or commercial and research parallel tools
- identification of parallel tools needs and collaboration in proposals and research & development with UCSD CSE

자. 미국 Research Collaboratory for Structural Bioinformatics(RCSB, 뉴저지주립대학교)

① 개 관

RCSB는 생물거대분자의 3차원구조에 대한 연구를 통해 생물계에 대한 이해를 증진시키기 위해 설립된 비영리 컨소시엄이다. 컨소시엄의 주요 참여기관은 다음과 같다.

- 뉴저지주립대학교(럿거스) 분자생물물리학 및 생물물리화학센터와 화학과
- 샌디아고 슈퍼컴센터(캘리포니아주립대학, 샌디아고)
- NIST 생명공학부

② RCSB에서 관리하는 데이터베이스

RCSB의 단백질자료은행(PDB)에서 관리하는 데이터베이스는 다음과 같다.

- ◦ 럿거스대학교: a la mode, Nucleic Acid Database(NDB), Structure Finder
- ◦ 샌디아고 슈퍼컴센터: Obsolete Structures, Structural Homology, MOOSE Property Finder, Protein Kinase Resource, WPDB Database for PC
- ◦ NIST: Biological Macromolecule Crystallization Database(BMCD)

③ 주요 소프트웨어

- ◦ Biomedical Servers and Software (SDSC)
- ◦ Comparative Analysis by Combinatorial Extension (SDSC)
- ◦ MEME/MAST Motif Recognition (SDSC)
- ◦ mmCIF (Rutgers)
- ◦ mmCIF Software (Rutgers)
- ◦ imgCIF/CBF (Rutgers)
- ◦ Query Languages (C++) (SDSC)
- ◦ QuickPDB (SDSC)
- ◦ PDBtool (SDSC)

◦ PDBlib (C++) (SDSC)
◦ Structure Solution (X-ray) (SDSC)

④ 교육자료

◦ An Introduction to Nucleic Acids (Rutgers)
◦ Using Internet Resources in Molecular Biology (SDSC)
◦ What is a Protein? (SDSC)
◦ Computational Biology Training at the Burnham Institute

차. 미국 Center for Biomedical Engineering(CBE, MIT)

① 개관

CBE는 생의학기술에 대한 새로운 접근방법을 개발하고 생명공학 연구를 촉진시키기 위해 분자 및 세포생물학과 엔지니어링을 결합하기 위해 설립되었다. MIT 및 하바드, 보스턴의대등 40여명의 인력으로 구성되어 학제간 연구를 진행하고 있다.

② 주요 연구활동

CBE의 주요 연구활동은 크게 분자공학, 세포 및 조직공학, 생리시스템공학으로 구분할 수 있다.

◦ **분자공학(Molecular Engineering)**
이 분야에서는 중요한 생물학적 거대분자의 구조와 기능에 대한 확인과 특징을 발견하는 것으로 DNA-based diagnostics이 대표적인 연구분야이다.

◦ **세포 및 조직공학**
세포 및 조직공학에서는 의약, 유전자, 세포치료, 물질조직의 효율적인 전달체 및 티슈의 재생성에 필요한 장치에 대해 연구한다.

◦ **생리시스템공학**
이 분야의 대표적인 연구분야에는 치료와 진단을 목적으로 세포 및 조직기능에 대한 정량적 측정이 있다.

카. 미국 Center for Automation Technologies(CAT, RPI)

① 개관

CAT는 RPI에 위치한 학제간 연구센터로 1988년 뉴욕주립대학교의 첨단기술센터(Center for Advanced Technology)의 후신이다. 현재 70여명의 인력을 보유하고 있으며 로보틱스에서 마이크로시스템공학까지 산업의 최첨단 자동화에 대한 연구를 진행하고 있다. 아울러 CAT는 뉴욕주의 연구개발센터 네트워크의 구성원으로 민간분야로 기술이전에 경주하고 있다.

② 주요 연구분야

- 자동화기술
- 마이크로시스템기술(Microsystems Technology; MST)
- 분산제어(Distributed Control)

③ 연구프로그램

CAR의 주 연구프로그램으로는 다음이 있다.

- 로보틱스 시스템: surgical robotics, hazardous environment systems, robotic welding, intelligent vehicles
- 제조자동화: precision assembly, mass customization, automated inspection
- 재료처리: aluminum extrusion, process control, rapid prototyping & tooling, smart materials
- 정보처리: virtual enterprise, automated document processing

④ 산업프로그램

CAT는 단기의 시장수요에 빠르게 반응하며 산업기반 연구의 지원을 위해 일대일 협력파트너쉽에 치중하고 있다. 이러한 산업계의 요구에 직면하여 최근에 진행된 프로젝트는 다음과 같다.

- Postal Tray Handling System
- Electrochemical Grinding Control

- Multi-Chip-Module (MCM) Testing
- Microgripper
- Modular Assembly Systems
- SuperOxygenating Water
- Advanced Technology Assembly
- Testing of a Flexible Coupling
- Ferrite Core Handling
- Robotic System for Filament Alignment
- High-Speed Goniometer
- Six-Legged Robot Inspection System
- On-Demand Electronic Printing for Textiles
- Gantry-Based Automated Palletizing System
- Cap Liner Insertion System

타. 미국 National Semiconductor Corporation(NSC)

① 개 관

1959년 설립된 NSC의 현재 본부는 캘리포니아 산타바바라에 있으며 1999년 매출액은 약 20억 달러이며 인력은 약 11,000명이다.

NSC는 정보화시대의 통합 솔루션과 아날로그 및 디지틀기술을 결합하고 단일칩에서 고성능 멀티칩 제품 등 정보응용, 퍼스털 컴퓨팅, 소비 및 통신시장의 최적 솔루션을 제공하는 것을 목적으로 하고 있다. 현재 NSC는 정보고속도로의 접근을 지원하는 아날로그 및 혼합 시그널 반도체 제품의 설계 및 제조를 주도하고 있다.

② 주요 제품 및 기술

◦ **정보응용**
  - Geode Family: 인터넷 접근을 자유롭게 할 수 있는 제품.
  - 개인컴퓨터, 노트북, 워크스테이션

◦ **PC 통신**

- 유무선 네트워킹 기술

◦ **무선통신**

- 무선통신을 위한 실리콘 기술, 광대역 개인통신 기술, 저전압 신호처리기술 등

◦ **모니터 및 디스플레이**

- 드라이버 및 버퍼, 평면 디스플레이

◦ **팩스 및 스캐너**

◦ **전력관리(Power Management)**

- 배터리 시스템

파. 미국 General Electric Company Corporate Research and Development

① 개관

20세기 초반부터 활발히 연구를 수행해 온 GE의 중앙연구소(CRD)는 GE의 연구소중 하나로 화학에서 자본재, 정보혁명에서 산업 전자공학, 의학진단에서 야금학까지 전체 기술을 포괄하고 있다. CRD의 주 임무는 다음과 같다.

- 기술적 우월성을 확보하기 위해 GE 사업부서와 팀을 구성하여 협력
- '게임을 변화하는' 새로운 사업기회를 창조하는 혁신 개발
- 핵심적인 기술문제에 대한 대안제시
- GE 전 사업부의 기술공유
- 세계 첨단 기술에 대한 접촉
- GE의 선도적 위치 개발

② 주요 연구활동

GE의 중앙연구소는 12개의 학제간 연구실로 구성되어 있다. 각각의 연구실은 특수한 기술분야를 다루고 있다. 12개의 연구실은 다음과 같다.

- Ceramics Lab
- Characterization and Environmental Technology Lab
- Chemical Process Technology Lab
- Control Systems & Electronic Technology Lab
- Electronic Systems Lab
- Engineering Mechanics Lab
- Industrial Electronics Lab
- Information Technology Lab
- Manufacturing and Business Process Lab
- Mechanical Systems Lab
- Physical Metallurgy Lab
- Polymer Materials Lab

하. 미국 Lawrence Berkeley National Laboratory(LBNL)

① 개관

LBNL은 사이클로트론을 발명한 Ernest Orlando Lawrence가 1931년 설립한 연구소로 입자물리학을 개척한 연구소로 노벨 물리학상 5명, 화학상 4명을 배출한 명망있는 연구소이다. 현재 LBNL은 첨단재료, 생명과학, 에너지, 검출기, 가속기 등에 대한 다양한 연구실을 운영하고 있다.

LBNL은 현재 4,000여명의 인력과 600여명의 학생이 소속되어 있으며 미국 에너지부에 의해 관리되고 있다. LBNL은 오늘날에도 가속기와 검출기의 혁신과 설계의 핵심 연구소일뿐 아니라 핵의학과 medical imaging 발명의 근원지이다. 심장병분야에서 동 연구소는 리포단백질을 처음으로 분리하였다. 화학적 레이저의 발명, 광합성에 대한 해명 등 수많은 업적을 자랑하고 있다. 현재 차세대 반도체에서 심장병 검진개발, 신물질 개발 등에 이르기까지 광범위한 분야에서 프로젝트를 수행하고 있다.

② 주요 연구분야

LBNL의 주요 연구분야는 다음과 같다.

◦ **물리학 및 우주학**
  - 우주의 운명
  - 자기력(Magnetic Attraction)
  - 중성자별

◦ **생명과학**
  - 세포의 비밀
  - 유방암
  - 다운신드롬에 대한 유전학

◦ **첨단 광학**
  - Shorter Waves for Dencer Chips
  - Beaming in on Cell Structure

◦ **재료 및 화학**
  - Image from Within
  - Signals from the far Reaches of Space
  - Electrons at the Interface

◦ **컴퓨터과학**
  - a Flaw in the Law
  - Zooming in on Data

◦ **에너지 및 지구과학**
  - Safe Storage
  - Living on the Fault Line

[별첨 2] 국내 주요 협력대상 연구소의 프로파일

가. 생명공학연구소

① 1997년 외국과의 협력협정

1997년 생명공학연구소의 협력협정은 다음과 같다.

- Montreal Joint Center for Structural Biology: 구조생물학센터 참가 합의
- 중국 동물연구소: Physiology and Molecular Mechanism 공동연구
- 인도 IIT: Biological Production of Chiral Compounds 공동연구
- University of Montreal: 해외 학·연 프로그램 운영(보완)
- 나라선단과학기술대학원대학: 공동연구, 정보교환, 인력교류
- Komarov Botanical Institute: Literature Sources on Type and Voucher Apecimens 공동연구
- 연변농학원: 공동연구, 인력교류, 정보교환
- 독일 GBF: 공동연구, 인력교류, 정보교환

② 국제공동연구실적

1997년 중국의 상해 생명(연), 중국과학원 동물(연), 연변대, 캐나다 웨시턴온타리오대, 미국 테네시대, Indian INS. of Technology, NIH, TRC, 프랑스 INSERM U., 꽁뻬엔느, CRC, 브라질 National Center for Genetic Resources and Biotechnology, COT, 캄피나스대, 일본 Kyto대, 오사카대, 네덜란드 Centraalbureau voor Schimmelcultures, 영국 뉴캐슬대 등과 공동연구를 수행하였다.

공동연구과제는 다음 표와 같다.

<표> 생명공학연구소의 국제공동연구

과 제 명	공동연구기관(국명)
한중 생명공학 협력센터 추진비 지원	생해 생명(연) (중국)
인체발암유전자 E7의 발암기적 분석 및 이용기술 연구	웨시턴온타리오대 (캐나다)
Ninjurin 유전자의 특성분석 및 기능점검	Tennessee대 (미국)
B형 간염바이러스 감염저해제 개발연구	INSERM U. (프랑스)
식물저장 기관에서 인체면역 강화단백질 락토페린 생산	National Center for Genetic Resources and Biotechnology (브라질)
고온성절대공생 미생물의 신규 아미노산 생합성 효소를 이용한 생물전환 기술	Kyto대 (일본)
광학활성 의약품 중간체 (R)a-B-cetylmercaptoisobutyric acid의 생물학적 생산공정 개발	Indian INS. of Technology (미국)
브라질의 다양한 생물자원으로부터 최첨단 기술을 이용한 신규활성물질을 생산하는 방선균 및 기차 세균의 분리 및 활용	COT (브라질)
Penicillium 및 Aspergillus의 분자계통분류 및 이용개발에 관한 연구	Centraalbureau voor Schimmelcultures (네덜란드)
곤충내 저온성 메카니즘의 유전생리학적 연구	중국과학원 동물(연) (중국)
APEC역내 유용생물자원의 탐색 및 활용기술 개발	
신호전달계 효소 및 항산화물질관련 형질전환 동물개발	NIH
대사공학을 이용한 비타민 C 생물학적 전환기술 연구	꽁삐엔느 (프랑스)
신기능 생물소재 공통기반지원기술	뉴캐슬대 (영국), TRC (미국), 캄피나스대 (브라질), 연변대 (중국)
신규 고온환경 미생물의 기능연구를 통한 유용 D-펩타이드의 합성 및 생산연구	오사카대 (일본)
효모 표면발현계의 개발 및 이를 이용한 생체 촉매개발	C.R.C. (미국)

③ 해외 과학자 활용

생명공학연구소는 국제협력의 일환으로 1997년 총 17명의 해외과학자를 초빙하였으며, 워크샵 및 세미나를 통해 재미, 재캐나다 한인과학자 등 해외 유명과학자가 방문하였다.(13건).

④ 국외 교육훈련 및 학술회의 참가

1997년 NIH(6명), 몬트리올대(1명), Vandebilt(1명), 일본 Osaka대학(1명), Univ. of Tenn.(1명), 콜로라도대학(1명), Northwestern 대학(2명), 미국 Missouri Univ.(1명), Texas Tech Univ.(1명), Washington State Univ.(1명), McGill Univ.(1명), Duke Univ.(1명), Alton Ochsner Hospital(1명), Hokkaido Univ.(1명), 일본 오사카대학 산업과학연구소(1명), 미국 Purde University(1명), NAIST(1명) 등의 기관을 통해 교육훈련을 수행하였으며 미국, 일본 등 국외에서 개최된 학회에 약 80여명의 연구인력이 참여하였다.

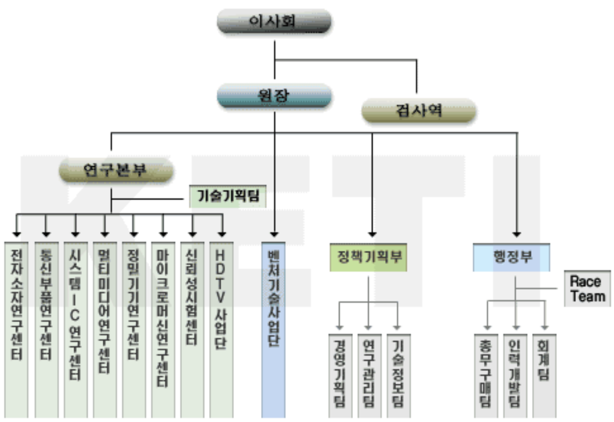
나. 전자부품연구원 System IC Research Center

전자부품연구원은 우리나라 전자・정보산업의 기술혁신과 선진화를 위한 기술개발 및 전략을 수립하고 중소부품업체의 기술력 향상을 위한 기술 지도와 산업계의 기술 기업화 및 국가 경쟁력을 제고하기 위해 설립된 산업자원부 산하 연구원이다.

① 센터 개관

시스템IC센터는 전자부품연구원 산하 7개 센터중 하나로 전자부품연구원의 조직은 다음과 같다.

<그림> 전자부품연구원의 조직



② 주요 연구분야

◦ **IC 카드 및 보안시스템개발**
- 스마트용 IC 설계기술에 관한 연구
- 스마트카드 시스템 개발
- 암호용 코아 개발
- 근거리통신용 RF 라이브러리 개발

◦ **시스템용 칩셋트 개발**
- 고속 무선 ATM 모뎀 설계 기술 개발
- 고속 무선 데이터 모뎀 칩셋트 설계 기술 개발
- 광대역 Digital Subscriber Line 모뎀 코어 IP 기술 개발
- 오디오 및 데이터방송 수신기 칩셋트 설계 기술 개발
- 고속 Internet Access용 IP Over ATM 시스템 개발
- MPEG Audio Encoder/Decoder 개발
- HDTV용 Demux 개발

◦ **중소기업 ASIC 개발 지원**

시스템 개발과 병행하여 ASIC 개발을 계획중인 중소 업체를 대상으로 ASIC 개발을 지원하고 있다.

◦ **System IC 2010 사업**
- IP DB 개발
- 오디오 및 데이터방송 수신기 칩셋트 설계 기술 개발

◦ **기타**
- 다기능 디스크램블러 ASIC 개발
- 승제산용 Coprocessor 개발
- 12bit, 10Mhz A/D 변환기 개발

다. 한국전자통신연구원 컴퓨터·소프트웨어기술연구소

① 연구소 개관

한국전자통신연구원은 4연구소, 4본부, 1부, 2지원부로 구성되어 있으며 컴퓨터·소프트웨어기술연구소는 4연구소중 하나로 346명의 인력을 보유하고 있다.

◦ **일반현황**

컴퓨터·소프트웨어기술연구소는 컴퓨터 시스템 S/W, 정보통신망 S/W, 멀티미디어 및 영상처리 S/W, 고성능 멀티미디어 서버 기술 등을 개발하는 전문 연구소로서 중소기업 공동체로 S/W 기술과 첨단 기반 S/W기술에 대한 연구개발을 수행하고 개발된 결과를 민간업체에 기술이전하여 S/W산업의 국제경쟁력 강화와 국가정보화 촉진에 기여함으로써 국민과 산업계로부터 신뢰받는 연구소가 되기 위해 연구력을 집중하고 있다.

◦ **주요 연구분야**

- 컴퓨터시스템 연구
- 인터넷서비스 연구
- 실시간컴퓨팅 연구
- 가상현실(VR) 연구
- 지식정보 연구
- 멀티미디어 연구
- 영상처리 연구
- 전자상거래 연구

◦ **연구개발 추진실적**

▶ 8비트 교육용 소형컴퓨터 개발 (PC개발)

▶ 16비트 및 32비트 수퍼마이크로급 유닉스 컴퓨터 개발

▶ 수퍼미니급 주전산기 (TICOM 1,2,3,4)

▶ 데이타베이스 관리시스템 (바다 1,2,3,4)

▶ 지능형 멀티미디어 워크스테이션 (ComBi Station 1,2)

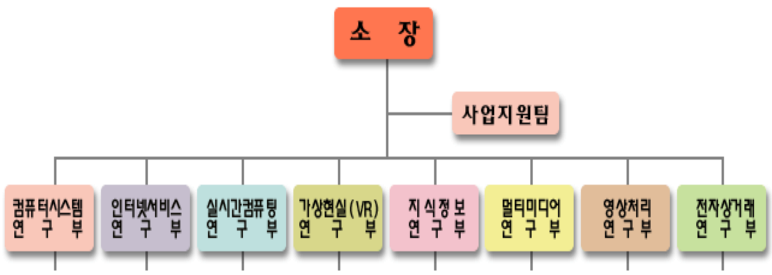
▶ 분산시스템 소프트웨어 (한우리)

▶ 초고속 정보통신망 운영체제 (GIANT)
▶ 멀티미디어 DBMS 개발
▶ 분산처리 진단 소프트웨어 개발
▶ 시스템개발 방법론(마르미)
▶ 프린터용 칼라일치 기술
▶ 영한 웹기반 번역 시스템 개발
▶ 공동작업 및 그룹웨어용 고성능 퍼스널 워크스테이션
▶ 얼굴 동영상 추적 및 복원 시스템 개발
▶ CALS 통합 데이터베이스 기술 개발

◦ **향후 연구계획**

광역 인간중심 정보처리(GHC:Global Human Computing)기술을 개발하여 미래 창조형 서비스 창출을 촉진하고 더불어 사는 인간중심 정보화 사회 구현을 앞당기는 연구개발에 전념할 계획이다

◦ **조직**



② 주요 연구개발활동

◦ **컴퓨터시스템기술**

- 고성능 멀티미디어 서버 기술 개발

◦ **인터넷서비스기술**

- 인터넷 멀티미디어 문서 DBMS(바다IV)기술 개발

- 인터넷 분산 시스템 소프트웨어 기술 개발
- 분산처리 진단/교정 소프트웨어 개발
- 하이브리드 메세징 시스템 개발

◦ **실시간컴퓨팅기술**
- 조립형실시간 OS연구 개발
- Java Embedded S/W 개발
- S/W 기술 표준 연구

◦ **가상현실(VR)기술**
- 통합형 디지털 TV 컨텐트 제작 시스템 (Solger 2001)
- 멀티미디어 장치간 원색재현 소프트웨어 개발
- 분신(Avatar)의 행동처리 양식 및 상호작용 S/W 개발
- 촉각 및 음성인터페이스 기반의 시각장애자용 정보단말기 개발

◦ **지식정보기술**
- 내용기반 멀티미디어 정보검색 기술개발
- 낭독체 음성 타자기 기술 개발
- 실용화를 위한 한영/영한 자동번역

◦ **멀티미디어기술**
- 지능형 휴대 클라이언트 기술 개발
- 광역 협동 멀티미디어 정보처리 기술개발
- 분산형 실감 서비스를 위한 3D 멀티미디어 기술 개발

◦ **영상처리기술**
- 다중동영상의 파노라마 생성 및 3D 실감합성 기술개발
- Web 기반 3차원 지리정보 소프트웨어 도구 개발
- 실시간 GPS 정보기술
- 개발형 GIS 컴포넌트 기술개발

◦ **전자상거래기술**

- CALS 요소기술 개발
- 사이버 커머스 S/W 기술개발실시간 GPS 정보기술
- 동시공학 기술개발
- 전자상거래 디렉토리서비스 S/W개발

라. 한국원자력연구소

한국원자력연구소의 국제협력은 크게 협력약정, 국제공동연구, 국제기구활동, 국외 위탁교육 및 학술회의 참가로 형태로 이루어진다.

① 국제 협력약정

1997년 현재 15개국(국제기구 1개) 39건의 기관간 원자력협력 약정을 체결하였는데 협력 대상 국가와 기관은 다음과 같다.

- 미국 : 아르곤국립연구소(ANL) 1건
- 캐나다 : 캐나다원자력공사(AECL) 8건
- 프랑스 : 원자력안정방호연구소(IPSN) 3건, 프랑스원자력청(CEA) 1건
- 독일 : 칼쓰루헤원자력연구소(KFK) 1건
- 영국 : AEA Technology(AEAT) 1건, 영국핵연료공사(BNFL) 1건
- 호주 : 호주원자력연구소(ANSTO) 1건
- 일본 : 일본원자력연구소(JAERI) 1건(연장추진), 일본전력중앙연구소(CRIEPI) 1건
- 중국 : 핵공업총공사(CNNC) 1건, 청화대부설원자력연구소(INET) 1건
- 러시아 : 과학센터쿠차로프연구소(RSCKI) 1건, 물리동력공학연구소(IPPE) 1건, 동력공학연구개발원(RDIPE) 1건, 일반물리연구소(GPI) 1건, 말라카이트연구소 (MALACHITE) 1건, 피츠버그핵물리연구소(PNPI) 1건, OKB기계공학연구소 (OKBM) 1건
- 우즈백 : 핵물리연구소(INP) 3건
- 체코 : 체코원자력연구소(CNRI) 1건
- 인도네시아 : 인도네시아원자력연구소(BATAN) 1건

• 필리핀 : 필리핀원자력연구소(PNRI) 1건
• 폴란드 : 핵물리연구소(INP) 1건
• 칠레 : 칠레원자력위원회(CCHEN) 1건
• OECD/NEA : 2건(1건 연장추진)

② 국제공동연구실적

1997년 원자력연구소는 미국의 LANL(1건), PPPL(2건), GE(1건), ANL(1건), ORNL(1건), 스탠포드(1건), 영국은 AEAT(5건), OECD/NEA(3건), IAEA(1건), 러시아의 경우 PNPI(2건), 부드커핵물리연구소(2건), IPPE(2건), Macrooptica(2건), 분광학연구소(1건), 쿠르차토프연구소(1건), 일본은 동북대(2건), 중국은 고능물리연구소(2건), 북경대학(2건), 프랑스는 Technicatome(1건), 체코는 NRI(1건), 독일은 NUKEM(1건), 캐나다의 AECL(2건), 스웨덴의 SKB(1건), 노르웨이 등과 국제공동연구를 수행하였다. 과제명과 공동연구기관은 다음 표와 같다.

<표> 한국원자력연구소의 국제공동연구

과 제 명	공동연구기관(국명)
반응도를 이용한 DUPIC 핵연료물질의 NDA 반응도 측정장치 개발	LANL (미국)
Research Collaboration for DUPIC IPS Design	AEAT (영국)
HRP 참여	OECD/NEA
CNS(냉중성자원)개념설계를 위한 공동연구	PNPI (러시아)
Assessement of Corrosion Susceptibility of Alloy 600 & 700	동북대 (일본)
2-Mev 전자가속기용 전자총 및 고주파발생장치 개발	부드커핵물리연구소 (러시아)
자유전자레이저용 고주파 열음극전자총 개발	고능물리연구소 (중국)
자유전자레이저용 초전도가속관 기술개발	북경대학 (중국)
액금로 노심특성실험연구	IPPE (러시아)
대전류 전자가속기 및 고출력자유전자레이저 설계	부드커핵물리연구소 (러시아)
KALIMER중간열교환통의 설계개념분석 및 설계용 전산코드 개발	AEAT (영국)
중성자 분광장치용 부품제작 및 분광기술개발	PNPI (러시아)
가열장치분야 공동연구	PPPL (미국)
OECD/NEA ASSARR Project	NEA 등
OECD/NEA Sorption Modeling Project	NEA 등 11개국

과　　제　　명	공동연구기관(국명)
HALDEN Project	(노르웨이)
한・캐・미・IAEA DUPIC 공동연구	한・카・미・IAEA
냉중성자원 개념설계의 기술검토를 위한 공동연구	Technicatiome (프랑스)
조사시험봉제작 및 BR-10 고속로를 이용한 노내조사시험	IPPE (러시아)
Assessement of Corrosion Susceptibility of Alloy 600 & 900	동북대 (일본)
Evaluation of Neutron Irradiation Embrittlement & Recovery Characteristics of R/V Steels	NRI (체코)
Activity Plan for Key96 (KAERI-GELMR Partnership Agreement)	GE (미국)
INKAR Phase 2 Project	AEAT (영국)
면진 및 원자로구조물 기술개발	ANL (미국)
Jointdev't work for Concept review & optimization of KAERI's SMART Facility	NUKEM (독일)
Colloid Migration Experiment in Fractured Rock-Effect of Colloid on Radionuclide Migration	AECL (캐나다)
MASCOT-K	AEAT (영국)
PWR/CANDU 사용후핵연료 처분포장 및 지하처분배열 방안검토 및 기술자문	SKB (스웨덴)
Volume Reduction Technology Development for Solid Waste from the Nuclear Fuel Cycle	AEAT (영국)
K Catalyst Contract	AECL (캐나다)
차세대 초전도 연구장치의 이온공명가열장치설계	ORNL (미국)
지하수-암석 진화환경에 따른 미량원소의 지화학적 거동해석	Stanford (미국)
Development of Digital Converter & Interpretation S/W for Remote Sensing Signals	Macrooptica (러시아)
Development of Receiving System & Processing S/W for micro-joule Pulse Lidar	Macrooptica (러시아)
Development of Superconducting Acceleration cavity for free electron laser	북경대학교 (중국)
자유전자레이저용 고주파 전자총 개발	고능물리연구소 (중국)
Development of precision wave length meter	분광학연구소 (러시아)
Development of electron beam maniputation system for welding system	쿠르차토프연구소 (러시아)
초우란 원소폐계측개발	IAEA 등
가열장치분야 공동연구	PPPL (미국)
원전디지털 계측제어 시스템 컴퓨터 안정성 공동연구	Lawrence Livermore National Laboratory

③ 국제기구 활동현황

원자력연구소는 국제원자력기구(IAEA)와의 협력을 통해 훈련생 파견, 전문가 초청, IAEA 사업수행, 자문회의 개최, 아・태지역협력협정(RCA) 수행, IAEA 국제행사 개최 및 국제회의 참가 등을 통해 인적 및 정보를 교환하고 있다. 아울러 단순히 인적 및 정보 교환 이외에도 OECD/NEA와의 협력을 통해 공동연구과제를 수행하고 있다.

④ 국외 위탁교육 및 학술회의 참가

3개월 미만의 단기 국외교육은 39명, 3개월 이상의 위탁교육은 1997년 총 23명으로 파견국가는 일본, 영국, 노르웨이, 미국, 캐나다, 벨기에 등이다. 1997년 국외 학회/세미나에는 총 268명이 참가하였다.

마. 한국에너지기술연구소

한국에너지기술연구소 또한 기술협정, 국제공동연구, 국제기구활동, 국외위탁교육 등을 통해 국제협력을 하고 있다.

① 1997년 기술협정체결현황

1997년 4개국 5개기관과 기술협정을 체결하였으며, 1997년 현재 총 16개국 44개기관과 기술협정을 체결하였다. 협정내용은 다음고 같다.

- 미국 : Lehigh University, 고온건식 탈황 BSU장치의 안정식 운전을 위한 고체순환기술개발 공동연구
- 미국 : Hawaii Natural Energy Institute(HNEI), University of Hawaii, 정보 및 인력교류
- 말레이시아 : University of Malaya, 고효율 저온 태양열 적용 시스템 개발 공동연구
- 인도 : Central Salt and Maring Chemicals Research Institute(CSMCRI), 정보 및 인력교류
- 캐나다 : Ecole Polytechnique, 정보 및 인력교류

② 국제공동연구실적

1997년의 경우, 10개 국가 13개 기관과 13개의 과제를 수행하였는데 일본의 경우 ETC, NIRE, NIMCR과 3과제, 미국은 NIST, CIT와 2과제, 인도 NCL과 1과제, 독일 ISFH와 1과제, 말레이시아 Malaya 대학과 1과제, 캐나다 British Columbia 대학과 1과제, 호주 UNSW와 1과제, 네덜란드 ECN과 1과제, 헝가리 CRIC와 1과제를 수행하였다.

공동연구의 상대기관과 과제명은 다음 표와 같다.

<표> 한국에너지기술연구소의 국제공동연구

과　제　명	공동연구기관(국명)
막분리형 알루미누실리게이트 개발 및 가스분리공정 연구	NCL (인도)
마이크로파를 이용한 강흡착성 물질의 흡탈착 기술연구	NIRE (일본)
수소저장화합물을 이용한 수소저장 기술	MOU (러시아)
고온 내열충격성 연소촉매 및 연소반응 설계기술 개발	CRIC (헝가리)
균일계 Organic dye를 활용한 폐수처리 태양반응기 개발	WIS (이스라엘)
고밀도 상변화(HDPE) 물질을 이용한 축열시스템 개발	ETL (일본)
고효율 저온태양열 적용시스템 개발	MOU (말레이시아)
고도산화/환원 (태양)광화학반응을 이용한 대기/토양 오염물질 해석	ISFH (독일), CIT (미국)
첨단 일사조절창호의 에너지 성능평가기술개발	UNSW (호주)
에너지설비의 최적성능 유지를 위한 실시간 상태감시제어와 이상검출 및 진단	NIST (미국)
고체산화물 연료전지 기술개발	NIMC (일본)
한·EU 고효율 에너지 기술평가 및 활용기술 공동연구	ECN (네덜란드)

③ 국제기구 활동 현황

국제원자력기구(IAEA) 에너지기술 및 연구개발 국제협력프로그램, APEC 에너지실무반, IPCC(기후변화협약), UNDP(유엔개발계획), UNESCO(유엔교육과학문화기구), ESCAP, WEC(세계에너지회의) 등에 전문가 혹은 자문위원으로 참가하고 있다.

④ 국외 위탁교육

1997년 해외교육훈련은 총 51명으로 해당 국가는 미국(18명), 네덜란드(1명), 일본(8명), 캐나다(1명), 영국(3명), 프랑스(1명), 중국(2명), 이탈리아(1명), 독일(11명), 덴마크(4명), 인도(1명) 등이다.

바. 한국전기연구소

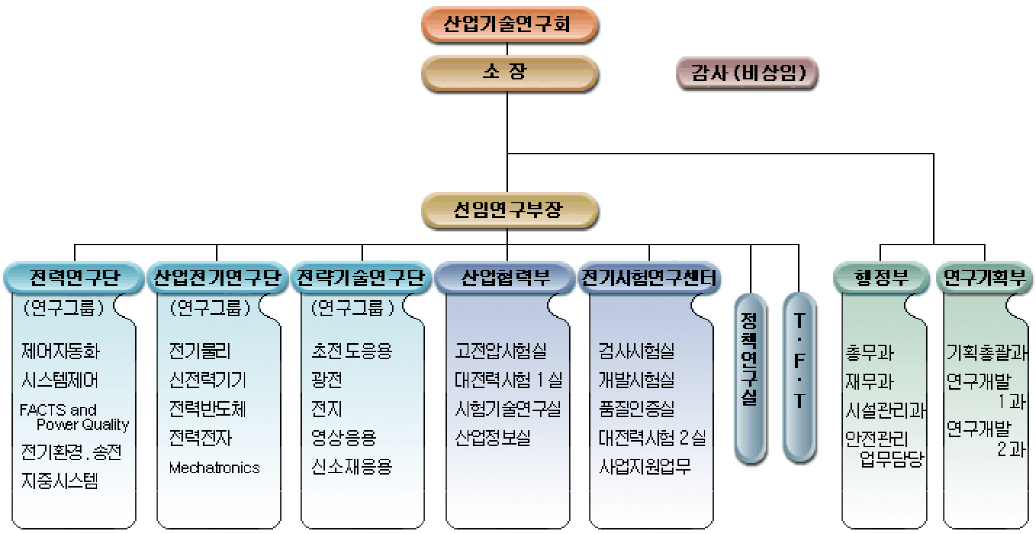
① 개 관

◦ **연혁**

한국전기연구소는 1976년 12월 29일 설립된 한국전기기기시험연구소의 후신으로 1981년 1월 20일 한국통신기술연구소와 통합되어 한국전기통신연구소로 명칭이 바뀌었다가 1985년 6월 17일 한국전기연구소로 발족하였다. 이후 1999년 1월 29일 출연(연)법에 의거, 한국전기연구소가 설립되었다.

◦ **조직**

한국전기연구소는 전력연구단, 산업전기연구단, 전략기술연구단 등 3개의 연구그룹과 기타 부서로 구성되어 있다. 한국전기연구소의 조직은 다음과 같다.



② 주요 사업

◦ **전력연구단**

- 국가전력망 계통연계 및 최적화 기술개발 : 신뢰도 및 전력품질 향상
- 환경친화형 전력수송시스템 기술개발 : 전기환경 및 전자파 대책, 지중시스템의 고도화

◦ **산업전기연구단**

- 21세기 첨단 기술분야인 반도체
- 초고압 GCB/GIS 기술, 레이저, 플라즈마, E-Beam 이용기술

◦ **전략기술연구단**

- 초전도응용, 광전, 신소재응용 개발연구를 통하여 전력 대용량화 및 고품질화에 대처
- 차세대 전지개발과 의료 영상화 기기 개발을 통하여 국민 복지증진에 기여

◦ **전기시험연구센터**

- 전기기자재의 시험평가와 품질인증등을 통한 중전기기 제품의 신뢰도 제고
- 전기기술인의 전기전문기술교육을 통한 전기산업의 기술수준 제고

◦ **산업협력부**

- 세계적 수준의 시험평가기술 확보
- 국제적 공인시험, 검사, 인증기관에 도달

◦ **정책연구실**

- 기술 및 전력정책연구

◦ **중점 국가연구개발사업**

- 전력용반도체기술개발사업단
- MR소자를 이용한 전류・전압센서 개발
- 고온초전도 자석개발
- 고용량축전장치를 이용한 에너지절약형 동력시스템 개발
- 고속전력선 가입자망 개발('99 중기거점 기술개발사업)

[부록 1] NSF 프로젝트 개요

(1) 생명과학(40개 과제)

① Biological Infrastructure(24개 과제)

연구과제명 : (9631642) Sequencing the Arabidopsis Genome
기관명 : Stanford University
NSF 프로그램 및 연구분야 : ARABIDOPSIS / Other Applications NEC
연구기간 : 1996. 8. 15. - 2000. 8. 31.(추정)
전체연구비(추정) : $3,355,000
연구요약 :

This award supports a consortium of three laboratories located at Stanford University, U.C. Berkley, and University of Pennsylvania. The long term goal of this project is to determine the total DNA sequence of the Arabidopsis thaliana genome. For the next three years, the specific goal of this consortium is to produce at least 5.2 Mb of finished sequences of DNA from chromosome 1. Additional important goal of this project is to apply the new high throughput DNA sequencing technologies to Arabidopsis genome sequencing. All sequences will be deposited in GenBank upon completion of each BAC or YAC clones. Unfinished sequence data will be made available on a WWW site to be set up at Stanford. Clones and other materials will be made available through the Arabidopsis Biological Resource Center at Ohio State. This award is one of the three awarded by the triagency (Department of Energy, National Science Foundation, and US Department of Agriculture) Arabidopsis thaliana genome research program. The activity of this consortium will be coordinated with the other groups engaged in large scale sequencing of the Arabidopsis genome. The results will contribute to determining the overall strategy for the completion of the sequence of the entire Arabidopsis genome. More importantly, the information and data produced will be useful to the general research community and will contribute to a rapid advance in plant biology.

연구과제명 : (9632082) A Genetic Approach to Ordered Sequencing of Arabidopsis
기관명 : Cold Spring Harbor Lab
NSF 프로그램 및 연구분야 : ARABIDOPSIS / Other Applications NEC
연구기간 : 1996. 8. 15. - 2000. 7. 31.(추정)
전체연구비(추정) : $4,185,000
연구요약 :

This award supports a consortium of three laboratories located at Cold Spring Harbor Laboratory, Washington University at St. Louis and the Applied Biosystems in forest City, California. It supports the group's effort to produce at least 7 Mb of finished sequences of DNA from chromosome 4 and 5. The sequencing strategy uses a combination of shotgun and more ordered approaches. This group makes maximal use of softwares and technologies developed for the C. elegans genome sequencing project for sequencing and finishing large contiguous DNA pieces. All sequences will be deposited in GenBank upon completion of each BAC clones. Unfinished sequence data will be made available on a WWW site very rapidly. Clones and other materials will be made available through the Arabidopsis Biological Resource Center at Ohio State. This award is one of the three awarded by the triagency (Department of Energy, National Science Foundation, and US Department of Agriculture) Arabidopsis thaliana genome research program. The activity of this consortium will be coordinated with the other groups engaged in large scale sequencing of the Arabidopsis genome. The results will contribute to determining the overall strategy for the completion of the sequence of the entire Arabidopsis genome. More importantly, the information and data produced will be useful to the general research community and will contribute to rapid advances in plant biology.

연구과제명 : (9813360) Genomics of Plant Stress Tolerance
기관명 : U of Arizona
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $8,270,704
연구요약 :
The long-term goal of this proposal is to identify and determine the role of all the genes involved in a plants response to salt and water stress. Over the last decade, it has become clear that responses to water deficit and ion imbalance are governed by complex molecular and biochemical signal transduction processes, which coordinately act to determine tolerance or sensitivity at the whole-plant levet. Within the last five years, however, advances in genomics, informatics, and functional genomics have made it technically feasible to gain a global understanding of the gene complement or set that becomes integrated to effect abiotic stress tolerance. To tackle the genetic basis of this tolerance in higher plants in the most efficient, comprehensive, and integrative way possible Drs. R. Bressan, P. Hasegawa (Purdue University), R. Burnap, J. Cushman, R. Prade (Oklahoma State University) and H. Bohnert, D. Gaibraith, J-K. Zhu (University of Arizona) have formed a consortium. Each participant has a documented and extensive experience in this research area with a proven record of productivity and in many instances past or present collaborations. This team will employ three distinct, yet complementary approaches to isolate, characterize, and assess the function of the core set of stress-related genes that provide the basis for the water and salt stress tolerance phenotype in plants. The first approach will encompass the functional identification of genes important to stress tolerance by random and targeted mutagenesis strategies in well-studied model organisms (Synechocystis PCC6803, Saccharomyces cerevisiae, Aspergillus nidulans, and Arabidopsis thaliana). For Arabidopsis, they will identify, map and clone genetic Ioci from a large set of mutants defective

in stress tolerance or signaling. The resulting sets of mutants will be used for complementation studies using genes from higher plant sources. The second approach aims to define the core set of stress-related transcripts from both sensitive plants (Arabidopsis thaliana and rice) and resistant plants (Dunaliella salina and ice plant) using EST sequendng and microarray analysis. This approach will focus on the comparative study of gene expression patterns in salt and drought sensitive and resistant organisms, since recent studies of resistant organisms have revealed the existence of mechanisms of stress tolerance not present or not appropriately expressed in sensitive organisms. The third approach will extend the functional analysis of stress-related transcripts by monitoring in situ Iocalizations by using promoter trapping approaches and gain-of-function studies. These approaches represent logical extensions of ongoing work in individual groups within this center. They will foster interaction and integration of Consortium activities through daily interactions, workshops/meetings and extended work periods in member laboratories for their students and postdoctoral fellows to ensure a new generation of researchers trained in multi-faceted and interdisciplinary problem solving. The impact of abiotic stress on crop productivity is remarkable according to USDA statistics and amounts to two-thirds of all yield reductions in agriculture. This proposal is exceptionally timely, combines unique expertise, is hypothesis-driven and culminates in a dearly defined goal - understanding the number, nature and networking of genes and physiological mechanisms that constitute plant abiotic stress tolerance.

연구과제명 : (9813392) The Generation of a Tomato EST Database
기관명 : Institute for Genomic Res
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 11. 1. - 2001. 10. 31.(추정)
전체연구비(추정) : $3,246,725
연구요약 :

The tomato plant has long been a popular species for various aspects of plant biology research including genetics, development, physiology and pathology. Today much of the research on tomato concentrates on fruit development and pathogen response since in these areas tomato still stands out as an ideal model. In recent years, genomics has risen to the forefront of modern biological research and now provides great opportunities for plant biology. One of the most widely used genomics approaches is to generate Expressed Sequence Tags (ESTs) from an organism. These are short sequences obtained from cDNA clones selected at random and are a very cost effective way of identifying a large number of genes expressed in a tissue. Once generated these sequences are a valuable resource for a large number of experimental approaches including mapping, expression studies, and genome annotation. This project will generate 90,000 ESTs from a variety of tomato tissues including core tissues present in most plants (shoots, roots, developing anthers and ovules, and developing seeds), as well as tissues of particular interest to tomato researchers such as ripening fruits, and diseased tissues. These

90,000 sequences will be used to construct a tomato EST database in which the ESTs from the same gene are grouped together and treated as a single entity. These will then be annotated to identify possible functions of each gene. Information about the source of each EST will also be part of this database, and therefore it will be possible to identify tissue-specific genes, and genes switched on in response to attacking pathogens. It is expected that the sequences and the clones from this project will become part of the collection of tools used by tomato researchers, and indeed researchers working on any number of other species.

연구과제명 : (9813578) A Genetic Approach to Ordered Sequencing of Arabidopsis
기관명 : Cold Spring Harbor Lab
NSF 프로그램 및 연구분야 : ARABIDOPSIS / Other Applications NEC
연구기간 : 1999. 2. 1. - 2002. 1. 31(추정)
전체연구비(추정) : $3,900,000
연구요약 :
The Cold Spring Harbor Consortium, consisting of laboratories based in Cold Spring Harbor Laboratories, Washington University and Perkin-Elmer ABI Corporation, will continue to sequence the genome of Arabidopsis thalania with the goal of contributing to the completion of the entire sequence by the end of the year, 2000 AD. At a projected cost of $0.50 per base pair, 2.4 million bases will be sequenced in 1999, initially on chromosomes IV and V, as agreed by the Arabidopsis Genome Initiative, the oversight group which coordinates this sequencing effort. If necessary, in order to reach the goal of 2.4 Mbs, other regions will be sequenced in accordance with decisions jointly reached by AGI and the CSH Consortium. Such joint decisions will determine the sequencing activities for this Consortium in the future years of this award. Additionally, all information relating to the genomic sequence of Arabidopsis thaliana, if not otherwise prohibited, will be made available to the community and other Arabidopsis sequencing groups in a timely fashion. An informatics person will be dedicated to the task of supplying the Arabidopsis community with such information in an interactive, user-friendly mode.

연구과제명 : (9813586) Sequencing of Arabidopsis Chromosome 2 (and beyond), and Development of Resources for Arabidopsisgenome Analysis
기관명 : Institute for Genomic Res
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Agriculture
연구기간 : 1998. 9. 1. - 2001. 8. 31.(추정)
전체연구비(추정) : $15,806,875
연구요약 :
The small crucifer, Arabidopsis thaliana, has become the most widely used experimental model planet system used in research laboratories. Its small size and rapid growth cycle combined with a small, diploid genome with few repetitive elements make it an ideal model system for studying

many aspects of plant biology. Since 1990, preparative work has been underway to develop the resources needed to study its genome. In 1996, TIGR was one of the three US groups funded to initiate genome sequencing on Arabidopsis. Their initial sequencing efforts have concentrated on chromosome 2 and have generated over 3.3Mb of finished annotated sequence containing over 750 genes, a further 4.5 mb of sequencing clones in progress, and have produced a large number of BAC end sequences used for the selection of sequencing clones. TIGR has also led the discussion on the importance of annotation to this project and developed guidelines for a more uniform annotation format for Arabidopsis genomic sequences. It is planned in this project to increase the sequencing capacity to approximately 12 Mb per year and use this capacity to complete the sequencing of chromosome 2, and to sequence in other regions of the genome in coordination with the other sequencing groups. In addition to the continued genomic sequencing, TIGR proposes to generate 5,000 sequence fragments from Landsberg erecta for use in identifying polymorphisms and therefore markers for fine mapping mutations. Finally, to address the variation in annotation standards currently facing the Arabidopsis community and the problem of outdated annotation due to rapid database changes, TIGR will establish an annotation resource for the entire Arabidopsis genome. This resource will update annotation for the entire genome, presenting it in a uniform and informative manner. The data format will be developed in collaboration with the Arabidopsis database, AtDB, so that the results can be linked to the wealth of non-sequence data used by the research community. The increase in sequencing capacity combined with the establishment of these two resources will further accelerate our understanding of Arabidopsis thaliana and therefore plant biology in general.

연구과제명 : (9814284) Macromolecular Structure Database
기관명 : Rutgers Univ New Brunswick
NSF 프로그램 및 연구분야 : DATABASE ACTIVITIES IN BIO SCI / Other Applications NEC
연구기간 : 1998. 10. 1. - 2004. 12. 31.(추정)
전체연구비(추정) : $3,735,148
연구요약 :
This award to Rutgers University supports the development and operation of an online database of atomic coordinates of proteins and other biological macromolecules whose three-dimensional structures have been determined experimentally. Most known structures have been obtained through use of x-ray scattering or nuclear magnetic resonance. The database will use modern relational database technologies to acquire, archive and distribute information about individual molecules, to enable database queries that survey the entire content of the database, and to facilitate linkage to other online databases, such as those providing protein and genomic sequence information. The PI and her colleagues at Rutgers University, the National Institute of Standards and Technology and the University of California at San Diego are skilled in all aspects of database construction and operation, and have expertise in the experimental techniques used to generate structural data. Knowledge of the three-dimensional structure of

proteins and other macromolecules is of great importance in both applied and basic modern biology. Among the types of studies for which such information is critical are the determination of the function of newly discovered genes and the design and modification of new pharmaceuticals. As the amount of such information increases, new uses in understanding the functional interaction of enzymes and other cellular constituents can be expected. Much of this work will depend on the availability of data through the central repository being funded.

연구과제명 : (9872565) A Functional Genomics Program for Soybean
기관명 : U of Ill Urbana-Champaign
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $4,460,359
연구요약 :
This is a collaborative and coordinated effort to provide the tools and the scientific knowledge base that will allow a rapid expansion of basic and applied research in functional genomics for the entire community of soybean researchers, and consequently those interested in all legumes. Soybean has many biological and economic features that make it attractive for moving rapidly with the application of functional genomics. Soybean is the third most economically valuable crop to the U.S. agricultural economy. Soybean accounts for over 80% of the edible consumption of fats and oils in the U.S. The U.S. accounts for fully 69% of the world soybean trade. Annual production value is approximately 17 billion ($U.S.) and the value of exports exceeds 6 billion ($U.S.). This project builds on an existing partnership with the soybean grower associations, who are funding the creation of a soybean expressed sequence tag (EST) database that forms the foundation of this project. The specific objectives and approaches are : 1. To develop the tools of functional genomics for use in soybean. These will include testing of the feasibility of high-density arrays, DNA microarrays, and SAGE (serial analysis of gene expression) techniques with appropriate tools for data analysis. 2. To apply the tools of functional genomics to develop baseline, global expression data for certain tissues and stages of development to aid in identification of useful promoters and genes and to test these approaches for selected biological questions. Identification of genes involved in biological pathways unique to plants including cell wall synthesis and flavonoid metabolism, is a specific focus as is developing detailed expression pattems in root development under different stress conditions. 3. To create a framework for physical mapping and comparative genomics of soybean with other plants by isolation and end sequence analysis of bacterial artificial chromosomes (BACs) that represent loci identified and mapped by simple sequence repeats (SSRs) and restriction fragment length polymorphisms (RFLPs) that are dispersed throughout the genome. 4. To host workshops on functional genomics approaches in order to stimulate transfer of the technology to other soybean researchers and thus enhance application of these approaches to a wide range of biological problems. The proposed research will result in development and distribution of tools for global gene expression and physical mapping. Public information to be derived from the project includes

release of : (a) baseline global expression data for different organ systems in soybean; (b) a set of 3′ sequences from 30,000 unique soybean cDNAs; and (c) genomic sequence data that will mark over 1000 positions on the soybean genetic map. Many questions of biological importance can be gleaned from the development and wide distribution of these tools to be used for global analysis of gene expression and organization by any researchers who address fundamental problems on the organization and expression of plant genes.

연구과제명 : (9872617) Development of Tools for Tomato Functional Genomics : Application to Analysis of Fruit Development, Responses to Pathogens, and Genome Synteny with Arabidopsis
기관명 : Cornell University State
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2001. 9. 30.(추정)
전체연구비(추정) : $4,648,484
연구요약 :
Tomato has long served as a model system for plant genetics, development, pathology, and physiology, which has resulted in an accumulation of substantial information regarding the biology of this economically important organism. In recent years, the most widely studied aspects of tomato biology include development and ripening of fleshy fruits and characterization of responses to infection by microbial pathogens. Although Arabidopsis has surpassed some plant systems as a model for basic plant biology research, the areas of fruit ripening and pathogen response continue to thrive with tomato as the experimental organism of choice. In the case of fruit development, this is simply due to the fact that the developmental program which results in the dramatic expansion and ripening of carpels in tomato and in many other economically and nutritionally important species does not occur in Arabidopsis. With regard to plant defense, decades of applied and basic research on tomato have resulted in characterization of responses to numerous disease agents. In many cases, this has led to the identification and genetic characterization of loci that confer general or pathogen-specific resistance. In addition, many experimental tools and features of tomato make it an excellent model system in its own right including : extensive germplasm collections; numerous natural, induced and transgenic mutants and genetic variants; routine transformation technology; a dense RFLP map; numerous cDNA and genomic libraries; a small genome; relatively short life-cycle; and ease of growth and maintenance. The intense research efforts in fruit biology and defense responses and the available tools that make tomato an especially attractive model system have resulted in many important recent discoveries. Specific highlights which have had a broad impact on the field of plant biology include : control of gene expression by antisense/sense technology; functional characterization of numerous genes influencing fruit development and ripening; transgenic analysis of genes which impact susceptibility or response to pathogen attack; and isolation of more disease resistance genes than any other plant species. This project involves development of

an integrated set of experimental tools for use in tomato functional genomics. The resources developed will be used to expand understanding of the molecular genetic events underlying fruit development and the response to pathogen infection and will be made available to the research community for analysis of diverse plant biological phenomena. Specific objectives include : (1) development of a tomato EST (Expressed Sequence Tag) database with emphasis on sequences expressed during fruit development and maturation and in pathogen-challenged tissues; (2) genome-wide gene expression analyses during fruit development and ripening and in response to pathogen infection; and (3) development of a tomato-Arabidopsis synteny map which will be used by members of this group and made publicly available for target gene isolation, candidate gene identification, and analysis of genome organization and evolution.

연구과제명 : (9872638) A Functional Analysis of the Arabidopsis Genome via Gene Disruption and Global Gene Expression Analysis
기관명 : Michigan State University
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 1. 1. - 2001. 12. 31.(추정)
전체연구비(추정) : $8,700,000
연구요약 :
In the near future, the complete sequence of the Arabidopsis genome will be known, which will lead to the identification of nearly all Arabidopsis genes. Most of these genes will have similarity with genes in other plants and many will have unknown function. The overall goal of this project is to provide plant biologists with a set of powerful tools that can be used in their efforts to understand the function and interrelationships of the 20,000 or more genes in this and other plants. The project has three components : technology development, service to the community, and biological application. Two synergistic technologies to investigate gene function will be developed and provided at service facilities. The first will be to assemble DNA microarrays of the genes of Arabidopsis. By hybridizing these arrays with probes corresponding to mRNA from different tissues and organs of wild type and mutant plants, global gene expression patterns under a variety of conditions can be investigated. Database and software support will facilitate sophisticated searching and comparisons among these global expression patterns. In parallel with the microarray experiments, the second technology development effort will be to optimize screening of Arabidopsis plants for mutations ("gene knockouts"). This will enable establishment of a gene knockout facility. A long-term goal of this facility will be to knock out all the genes of Arabidopsis. The PIs will use their microarrays to speed up the identification of gene knockouts from pools of candidates. The gene knockout facility and the microarray facility will comprise the service component of this project. The community will also be provided access to project databases and boinformatics tools through the existing Arabidopsis thaliana DataBase (AtDB) so that microarray and gene knockout data can be analyzed and cross-referenced with other plant genome data most effectively. The synergy between the microarray and gene

knockout technologies will be most fully realized within the biological application component of this proposal. This component will focus on enhancing understanding of plant-specific genes of unknown function, but it will generate a large amount of data on the other Arabidopsis genes as well. Plant-specific genes (i.e., genes found in Arabidopsis and other plants but not in yeast, bacterial, or animal systems) are of great interest because they may be involved in plant-specific processes such as plant-pathogen interactions, cell-wall biosynthesis, and others. The PIs will identify knockout mutations in a large number of these genes and then examine the mutant plants for altered phenotypes under a variety of conditions. This will allow members of the community to formulate and test hypotheses about the function of these plant-specific genes. The impact of this project is expected to extend far beyond Arabidopsis. This is particularly true for the information obtained about plant-specific genes, many of which will be of general significance to crop plants and other plants of commercial value.

연구과제명 : (98726490 Cross-Linked Sorghum and Rice Physical Maps as a Foundation for Analyzing Genome Structure, Function, and Variation in C 4 Grasses
기관명 : U of Georgia Res Fdn Inc
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2001. 9. 30.(추정)
전체연구비(추정) : $3,246,755
연구요약 :
Researchers from a vertically integrated "center without walls" will conduct closely coordinated research in structural, functional, and population genomics across leading Poaceae (grass family) seed/grain crops, biomass crops, and major weeds. The grass family stands between humankind and famine, as most calories consumed by humans and livestock derive from sorghum, rice, maize, wheat, sugarcane, millet, and other grasses. Population growth and industrial/residential encroachment on arable land place greater pressure on agriculture to secure higher yields at less cost. Modern capabilities for gene discovery open new doors to intrinsic genetic improvement of crops in a manner that is consistent with responsible stewardship of the biosphere. By utilizing well-established parallels in the organization of genes along the chromosomes of different grass genomes, the small genomes of sorghum and rice will be used to accelerate study and improvement of crops with much larger genomes such as maize and sugarcane. The small Sorghum genome (approximately 760 megabases) is the most logical complement to that of rice (approximately 440 megabases) as a "grass genome template", and is an important bridge to closely related large genome crops such as maize (approximately 2500 megabases) and sugarcane (2500 - 4200 megabases). This project has four major components : Genome organization. Physical maps for the sorghum and rice genomes will be developed that are "cross-linked" to each other and also to other large genome crops. This will accelerate completion of a sequence-ready physical map for rice, and will provide reference points to extrapolate genomic sequence data to sorghum, maize, sugarcane, and other grasses. Genome

function. A library of unique expressed sequence tags (ESTs) and corresponding cDNA clones will be developed, with a target of obtaining sequence information for 10,000 different genes, expressed at key stages in the growth and development of the sorghum plant. These resources will be used for many applications, including study of gene expression at key stages of plant growth and development. Population genomics. Both a methodological and intellectual structure for investigating relationships between naturally occurring allelic diversity at the DNA level and morphological/ecogeographic diversity among Sorghum genotypes will be developed as a valuable complement to genetic/physical approaches to the identification of genes responsible for variation in key steps of plant growth and development. Informatics. Software and web-based resources will be developed and implemented to make genomic data rapidly accessible by remote users. This project, together with links to national and international efforts, will yield a well-integrated set of shared resources for intrinsic genetic improvement of both seed/grain and biomass crops that are keystones of agriculture. Sorghum is a leading cereal grain in arid and semi-arid agriculture; ranking fifth in importance among the world' s grain crops. Rice, although a minor U.S. crop, provides more calories to humans worldwide than any other crop. Sugarcane is arguably the world's most valuable crop at approximately $143 billion per year. The sorghum genus also includes one of the world's most aggressive weeds - "Johnsongrass" (S. halepense) - that reduces yields of maize, soybean, cotton and other major crops by up to 45%. Sorghum genomics may lead to new strategies for environmentally benign plant growth regulation, either suppressing the spread of weeds or stimulating dense stands of desirable forage and turf grasses.

연구과제명 : (9872655) Comprehensive Genetic, Physical, and Database Resources for Maize
기관명 : U of Missouri Columbia
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $11,075,485
연구요약 :
The US is a recognized world leader in the production and trade of agricultural commodities and US corn exports represent 80% of the total world trade in corn. While the yield of corn in the US has steadily increased over the last 40 years, it is beginning to level off. With the expected increase in world population combined with concerns over the environmental effects of chemical intensive agricultural practices, it is clear that a new way to increase corn yield is needed. According to some experts, 50% of the increase in corn yield can be attributed to genetic improvements made to corn with the other 50% coming from use of agrochemicals. With the advent of genomics, the scientific community has an unprecedented opportunity to make significant genetic improvements in corn. The primary goal of this project is to take the first step toward understanding the structure and function of the Maize Genome by developing and disseminating a comprehensive integrated physical and genetic map of the Maize genome. This will involve the preparation of Maize Genome fragments inserted into a Bacterial Artificial Chromosome library, and the development and use of an array of markers (Expressed Sequence

Tags, Single Sequence Repeats and Radiation Hybrids) to help determine the map. In all cases the results (the map) and the reagents (the markers) will be made available to the scientific community at large. A consolidated physical and genomic map of maize, and the molecular mapping markers to be developed will enable the use by basic scientists for gene discovery, studies of gene functions, and comparative genomics among others. The information and resources that will result from this activity will be invaluable to basic research, the corn industry, and, ultimately, US consumers.

연구과제명 : (9872657) Maize Gene Discovery, Sequencing and Phenotypic Analysis
기관명 : Stanford University
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $12,548,370
연구요약 :
A virtual center will be established, comprising 10 investigators at 6 universities (Virginia Walbot, Stanford University; Vicky Chandler, David Galbraith, and Brian Larkins, University of Arizona; Sarah Hake and Mike Freeling, University of California at Berkeley; Robert Schmidt and Laurie Smith, University of California at San Diego; Martin M. Sachs, University of Illinois; and Volker Brendel, Iowa State University). These investigators will identify, sequence, and determine the effects of mutating every gene in maize. Dr. Walbot, the PI, has studied the regulation of a mobile genetic element, the Mu transposon, for many years. Transposons are pieces of DNA that replicate and insert themselves at other sites in the genome. Mu inserts preferentially within genes, which causes mutations. Dr. Walbot has developed a version of Mu, called RescueMu, which will allow the DNA that flanks the insertion site to be cloned in a simple, one-step procedure. This approach allows a very powerful strategy for elucidating gene sequence and function. A population of maize plants will be generated that together contain RescueMu insertions in every maize gene. These plants will be screened for morphological abnormalities. The DNA flanking the inserted RescueMu elements will be isolated and sequenced. Overall, this approach allows maize genes to be identified and sequenced, and the consequence of disrupting their function to be tested. As a second approach to identify genes that are expressed in maize, this project will determine partial and complete sequences for more than 50,000 cDNAs; (cDNAs are DNA copies of mRNAs). The investigators will fabricate microarrays (arrays of immobilized DNAs) which will be used to survey expression of each gene in different maize lines and tissues. Finally, a simple method will be developed to map these genes to the appropriate maize chromosome in a single step. All information and biological materials developed during the project will be made available to the maize community in a timely fashion. Maize is the most important crop plant in the U.S., and is a distant cousin of Arabidopsis. Consequently, many new genes remain to be discovered in maize. It is clear that genes discovered through this project will affect agronomically important traits. The information and experimental tools developed in the course of the project will be valuable to researchers who

study not only maize, but rice, sorghum, and other crops. The RescueMu technology that will be developed during this project will likely be transferable to other important model and crop plants.

연구과제명 : (9872664) Medicago Truncatula as the Nodal Species for Comparative and Functional Legume Genomics
기관명 : Texas A&M Research Fdn
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 12. 1. - 2001. 11. 30.(추정)
전체연구비(추정) : $3,440,561
연구요약 :
The legume family is one of the most important groups of plants worldwide, as an important source of protein in the human diet, of fodder and forage crops for animals, of oil crops, and for available nitrogen in the biosphere. Moreover, several crop legumes are among the best characterized plant genetic systems, with numerous classical genetic markers, well developed DNA marker maps, and basic tools for genome analysis. Nevertheless, despite the investment of considerable resources from private and public sources, features such as large and complex genomes, and difficulties with introduction of foreign genes have severely limited the pace of molecular analysis in crop legumes. In response to the need for a simple genetic system in legumes, investigators selected Medicago truncatula as a model species for legume biology. Unlike the major crop legumes, Medicago truncatula is amenable to efficient molecular and genetic analyses and it is well suited for study of biological issues important to the related crop legume species. This project will undertake the large scale analysis of Medicago truncatula's total DNA, called its "genome". In particular, a map of the organization of genes (comparative genomics), and of their functions in plant biology (functional genomics), are the emphases of this project. Recent results from this research team document the first indications of conserved genome structure between Medicago truncatula and crop legumes and between Medicago truncatula and the well-characterized model plant Arabidopsis thaliana. Conserved genome structure between model plants and related crop species is significant because it is expected to accelerate the pace of cloning and characterization of agronomically important genes and traits. Research activities conducted under this program will encompass the following approaches : (1) comparative genomics, which will involve comparing the organization of genes between Medicago truncatula the crop legumes pea, alfalfa, and soybean, and the well-characterized model plant Arabidopsis thaliana; (2) functional genomics, which will involve constructing and characterizing a library of expressed gene sequences, and conducting large scale gene expression analysis to study gene function, and (3) bioinformatics, which will involve developing a database and database resources for analysis and dissemination of Medicago truncatula genome information. The long term impact of this research will be to integrate genetic and functional information across legumes, and thereby expand opportunities for basic and applied research in economically important legume species. This research will allow scientists to compare genes of agronomic and scientific interest in Medicago truncatula and the related crop legumes. This

knowledge will enable more efficient cloning and characterization of valuable genes and traits, such as disease resistance and crop productivity, and it will ultimately facilitate the development of improved crop varieties. The database of expressed genes generated by this research will enable the detailed analysis of the role of specific genes in plant growth and development. Many of the genes identified in the course of this research will become the focus of crop improvement strategies and of continued scientific investigation by legume biologists. The proposed work benefits enormously from previous NSF-sponsored research on the model plant Arabidopsis thaliana. Likewise, completion of the project will benefit not only research on legumes, but the broader scientific community as well.

연구과제명 : (9872752) Sequencing the Arabidopsis Genome
기관명 : Stanford University
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1998. 9. 1. - 2001. 8. 31.(추정)
전체연구비(추정) : $12,677,998
연구요약 :
This award provides funds for the SPP (Stanford - University of Pennsylvania - Plant Gene Expression Laboratory/UC Berkeley) Consortium to continue sequencing the genome of the model plant, Arabidopsis thaliana. The SPP was established for the purpose of sequencing the genome of Arabidopsis thaliana and the effort was initiated in 1996 as part of the multinational project involving 6 groups in 4 nations. In this renewal award, the SPP Consortium plans to complete the sequence of chromosome 1 of Arabidopsis thaliana during the next three-year period. The size of the chromosome is estimated to be approximately 25 Mb (megabases). The estimated cost of sequencing is between $0.40 and $0.50 per base pair. The accuracy of the sequencing process is continually monitored and, the SPP has exceeded the accepted rate of less than 1 inaccurate base in 10,000 bases. The immediate data release policy of the SPP Consortium mandates that all contiguous sequences (contigs) greater than 2 kb be released to the public database with information on the degree of finishing. This allows research scientists in all fields to access the sequence data at the earliest possible time but with some notation as to the level of completion. Annotation (pertinent biological information) is added to the GenBank entries as soon as possible after release. Each SPP site has constructed and maintains its own web page with current progress and details about the specific duties and progress at each location. In addition, the SPP Consortium has recently built a new web page summarizing in one location the overall progress (http://www-sequence.stanford.edu/ara/SPP.html). The individual web sites can also be accessed from that address. The SPP efforts, combined with the coordinated efforts by the other sequencing groups, will contributed to the goal of completing the sequencing of the Arabidopsis genome by the end of the year 2000. Partial Arabidopsis genome sequence information obtained thus far has already contributed new insights into the biology of flowering plants. As Arabidopsis is a typical flowering plant, what is learned from Arabidopsis is readily transferable to all plants. It is expected that the complete genome sequence information will

revolutionize the field of plant biology.

연구과제명 : (9975618) Collinearity of Maize and Sorghum at the DNA Sequence Level
기관명 : Rutgers Univ New Brunswick
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $3,500,000
연구요약 :
Comparative analysis of aligned plant chromosomal regions have exceptional, but largely untested, potential for the discovery of genes, new classes of mobile DNAs, and the nature, rates and mechanisms of evolutionary change. Moreover, comparative analysis of closely-related genomes that differ greatly in size can indicate both the origin(s) of that genome size difference and, equally important, determine whether the small genome could be used instead for map-based cloning of significant genes in the large genome species. In this project, maize and sorghum have been chosen for such an analysis because of their importance as crop plants and as model genetic systems. In particular, it is sought (1) to uncover basic genomic composition of several gene-rich regions, (2) to use this two genome approach to improve and test annotation (including gene prediction) programs, (3) to determine whether the compactness of the sorghum genome can be used to physically link maize genes that have been genetically mapped to be as close as one map unit, and (4) to characterize the chromosomal composition of maize and its relationship to the origin of the sorghum genome for gene clusters and intergenic regions. The content of contiguous DNA sequence from 10 different chromosomal locations in maize and sorghum will be characterized. The size of these regions will differ between the two genomes because of their differential gene density. In maize, a minimum pathway of clones to link two BAC clones whose overlap hybridizes to a designated nucleation probe sequence will be used, whereas in sorghum, the probe will be centered within a single BAC. By selecting gene sequences as probes to genic regions of the respective genomes, 10 clusters, each with a predicted 20-25 genes and their intergenic regions will be obtained. By comparing gene clusters in a bi-genomic fashion, better computational programs for predicting gene boundaries and repeat elements will emerge. In a number of cases, gene sequences will be discovered with known phenotypes because of the integration of genetic and DNA sequence data. Current projects to increase the density of DNA markers and phenotypes on both maize and sorghum maps will also benefit from this analysis because it will provide extensive evidence on the feasibility/difficulty of positional cloning in maize or its relatives. Evolutionary studies of cereal genomes based on gene islands will now be enhanced by the analysis of gene clusters and intergenic regions.Comparative analysis of syntenic plant chromosomal regions have exceptional, but largely untested, potential for the discovery of genes, new classes of mobile DNAs, and the nature, rates and mechanisms of evolutionary change. Moreover, comparative analysis of closely related genomes that differ greatly in size can indicate both the origin(s) of that genome size difference and, equally important, determine whether the small genome could be used as a

surrogate for map-based cloning of significant genes in the large genome species. In this project maize and sorghum have been chosen for this analysis because of their importance as crop plants and as model genetic systems. In particular, this comparison seeks (1) to uncover basic genomic composition of several gene-rich regions, (2) to use this bi-genomic approach to improve/test annotation (including gene prediction) programs, (3) to determine whether the compactness of the sorghum genome can be used to physically link maize genes that have been genetically mapped to be as close as one centiMorgan, and (4) to characterize the segmental allotetraploidy of maize and its relationship to the origin of the sorghum genome for gene clusters and intergenic regions. The content of contiguous DNA sequence from 10 different chromosomal locations in maize and sorghum will be characterized. The size of these regions will differ between the two genomes because of their differential gene density. In maize, a minimum tiling path to link two BAC clones whose overlap hybridizes to a designated nucleation probe sequence will be used, whereas in sorghum, the probe will be centered within a single BAC. By selecting gene sequences as probes to genic regions of the respective genomes, 10 clusters, each with a predicted 20-25 genes and their intergenic regions will be obtained. By comparing gene clusters in a bi-genomic fashion, better computational programs for predicting gene boundaries and repeat elements will emerge. In a number of cases, gene sequences will be discovered with known phenotypes because of the integration of genetic and DNA sequence data. Current projects to increase the density of DNA markers and phenotypes on both maize and sorghum maps will also benefit from this analysis because it will provide extensive evidence on the feasibility/difficulty of positional cloning in maize or its surrogates. Evolutionary studies of cereal genomes based on gene islands will now be enhanced by the analysis of gene clusters and intergenic regions.

연구과제명 : (9975715) Identification of Plant Genes Involved in Agrobacterium-Mediated Transformation
기관명 : Purdue Research Foundation
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 9. 1. - 2004. 8. 31.(추정)
전체연구비(추정) : $4,440,751
연구요약 :

The objectives of this project are to identify plant genes involved in Agrobacterium-mediated genetic transformation, and subsequently to utilize this information to improve the genetic transformation of maize and to prevent crown gall disease on grape. Agrobacterium-mediated transformation is the most popular method currently in use for generating transgenic plants. However, there are many aspects of the transformation process that are poorly understood. Specifically, little is known about the roles that host genes and proteins play in Agrobacterium-plant cell interactions. Understanding of the plant contribution to the transformation process will certainly result in new technologies for genetic manipulation of agronomically important species that are presently recalcitrant to Agrobacterium-mediated transformation. For example, many plants can be relatively efficiently transformed transiently by

Agrobacterium, yet their stable transformation remains elusive. It is likely that these crops are deficient in T-DNA integration into the plant genome. An understanding of the plant genes involved in the integration process may allow scientists to devise strategies to over-express homologues of these genes in the recalcitrant species and alter them to transformation-competence. On the other hand, inactivation of the same genes in susceptible plants will make them crown gall-resistant. Crown gall disease affects numerous target crop species, and its prevention would be important for many sectors of the agricultural community. This project involves an international collaboration of three laboratories (two in the US and one in Switzerland) and will use four approaches to identify and characterize plant genes involved in Agrobacterium-mediated transformation : 1) Screening of existing collections of T-DNA-tagged Arabidopsis mutants for rat (resistant to Agrobacterium transformation) phenotypes. These mutants will be investigated genetically and biochemically to identify the specific stage at which the transformation process is arrested; 2) Utilization of the yeast one- and two-hybrid systems to identify plant proteins that interact with Vir (virulence) proteins transferred to the plant by Agrobacterium. These Vir proteins include VirF, VirB2, VirD2, and VirE2; 3) Utilization of differential display, microarray, and subtraction approaches to identify plant genes whose expression is up- or down-regulated during early stages of Agrobacterium-mediated transformation; 4) Characterization of Arabidopsis genes involved in Agrobacterium-mediated transformation using reverse genetics, and examination of the functions of proteins encoded by these genes using specific biological assays developed in each of the collaborating laboratories. The information gained from our analysis of Arabidopsis genes will be used to genetically modify maize such that it will become more susceptible to Agrobacterium-mediated transformation, and to genetically modify grape such that it will become resistant to crown gall disease.

연구과제명 : (9975718) Global Expression Studies of the Arabidopsis Genome
기관명 : U of Pennsylvania
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $7,600,000
연구요약 :
The elucidation of the DNA sequence of the 130 Mb Arabidopsis genome by the end of the year 2000 is estimated to reveal the presence of approximately 25,000 genes using various computational approaches. In order for this vast structural information to be most useful to plant biologists, another large-scale project is needed to characterize the expression patterns of the entire genome. This project will provide a framework for the identification of all the transcriptional units and the construction of full-length cDNAs for all the genes in the Arabidopsis genome. Such an endeavor will allow the precise determination of the molecular mass of each protein encoded by each transcriptional unit. In addition, this approach is much more cost effective than having different laboratories isolate and sequence individual cDNAs of interest. The central focus of this project is the development of molecular resources

(infrastructure) for the entire plant biology community by utilizing emerging genomic technologies for understanding various aspects of plant growth and development. The project takes advantage of the rapid growth in Arabidopsis genomic sequence and the advent of new technologies to achieve this long term goal. This award will support the following objectives : (1) Construction and development of a high density Affymetrix oligonucleotide chip that contains all the predicted genes from the Arabidopsis Genome Initiative. The chip will be updated annually until the entire genome sequence is available. (2) Global expression studies for determining the expression pattern of all the Arabidopsis genes utilizing the Affymetrix chip and mRNAs isolated from ~100 different treatment conditions of various tissues from dark and light grown plants. The chips will be available to the entire scientific community (3) Isolation and sequencing of 8,000 full-length cDNAs. The completion of this goal will provide experimental annotation of 1/3 of all Arabidopsis genes and determine the accuracy of computational approaches currently utilized for gene prediction. The cDNAs will be useful tools for a variety of experimental purposes. An important feature of this proposal is that all of the above-described materials will be made freely available to the plant biology community as soon as they are produced. These new resources will allow the advancement of plant biology and by extension, world agriculture and plant biotechnology.

연구과제명 : (9975806) Genomics of Wood Formation in Loblolly Pine
기관명 : North Carolina State U
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 9. 1. - 2002. 8. 31.(추정)
전체연구비(추정) : $4,450,000
연구요약 :
Pines are one of the world's most important crops and one of the most important genera of trees in the world's forests. Pines, as gymnosperms, represent one of the oldest and most successful groups of higher plants. Pines can be difficult to study, due to their long generation times and large DNA content; however, new technology and a genomic strategy promise great returns in knowledge and practical application from understanding the fundamental biology of trees. Forest trees are in the earliest stages of domestication and the major genetic changes usually associated with domestication have not yet been made. Therefore, a genomic approach to understanding the formation of wood and the identification of the genes that determine the major features of wood properties could lead to genetic modifications of great economic significance. Virtually every problem of scientific or commercial importance that depends upon the biology of pine trees would be advanced by knowledge of the identity and function of all of the expressed genes. Wood formation is also of general biological interest as a specialized system for both biochemical and genetic analysis of cell wall biosynthesis. This award will allow us to identify and characterize large numbers of genes that are important in wood formation (xylogenesis) and determine how many of these genes affect the properties of wood and its derived products, pulp and paper. First, we propose to identify large numbers of expressed genes from differentiating

xylem. Second, we will use DNA microarrays to identify genes implicated in the formation of the wood cell wall, through studies of their specific regulation, abundance, or interactions. Third, new methods will be developed to map these genes onto the pine genome using microarrays. The fourth objective is an intensive effort to obtain phenotypic information on the physical and chemical properties of wood from mapping populations. This phenotypic information will be used to map loci having quantitative effects on wood properties and to identify concordance between genes identified from expression data/map location and the wood property phenotypes. Similarly, association in populations of alleles and phenotypes will be examined for genes affecting wood properties and to identify alleles that may be useful for tree breeding. This award will lead to the discovery of a large number of functional plant genes, many of which may have novel functions. The large sequence database of gymnosperm gene sequences will be a rich source of comparative sequence information for studies of evolution and functional genomics of all plant genomes. There is currently very little information available on the sequences of genes from gymnosperms, one of the two major groups of higher plants. A genomic approach to understanding the biology of pines represents the first major public genome initiative on an undomesticated forest species with a dominant role in the world's temperate ecosystems. Such studies will lead to understanding of the molecular basis of response to climate change and adaptation in both the recent past and since the conquest of the land by higher plants.

연구과제명 : (9975866) Tools for Potato Structural and Functional Genomics
기관명 : U of Cal Berkeley
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $5,300,000
연구요약 :

Potato is a crop of worldwide importance and one of the most important dicotyledonous sources of food for humans. In light of threats to worldwide potato production by late blight, research on the plant's response to infection by microbial pathogens will be critical to environmentally sound agricultural production. A century of breeding efforts in potato have resulted in the introduction of resistance traits from abundant wild Solanum germplasm collections to pathogen susceptible cultivated species. However, breeding of cultivated potato for a single disease resistance trait can take years and pathogens rapidly evolve to overcome single resistance traits. Potato breeders are in need of additional information and genetic resources to compete with the challenges of ever changing pathogen populations. Genetic studies have identified untapped pathogen resistance traits in wild Solanum species. Accumulating evidence suggests that regions of wild potato genomes may contain large clustered arrays of resistance loci to several different pathogens. Recent developments in biotechnology have greatly facilitated genetic research in potato, including recent advances in genomic sequencing which allow for the rapid collection and analysis of vast amounts of DNA sequence data. The genomes of two wild potato species containing many resistance traits are available as deep bacterial artificial chromosome (BAC) libraries. The genomic sequences of these important regions will be determined, allowing interspecific comparisons as well as the development of allele-specific molecular markers that can be used by researchers for introgression of desirable traits using marker-aided selection. Another widely used approach is the generation of Expressed Sequence Tags (ESTs). These short, randomly selected sequences are a very cost effective way of identifying a large number of genes expressed in a tissue. This award supports : (1) Identification, isolation and sequencing of regions of wild potato genomes bearing disease resistance (R) genes and quantitative trait loci (QTLs) for P. infestans resistance. The genome sequences of these important regions will be determined, annotated, compared to each other and made publicly available. These sequences will facilitate the cloning of the significant resistance genes and other traits to combat late blight disease, provide tools to readily isolate and characterize functionally similar regions from other wild Solanum genomes to combat late blight, and provide substrates for evolutionary studies; (2) Generation of 55,000 ESTs from a variety of potato tissues and from disease-challenged tissues, to construct an annotated, publicly available Potato Gene Index and establishment of a potato Expressed Sequence Tag (EST) database including sequences expressed during response to late blight pathogen infection; (3) Specific ESTs will be selected and arrayed to fabricate potato cDNA microarrays, and used for genome-wide analyses during responses to pathogen infection and other plant processes; (4) Refinement of the syntenic relationship between potato and tomato and to base the linkage between these two genomes on orthologous sequences, which are also being anchored in the Arabidopsis genome. Tools and information will be made available to the scientific community for studies on late blight disease and will provide materials and information pertinent to the investigation of other pathogen diseases and critical plant processes.

연구과제명 : (9975930) Chromatin-based Control of Gene Expression in Maize and Arabidopsis
기관명 : U of Arizona
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 9. 1. - 2004. 8. 31.(추정)
전체연구비(추정) : $10,500,000
연구요약 :
This award supports the generation of mutations in genes that control gene expression at the level of chromatin. The overall goal of the project is to identify and functionally analyze most, if not all, of the several hundred genes in maize (corn) and Arabidopsis that contribute to chromatin-level control of gene expression. Maize is the most important agricultural crop in the US, as well as the premier model system for addressing fundamental questions in monocots, particularly cereals. Chromatin is the proteinaceous material that together with DNA comprises chromosomes. A key requirement for the expression of genes in chromosomes is that chromatin be remodeled (i.e., "opened") in such a way that transcriptional activator proteins and RNA polymerases can have access to the DNA, permitting the assembly of a transcription complex which then transcribes the gene into messenger RNA. The approach exploits conserved chromatin genes identified in the human, yeast, worm, and fly genome projects to : (1) identify

similar genes in the complete Arabidopsis genome sequence and (2) isolate related genes from maize. Identification of genes in Arabidopsis greatly facilitates the isolation of genes from maize. Certain tests of chromatin gene function require dominant mutations, so dominant negative mutations will be made for each target chromatin gene. Most importantly, all mutations will be characterized to determine their effects on genetic transmission, plant growth and development, and a comprehensive battery of biochemical and epigenetic tests. These tests include histone acetylation, DNA methylation, the processes of epimutation and paramutation, reactivation of silenced transgenes and transposons, the efficiency of Agrobacterium T-DNA integration, and nucleolar dominance. Also, fusions of chromatin gene products to the GAL4 DNA binding domain will be tested for effects on a reporter transgene possessing a GAL4 DNA binding site to determine the ability of candidate genes to reverse or promote the formation of repressive chromatin. These lines will be valuable for isolation of additional mutations that suppress activity of chromatin genes. This "forward" genetic approach will be important to identify the many interesting regulatory components in chromatin that are not highly conserved or are plant specific. This award will result in the generation and classification of a large set of useful mutations that will facilitate investigations of gene regulation in plants, leading to deeper understanding of the complex mechanisms by which plants control the expression of their genes. Equally important, a chromatin database and web site will be created that will facilitate communication among scientists and dissemination of information on chromatin level control in plants and other organisms. Understanding how plants control gene expression is essential for understanding how plants grow and develop and how they respond and adapt to the environment. Quality and yield improvements in crops continue to depend on applying new genetic insights and tools like those to be gained from this program. The research here will have a direct impact on genetic improvement of maize, and will also be applicable to many other important crop plants.

연구과제명 : (9975989) The Structure and Function of the Expressed Portion of the Wheat Genomes
기관명 : U of Cal Div Agr & Nat Res
NSF 프로그램 및 연구분야 : PLANT GENOME RESEARCH PROJECT / Other Applications NEC
연구기간 : 1999. 9. 1. - 2003. 8. 31.(추정)
전체연구비(추정) : $7,300,000
연구요약 :
This award supports a project to generate and map a large number (target is 10,000) of unique DNA sequences from the genetic code (genome) of bread wheat. The assumption is that these unique DNA sequences will correspond to individual genes of wheat and their identification is a first step in determining the function of these genes. The ultimate goal is to use this information to improve the quality and yield of wheat and enable successful adaptations to new and marginal environments, thus increasing production. Wheat belongs to a group of closely related species (termed a tribe, named Triticeae) in the grass family which includes more than 300 species, including several very important crops (bread and durum wheats, barley, rye, triticale) and

several forage-grass species. World-wide, wheat is the most widely grown crop and the third in economic significance for the United States. The US is the largest wheat exporter in the world and, to maintain this market continuous genetic improvement of the crop is required. Recent advances in plant genetics and genomics offer unprecedented opportunities for discovering the function of genes and potential for their manipulation for crop improvement. Because of the large size of the wheat genome (the total DNA or genetic information of the species), it is unlikely that the actual base pair sequences of the DNA molecules will be learned completely in the near future. This project takes an alternative strategy to realize the benefits of new techniques for discovering genes and learning their function (functional genomics). Following the identification of 10,000 unique wheat DNA sequences (termed ESTs, Expressed Sequence Tags), they will be mapped to their physical location on the chromosomes of wheat. This process utilizes a unique feature of the wheat chromosomes, their ability to tolerate deletions of portions of the chromosomes and still produce a viable plant. The mapping logic is direct : if an EST is present in a plant with complete chromosomes, but absent in a plant missing a known part of a single chromosome, then it can be inferred that the DNA sequence that corresponds to that EST is located in that segment of the chromosome. By the end of the mapping component of this project, a most valuable tool will have been produced : 10,000 unique DNA sequences, likely corresponding to genes, whose physical location in the chromosomes of wheat are known. This sets the stage for the next phase of the project, the analysis of this array of mapped ESTs to determine function. The project will focus on characteristics of the wheat reproductive stages, from flowering signals through seed development and dormancy. The information gathered on the sequence, function, and position of these genes in the wheat chromosomes will be collected and distributed by means of a USDA public database of genomics information (known as GrainGenes). Because of the close relationship of wheat to other species in the Triticeae tribe and other grass species, especially corn and rice, the results from this project will be immediately applicable to other crops in the Triticeae. Most of the collaborating investigators are already collaborating members of the International Triticeae Mapping Initiative which has produced molecular genetic maps of the chromosomes of wheat and related species. The diversity of experimental techniques and traits pursued in the individual laboratories collaborating on this project will be an ideal training ground for graduate students and postdoctoral scientists. The large pool of well-characterized and mapped unique DNA sequences, available in the public domain will be an exceedingly important resource for future Triticeae research and basic functional genomics research.

연구과제명 : (9978564) AtIR : An Arabidopsis thaliana Information Resource
기관명 : Carnegie Inst of Wash
NSF 프로그램 및 연구분야 : DATABASE ACTIVITIES IN BIO SCI / Other Applications NEC
연구기간 : 1999. 10. 1. - 2004. 9. 30.(추정)
전체연구비(추정) : $5,429,525

연구요약 :
This project is to develop a new database, designated AtIR, that will provide public electronic access to all public information pertaining to, and derived from, the Arabidopsis genome project. AtIR will be the next generation of a product formerly known as AtDB. The stated goal of the project is to facilitate utilization by the scientific community of the genomic resources available in Arabidopsis. The design anticipates the completion of the Arabidopsis genome sequence, widespread use of high density DNA microarrays for studies of gene expression and other emerging genetic technologies. In addition, relevant information from the approximately 9000 papers published on Arabidopsis will be entered into the database and associated with genome-related information. Because of the importance of Arabidopsis as a model for all higher plants, a fundamental design feature of AtIR will be ease of access by scientists who do not have a primary research interest in Arabidopsis. For similar reasons, the database design and implementation will attempt to maximize communication of AtIR with other databases. The database will be managed as a public resource by an executive committee with representatives from four institutions, and will be overseen by both advisory bodies and user focus groups.

연구과제명 : (9983282) Sequencing of Chromosome 10 of Rice and Validation of Annotation Methods for Rice
기관명 : Institute for Genomic Res
NSF 프로그램 및 연구분야 : PLANT SCIENCE INITIATIVE / Other Applications NEC
연구기간 : 1999. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $3,450,000
연구요약 :
Rice is considered a model species for monocotyledonous plants, which include cereals such as maize, wheat, sorghum, and barley. Rice has a relatively small genome, is diploid, is readily transformable, and has tractable genetics and a diverse germplasm. These attributes, in addition to its role as a major food source for a majority of the world's population, have resulted in the development of genetic and molecular resources focused on obtaining the complete genome sequence of rice. Not only will the complete sequence of rice provide a reservoir of genes by which to understand rice growth and development, but it will also provide a set of molecular tools to leverage sequence information to highly related species such as maize, wheat and barley, which are more recalcitrant to genomic approaches. This award will enable a total of 31.5 Mb of rice genomic sequence to be generated and released to Genbank. This sequence will be annotated using gene prediction programs, related genes within the database will be identified, and repetitive structures and sequences characterized. In addition, links between rice data and sequence, physical, and genetic information from other plant species will be generated. All of this work will be performed in conjunction with the international rice genome project.

② Environmental Biology (13개 과제)

연구과제명 : (9632852) Long Term Ecological Research Program : Shortgrass Steppe
기관명 : Colorado State University
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics, Structure & Function, Global Carbon Cycle, Regional & Environmental
연구기간 : 1997. 2. 1 - 2003. 1. 31(추정)
전체연구비(추정) : $3,360,000
연구요약 :

The shortgrass steppe (SGS) occupies the middle of the productivity gradient along which the LTER grassland sites lie. It is unique among North American grasslands for its long evolutionary history of intense selection by both drought and herbivory, leading to an ecosystem that is very well adapted to withstand grazing by domestic livestock. The distinctive features of the SGS are both its vegetation and the concentration of biological activity and organic matter belowground. The vegetation of the SGS is characterized by low-growing plants that are either tolerant or resistant to grazing and drought. The large concentration of biological activity belowground reflects the distribution of plant production and the enhanced rates of energy flow through heterotrophs belowground. It is also explained in part by the fact that most biologically active elements in grasslands are protected from natural disturbances by being stored in soil organic matter. The SGS LTER project has been in operation since 1982 and currently supports 46 long-term experiments, numerous short-term experiments, and has a large emphasis on integrative simulation analysis. SGS LTER work is divided into five major areas : populations and processes, biogeochemical dynamics, paleoecology and paleopedology, water and energy dynamics, and disturbances. In addition, the SGS is involved in many synthesis activities which will soon be summarized in a synthesis volume. One of the unique aspects of this research program is the emphasis on integrating knowledge about SGS ecosystems into simulation models. These models are used widely, and they will continue to serve as a mean of integrating ideas and developing hypotheses for future research in the SGS LTER program.

연구과제명 : (9632853) Comparative Study of a Suite of Lakes in Wisconsin
기관명 : U of Wisconsin Madison
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics, Water Resources, Structure & Function, Regional & Environmental
연구기간 : 1996. 11. 1. - 2001. 10. 31(추정)
전체연구비(추정) : $5,000,000
연구요약 :

Lakes are central to the vitality of landscapes and society. As collectors of water, energy, solutes, and pollutants from the landscape and atmosphere, as habitats for aquatic biota, and as attractors of human activities, lakes affect and are affected by natural and human-induced changes in the local and regional landscape and atmosphere. The North Temperate Lakes Long-term Ecological Research program seeks to understand the long-term ecology of lakes and their interactions with a range of relevant landscape, atmospheric, and human processes. This program has the following interrelated goals : * Perceive long-term changes in the physical, chemical, and biological properties of lake ecosystems, * Understand interactions among physical, chemical, an biological processes within lakes and their influence on lake characteristics and long-term dynamics, * Develop a regional understanding of lake ecosystems through an analysis of the patterns and processes organizing lake districts, * Develop a regional understanding of lake ecosystems through integration of atmospheric, hydrologic, and biotic processes, and * Understand the way human, hydrologic, and biogeochemical processes interact within the terrestrial landscape to affect lakes and the way lakes, in turn, influence these interactions. Research will examine patterns, processes, and interactions of lakes and their surroundings at a nested set of spatial and temporal scales. This comprehensive long-term research program will yield important understanding of landscape-lake-human interactions that will have direct relevance to development of policies affecting the future of the Upper Great Lakes Region and enhancement of the quality of life for its residents.

연구과제명 : (9632854) Long-Term Studies of Disturbances as They Affect Ecological Processes in Landscapes of the Southern Appalachians
기관명 : U of Georgia Res Fdn Inc
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics
연구기간 : 1996. 10. 15 - 2001. 9. 30(추정)
전체연구비(추정) : $5,000,070
연구요약 :
This research will continue investigations on the extent and complexity of natural and human-caused disturbances, and how they interact with ecological processes along environmental gradients in the landscape. This work builds upon extensive long-term studies of landscape processes in the southern Appalachians and spans four levels of resolution (plot, watershed, landscape and region) in the Little Tennessee and French Broad River basins. Individual and interacting effects of disturbance and environmental heterogeneity on populations, communities, and ecological processes forms the unifying theme of this proposed LTER research. The research team will focus on three areas of inquiry : (1) characterization of disturbance and environmental heterogeneity in the southern Appalachians, (2) effects of disturbance and environmental heterogeneity on populations and communities, and (3) effects of disturbance and environmental heterogeneity on biogeochemical cycling and ecosystem processes. The project builds on extensive understanding of disturbances occurring with the Coweeta basin and continues to characterize environmental heterogeneity, maintaining continuity in the 60+ year record for some variables. As the focus expands to the southern Appalachian region, historical fire regime and socio-economic drivers of land-use change will also be considered. The effects of disturbance and environmental heterogeneity on plant and animal populations will be assessed

at a range of scales and key questions will be addressed on the effects of resource variability on terrestrial and aquatic biodiversity. Using a combination of new studies and continued long-term measurements, investigators will examine the role of environmental heterogeneity and disturbance in regulating ecosystem pools and processes in streams, riparian zones, and forests. This research approach utilizes an integrated program of long-term field measurements, experiments and modeling.

연구과제명 : (9632921) Long-Term Ecological Research at the H.J. Andrews Experimental Forest (LTER4)
기관명 : Oregon State University
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Biology of Pest Organisms, Regional & Environmental, Global Carbon Cycle
연구기간 : 1996. 12. 1. - 2002. 11. 30.(추정)
전체연구비(추정) : $3,360,000
연구요약 :
The central question guiding the HJ Andrews LTER is : How do land use, natural disturbances and climate change affect three key ecosystem properties : carbon dynamics, biodiversity, and hydrology? These three ecosystem properties are of high scientific and social interest and represent three rather different categories of ecological response to landscape patterns. The principle spatial scale for synthesizing results of these studies is the Andrews Forest landscape (6400 ha) and the adjacent upper Blue River watershed (9000 ha). The time scale of interest spans the past 500 yrs and extends several centuries into the future, based on model projections of alternative possible future conditions. LTER studies link closely with work at larger spatial scales and paleoecological time scales. This research follows a strategic plan to answer this guiding question by continuing to use the Andrews LTER as the core of the large, multi-faceted research program based at Andrews Experimental Forest in Oregon. Since its inception in 1980, the Andrews Forest LTER program has consisted of long-term experiments, measurement programs, short-term studies and modeling analyses in a series of research components : climate, hydrology, disturbance regimes/landscape dynamics, vegetation succession, biological diversity, carbon and nutrient dynamics, and forest-stream interactions. Under this renewal proposal, four related synthesis efforts will take place : effects of species on ecosystem functioning, pattern and process during early succession, analysis of small watersheds, and analysis of landscape dynamics. Research under the continuation of this LTER activity will advance scientific understanding of controls on ecosystem structure and function in the forested landscapes of the Pacific Northwest.

연구과제명 : (9634135) A Proposal for the Network Office of the U.S. Long Term Ecological Research Network form an Association of Institutions
기관명 : University of New Mexico
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Data Banks,

Analytical Procedures, Facilities
연구기간 : 1997. 3. 15. 2003. 2. 28.(추정)
전체연구비(추정) : $3,567,257
연구요약 :
This project will support the Network Office for the Long-term Ecological Research Network to continue critical activities including communication, data management, data dissemination, and technological advances. The Network Office will form a consortium with the San Diego Supercomputer Center, the Santa Fe Institute, the Center for Microbial Ecology at Michigan State University, and the National Center for Ecological Analysis and Synthesis. The facilities and interactions with these institutions and centers will enhance the research and creative activities of the Long-term Ecological Research sites. The principal goals of the Network Office are to (1) facilitate communication among the LTER sites to encourage integration of data sets and data analyses, (2) enhance the interaction of the LTER Network with a broad group of disciplines outside of ecology, (3) promote and disseminate new technologies relevant to long-term ecological research, and (4) provide leadership in data management and data dissemination to the LTER community and other scientific communities. Long-term data are fundamental to understanding environmental systems and the management of our natural resources. The Long-term Ecological Research program provides a unique ability to generate this important information and the current LTER sites have provided many important contributions. The LTER Network Offices plays the very important role of catalyzing intersite activities that allow the individual sites to function as an integrated network. This network approach allows new knowledge to be generated from the individual sites in the form of comparative research, synthesis and expansion to regional scales. The collaboration of the LTER network with other international networks provides unprecedented opportunities to share information with international colleagues, develop exchanges of scientists and students. And develop a global understanding of our ecological systems.

연구과제명 : (9714833) Urban LTER : Central Arizona - Phoenix LTER
기관명 : Arizona State University
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics, Regional & Environmental, Land Use & Planning
연구기간 : 1997. 11. 1. - 2004. 10. 31.(추정)
전체연구비(추정) : $4,274,940
연구요약 :
This project is a long-term study of the Phoenix metropolitan area and fringing regions of central Arizona into which Phoenix is rapidly expanding. Objectives of this LTER program are to : 1) generate and test general ecological theory in an urban environment, 2) enhance understanding of the ecology of cities, 3) identify feedbacks between ecological and socio-economic factors, and 4) involve K-12 students in the enterprise of scientific discovery.

Phoenix is one of the largest and most rapidly growing cities of the arid and semi-arid American west. Because Phoenix is young, urban redevelopment is minor compared to expansive growth of the city's edges, where agricultural lands and natural desert habitats are being rapidly converted to suburbia. Historic patterns of growth will be reconstructed using maps, planning documents, aerial photographs and satellite imagery to generate a GIS-based record of urban change. Modeling will be centered on a hierarchical, spatially-explicit, patch-dynamic approach, based on land-use patch types. At intermediate scales, landscape models will be developed to determine configuration effects of multiple patches. A regional simulation model of the entire area will be developed to predict and test ecological consequences of alternative patterns of future development. Patch-specific ecological characteristics will be monitored in five core area s : primary production, natural population and community characteristics, storage and dynamics of organic matter, movement of materials (including water), and patterns of disturbances by redevelopment, fire and flood. A successional model will guide this work; both short-term ecological trends associated with land-use change at the patch scale, and long-term changes as patches mature will be followed. Of special interest is ecological change within a given patch type on the city-center to suburban-edge gradient. Socioeconomic factors are included in this study as feedbacks between land-use decisions and ecol ogical characteristics. That is, how do ecological features shape land-use decisions and how, in return, do ecological consequences modify future land use policy? Research will determine the importance of ecological factors to individual perceptions of quality of life. In addition, objective analyses of change in property values and shifting demographic patterns within the urban landscape will be assessed as an indicator of ecological and other values. These efforts will be enriched by multiple partnerships with agencies and municipalities. This research effort includes a substantial commitment to K-12 education by involving teachers and students as hands-on research partners, through interaction with developing urban science curricula, and by providing a real time electronic interface with research discoveries via the Internet. This component of the project is enhanced by a strong interface with numerous educational partners in the greater Phoenix area.

연구과제명 : (9714835) Urban LTER : Human Settlements as Ecosystems : Metropolitan Baltimore from 1797 - 2100
기관명 : Inst of Ecosyst Stud
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics, Regional & Environmental, Land Use & Planning
연구기간 : 1997. 11. 1. - 2004. 10. 31(추정)
전체연구비(추정) : $4,375,000
연구요약 :

This LTER project in metropolitan Baltimore, Maryland, will address three general questions : 1) How do the spatial structure of socio-economic, ecological, and physical factors in an urban area relate to one another, and how do they change through time? 2) What are the fluxes of energy, matter, capital, and population in urban systems, and how do they change over time? 3) How can people develop and use an understanding of the metropolis as an ecological system to improve the quality of their environment? These questions will be addressed at a range of scales, from individual patches up to the entire Primary Statistical Metropolitan Area. In so doing, this project will help resolve fundamental issues about the ecology and temporal dynamics of cities and suburbs, and quantify an end member ecosystem for comparison with less human-dominated ecosystems. The project revolves around an integrated framework to study urban areas as ecological systems, including physical, ecological, and socio-economic components. The target will be processes that control the function of urban areas as ecological systems, and their effects on other ecosystems. The framework will be tested by determining whether socio-economic, physical and ecological components of systems share common spatial structures, and whether each component responds to changes in others in space and time. The research plan includes descriptive, historical, and experimental analyses. Dominant patch types will be characterized using ecological, physical, and socio-economic variables. This approach will produce high resolution, whole watershed, and whole city estimates of ecological and socio-economic fluxes, as well as allow development of simulation models capable of depicting the interactive effects of land use, habitat and social change on ecological functions. Data from historical records and sediment pollen cores will allow testing of hypotheses about how social and ecological factors interact to affect how these function s have changed in the past and how they might change in the future. Two long-term experiments - a manipulation of exotic plant species and an ecologically-based social initiative in neighborhood restoration - will test how human and ecological components of the system interact and change. Research on system function will address surface/atmosphere energy exchange, hydrologic and nutrient flux, atmospheric deposition, and the import/export of raw and processed materials and waste products, and of capital. Two scales will be considered - the whole-city scale and the small-watershed scale - in part to foster comparison with other studies of natural and human-dominated ecosystems. The education objectives will provide useful ecological understandings and data access to the research process, and direct support to students, teachers, managers, and the general public. This project will build close linkages with existing formal and informal education programs and institutions to build programs that improve the ecological literacy of students, citizens, and decision makers.

연구과제명 : (9810218) LTER : The Niwot Ridge LTER Research Program 1998-2004 : Controls on the Structure, Function & Interactions of Alpine & Subalpine Ecosystems of the Colorado Front Range
기관명 : U of Colorado Boulder
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics
연구기간 : 1998. 12. 15. - 2004. 11. 30.(추정)
전체연구비(추정) : $4,200,000
연구요약 :

The Niwot Ridge LTER employs a program of long- and short-term manipulative experiments and long-term monitoring to study biotic and ecosystem responses and feedbacks to interannual variation in climatic and atmospheric inputs. The 45-yr climate record shows that the alpine tundra at Niwot Ridge is experiencing increased amounts of precipitation; similar measurements of atmospheric nitrogen inputs begun in the early 1980's demonstrate increased atmospheric nitrogen deposition. Redistribution of snowpack by wind amplifies and attenuates these inputs across the alpine tundra and subalpine forest and meadows. Descriptive and manipulative studies designed to understand the consequences of these phenomena in terms of ecosystem structure, function and fluxes are proposed. Concurrently, questions on influence of treeline on nitrogen redistribution and ecosystem response, and test of hypotheses on controls of treeline are also presented. Interpretation of biotic responses to changing inputs requires a hierarchical perspective that explicitly acknowledges the evolutionary history of the biota, the paleoecological record, and the current interactions among ecosystem components. The inclusion of the subalpine provides not only new ecosystem comparisons, but also generates a separate line of questions regarding the biotic and biogeochemical significance of ecotones. At treeline, vegetation structure appears to control snowpack rather than vice-versa, and therefore the consequences of enhanced snowpack and accompanying N deposition are under biotic as well topographic controls. In essence, the mesoscale snowpack model is overridden by a higher order constraint, the controls on treeline. The proposed research outlines a series of descriptive and manipulative studies to identify these controls. Niwot Ridge is the only multidisciplinary, long-term alpine and subalpine study site on the continent. As such, the site is an essential benchmark for local, regional and national networks that measure ecological phenomena and biological response to human-induced changes in climate and atmospheric chemistry. Accordingly, emphasis is placed on documenting research and archiving data for current and future scientists. This research is a continuation of studies initiated in 1981, and is based upon research and databases begun in the 1950s. Continued support of this long-term research program will allow these investigators to build upon the significant research accomplishments in alpine ecosystems at Niwot Ridge.

연구과제명 : (9810220) LTER : Long-Term Ecological Research in Field Crop Ecosystems
기관명 : Michigan State University
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics
연구기간 : 1998. 12. 15. - 2004. 11. 30.(추정)
전체연구비(추정) : $4,200,000
연구요약 :
Agricultural activities worldwide are carried out through a combination of biological and chemical management practices. The Kellogg Biological Station (KBS) Long-Term Ecological Research program has been conducting research since 1987 focusing on testing the hypothesis that agronomic management practices based on knowledge of ecological interactions can effectively replace management based on chemical subsidies. Work to test this general hypothesis is focused on field-crop ecosystems that are used extensively throughout the US

Midwest. KBS research employs a series of sites where 11 different cropping systems and successional communities have been established to represent different levels and types of ecological disturbance. Within this series of sites, working hypotheses are being tested in general areas of soil microbial communities, the dynamics of insect consumers, nutrient availability, and plant community dynamics. Recent work has led to development of biologically based agricultural systems that produce acceptable crop yields. The KBS site has documented changes in abundance of various taxa that appear to be important in row-crop function and in ecosystem-level attributes of agricultural systems. General ecological understanding has been advanced in key relationships in field-crop ecosystems. In addition to continuing these efforts, proposed work will evaluate the effects of agricultural practices at scales larger than individual fields on the dynamics of biogeochemical processes in entire watersheds. Efforts will also be developed to incorporate a social component to evaluate the degree to which human decision making plays critical roles in the ecological processes occurring in agricultural ecosystems. Finally, the results of efforts at the KBS site will be regionalized to develop a general understanding of the interactions between climate and productivity across the entire North Central Region.

연구과제명 : (9810221) LTER : Hubbard Brook Experimental Forest
기관명 : Cornell University State
NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Other Applications NEC
연구기간 : 1998. 12. 1 - 2004. 11.30(추정)
전체연구비(추정) : $4,200,000
연구요약 :
This project will continue the Long-term Ecological Research (LTER) at the Hubbard Brook Experimental Forest in an effort to improve general understanding of the mutual influences of environment, disturbance, biological activity and the flows of energy and materials in forest landscapes. This integrated program of long-term monitoring and process-level studies at Hubbard Brook and other regional sites address a series of hypotheses in two thematic categories : biogeochemistry and vegetation dynamics. The biogeochemical studies focus on the cycles of carbon, nitrogen, calcium, and sulfur and build especially upon a 30+ year record of fluxes from the Hubbard Brook Experimental watersheds to address several striking and surprising observations about element cycling in northeastern forests. In addition, investigations of vegetation and primary productivity at the landscape scale will be expanded, focusing upon the interactions between tree spatial distributions, soil and glacial till properties, and nitrogen cycling and nutrition. This research will be synthesized and integrated using simulation models and in the form of monographic overviews of elemental cycles.

연구과제명 : (9810222) LTER : The Arctic LTER Project : The Future Characteristics of Arctic Communities, Ecosystems, and Landscapes
기관명 : Marine Biological Lab

NSF 프로그램 및 연구분야 : LONG TERM ECOLOGICAL RESEARCH / Ecosystem Dynamics
연구기간 : 1998. 12. 15. - 2004. 11. 30.(추정)
전체연구비(추정) : $4,199,882
연구요약 :
The Arctic LTER site is located in the northern foothills of the Brooks Range, Alaska, in tundra vegetation of sedges and grasses mixed with dwarf birch and low willows. The tundra, streams and lakes at the site have been undisturbed and unchanged for more than 5,000 years. This allows the analysis of relationships among plants and animals in this ecosystem which is unaffected by an ecological legacy of human use. In contrast to this ecological stability, the climate of northern Alaska has changed remarkablyover the past 30 years. The temperature of the region has increased by more than 0.5oC per decade. No one knows if this warming is a part of the 3-5 degree change predicted by GCM models but it is known that other areas of the Arctic have either not changed or have become colder. Based on several types of observations, there appears to be a biotic response to this regional warming. The goal of this LTER project is to predict the future ecological characteristics of the site. This prediction is based on knowledge of the controls of ecosystem structure and function as exerted by physical setting and geologic factors, climatic factors, biotic factors, and the changes in fluxes of water and materials from land to water. The long-term research is based on the following approaches : (1) Long-term monitoring and surveys of natural variation of ecosystem characteristics in space and time. This will include routine monitoring of variables, such as climate, tundra plant communities and productivity, thaw depth, stream flow, stream chemistry, lake temperatures, lake chemistry, lake productivity and the abundance of zooplankton and fish. (2) A north-south regional transect in cooperation with the Bonanza Creek LTER program. (3) Experimental manipulations of ecosystems which are maintained and measured for decades. These experiments include tundra warming, shading and fertilizing, the exclusion of large herbivores, fertilization of lakes and streams, and the addition and removal of predators. (4) Synthesis and modeling efforts. Overall, this research will add to our basic understanding of the response of ecosystems to human induced global environmental change. In addition, these analyses will contribute to theoretical questions in ecology, including issues related to disturbances, resource availability, top-down vs. bottom-up controls on communities, and ecosystem structure and function.

연구과제명 : (9981397) BIOCOMPLEXITY : Bacterial and Computational Experiments to Identify General Principles that Govern the Evolution of Complexity
기관명 : Michigan State University
NSF 프로그램 및 연구분야 : POPULATION BIOLOGY / Population
연구기간 : 1999. 11. 1. - 2004. 10. 31.(추정)
전체연구비(추정) : $4,050,077
연구요약 :
The principal investigators define biocomplexity as the dynamic web of interactions among

genes, organisms, and environments. They will investigate the emergence of biocomplexity and examine its consequences for the performance of living organisms and ecological communities. Parallel experiments will be performed with two very different systems, in order to study general principles. One system employs bacteria, and the other system is digital. The latter consists of special computer programs that self-replicate, mutate, and evolve novel sequences of instructions to solve problems. One set of experiments will monitor the evolution of ecosystem complexity, in which a single progenitor diverges into multiple types that perform distinct functions by exploiting different resources. Follow-up experiments will examine the effects of removing member species on the remainder of the community. Another project will develop the software used for studying digital organisms into an educational tool. This project, which is being supported by the Directorates for Biological Sciences, Computer Information Science and Engineering, Engineering, and by the division of Mathematical Sciences and the MPS Office of Multidisciplinary Activities, will impact several scientific fields, and the findings may provide basic information useful for both environmental and biotechnological applications. For example, ecologists may find principles useful for improving the performance of beneficial organisms in the environment. Computer scientists may discover computational strategies, evolved by real organisms that can be employed in developing more complex software.

연구과제명 : (9981711) BIOCOMPLEXITY:Common Mycorrhizal Networks - Active or Passive Channels? Interacting Roles of Mycorrhizal Fungi, Plants and Soil Resources in Carbon & Nutrient Transfers
기관명 : U of Cal Davis
NSF 프로그램 및 연구분야 : ECOSYSTEM STUDIES / Structure & Function
연구기간 : 1999. 11. 1. - 2004. 10. 31.(추정)
전체연구비(추정) : $3,219,499
연구요약 :
Researchers at the University of California at Davis and Riverside and from Southern Oregon University will examine how the spatial and temporal distributions of soil resources interact with mycorrhizal fungi and plant roots to form networks belowground (common mycorrhizal networks, CMNs). The central hypothesis is that flows of carbon and nutrients in CMNs are not wholly determined either by plants or fungi. The magnitude and direction of flows are determined by interactions between plant species, mycorrhizal fungal species and soil resources -- resources whose availability changes in complex ways in space and time. Changes in any one of the 3 components will result in altered CMN structure and function. The researchers predict that changes in the 3 components will significantly alter fungal and plant species composition and soil resource distribution, resulting in long-term changes in plant community dynamics, soil stability, nutrient cycling rates, and ecosystem production. Research activities, which are being supported by the Directorate for Biological Sciences, and the Division of Mathematical Sciences, and the Office of Multidisciplinary Activities in the Directorate for Mathematics and Physical Sciences, among institutions will be coordinated using three innovative approaches. These include student and post-doctoral researcher rotations among institutions, annual field campaigns

integrating participants from all institutions, and web sites to disseminate information. This approach will train students to think broadly about complex systems and about the value of applying multiple skills and tools to complex problems. The research will enhance understanding of the dynamic interactions between oaks and grasses in oak woodlands in California, perhaps allowing more successful preservation and restoration of these woodlands. By comparing biocomplexity above and below-ground in a model system, the researchers expect to learn general principles about how above and below ground systems are linked.

③ Integrative Biology & Neuroscience (1개 과제)

연구과제명 : (9632851) Long-Term Ecological Research in Tallgrass Prairie : The Konza Prairie LTER Program
기관명 : Kansas State University
NSF 프로그램 및 연구분야 : ECOLOGICAL & EVOLUTIONARY PHYS / Biology of Pest Organisms, Regional & Environmental, Global Carbon Cycle
연구기간 : 1996. 11. 1. - 2002. 10. 31.(추정)
전체연구비(추정) : $3,360,000
연구요약 :

A long-term ecological research program will be continued and expanded at the Konza Prairie LTER site in NE Kansas. Konza Prairie, a pristine tallgrass prairie is, arguably, the most intensively studied grassland site on earth. The 15 year old, broadly-based research program encompasses studies from the population, community, ecosystem and landscape ecology levels. These studies are linked by a theme that includes all the major abiotic and biotic factors influencing this ecosystem. Our central hypothesis is that fire, grazing and climatic variability are essential and responsible for the structure and function of tallgrass prairie. In contrast to many other grasslands where ecological processes are constrained by a single resource (e.g., water), organismic to ecosystem processes and dynamics in tallgrass prairie are products of a variety of limiting resources (water, light, nitrogen). Variability in, and switching among, these primary limiting resources are caused by both present and historical fire, grazing and climatic regimes. As a result of this complexity, and because grazing and fire regimes are managed in grassland systems worldwide, data from the Konza Prairie LTER program have relevance not only for understanding this grassland, but for broader ecological issues such as stability diversity questions and interactions between land-use, biodiversity and climate change. The proposed research includes continuation of long-term fire and grazing studies as well as short-term studies focused on key processes and mechanisms. Proposed new research includes studies of the effect of fire season, a fire-treatment reversal experiment in which watersheds that have been annually burned or unburned for 20 years will have their treatments reversed, comparative studies of bison vs. cattle as the dominant grazers, and a long-term study of how grazing, fire, climatic variability and agriculture affect annual carbon, water and energy budgets in tallgrass prairie. A key question addressed by the latter study is whether or not tallgrass prairie soils are a sink or source for carbon and how land-use (fire, grazing) and climate affects the carbon budget.

④ Molecular & Celluar Bioscience (2개 과제)

연구과제명 : (9907939) Genetic Analysis of Nervous System
기관명 : California Inst of Tech
NSF 프로그램 및 연구분야 : EUKARYOTIC GENETICS / Other Applications NEC
연구기간 : 1999. 11. 1. - 2004. 10. 31.(추정)
전체연구비(추정) : $3,526,899
연구요약 :

Methods are described for using the fruit fly Drosophila as a model system for genetic analysis of mechanisms that control lifespan and behavior during adult life. In the fly, as in humans, there is a scenario of up and down regulation of various genes as life progresses. The project describes methods for identifying the genes involved and measuring their activities. Three special groups of mutants to be used for the analysis are 1)short-life mutants, 2) mutants that are sluggish in their locomotor activity during life, and 3) mutants that have extended lifetimes. In some cases, the mutants have been found to have late-onset neurodegeneration and characterization of those phenotypes will continue. Identification and cloning of the genes affected in such mutants and monitoring their activities during life, can provide keys to the underlying events. An investigation into the genetics of pain will also be initiated. Genetic analysis of Drosophila development has had dramatic success in analyzing early events in embryogenesis and postembryonic events in the larva and pupa. However, many studies end at the point of emergence of the adult, which, with the exception of gametogenesis, is generally regarded as postmitotic and finalized, with the nervous system hard-wired. But the newly emerged adult fly continues to undergo important developmental and behavioral changes and the nervous system retains plasticity, as demonstrated by the fly's ability to learn. This proposal uses genetic analysis to address such on-going events in the adult.

연구과제명 : (9975765) Analyses of the Chlamydomonas Reinhardtii Genome : A Model, Unicellular System for Analyzing Gene Function and Regulation in Vascular Plants
기관명 : Carnegie Inst of Wash
NSF 프로그램 및 연구분야 : GENETICS / Other Applications NEC
연구기간 : 1999. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $3,300,000
연구요약 :

The personnel involved in this project are Arthur Grossman (PI, Carnegie Institution of Washington), Paul Lefebvre and Carloyn Silflow (Co-Pls, University of Minnesota), John Davies

(Co-PI, Iowa State University), Elizabeth Harris (Co-PI, Duke University), David Stem (Co-PI, Boyce Thompson Institute, Cornell University), and Ronald Davis (Co-PI, Stanford University). Chlamydomonas reinhardtii, a unicellular haploid green alga, has been and will continue to be a very important model system for elucidating basic biological processes in plants. Experimentation with Chlamydomonas is particularly important for the dissection of photosynthetic processes since this alga can be grown rapidly on an exogenous source of fixed carbon and is the only genetically tractable eukaryote for which mutations that affect all aspects of photosynthesis and carbon assimilation are conditional rather than lethal. The application of sophisticated genome-wide methodologies to studies of Chlamydomonas will augment its utility as a model for the analysis of photosynthetic function and regulation. Specifically, as a first goal, normalized Chlamydomonas CDNA libraries will be generated using RNA isolated from cells grown under a variety of environmental conditions. The 3′ and 5′ sequences of the cDNAs will help generate unique sets of ESTs that will be arrayed onto polylysine coated slides. These arrays will be used to examine global gene expression under conditions that markedly alter the activity and biosynthesis of the photosynthetic apparatus. The microarrays will also be used to analyze gene expression in those photosynthetic mutants that appear to be regulatory in nature (to identify potential gene targets for regulatory elements). Furthermore, full-length sequences will be generated for most of the cDNAs, which would represent almost the complete coding capacity of the Chlamydomonas nuclear genome. A second goal is to establish a partial physical map of the nuclear genome that is aligned with the genetic map with the aim of using the information to perform rapid and efficient map-based cloning of genes. The mapping studies will focus on specific regions of the nuclear genome that are centered around mutations that define genes having critical functions in photosynthesis. A third goal is to complete the sequence of the chloroplast genome, generate and analyze strains that are deleted for each of the chloroplast open reading frames, and use microarrays containing each of the chloroplast open reading frames to characterize global expression of chloroplast genes under different environmental conditions. The microarray technology will also be used to evaluate the abundance of all chloroplast mRNAs in nuclear mutants that exhibit aberrant transcriptional and post-transcriptional control of plastid gene expression. Much of the information and many of the tools that will be developed during the course of this work will allow studies of photosynthesis to attain a global dimension, which is critical for elucidating the dynamic nature of chloroplast function and the mechanisms involved in regulating chloroplast gene expression.

⑵ 컴퓨터 및 정보과학 (21개 과제)

① Advanced Computational Infrastructure and Research (3개 과제)

연구과제명 : (9613855) Acquistion and Evaluation of a Multi-Threaded, Shared Memory Supercomputer
기관명 : U of Cal San Diego
NSF 프로그램 및 연구분야 : ADVANCED COMP RESEARCH PROGRAM / Other Applications NEC

연구기간 : 1996. 9. 15. - 1999. 8. 31.(추정)
전체연구비(추정) : $4,200,000
연구요약 :
The University of California, San Diego (UCSD) and the San Diego Supercomputer Center (SDSC) propose acquisition of the first commercial MTA system. The salient features of the Tera MTA multiprocessors are : -high-speed GaAs processors, -its multi-threaded architecture (hence MTA), which should allow more concurrency and thus higher processor efficiency, -an interconnection network scalable to hundreds of processors, -shared memory with its convenient programming model and broad applicability, -a sophisticated compiler for automatic parallelization. This system will be made accessible to researchers and educators nationwide for production computing and computer science experimentation. In addition, local researchers will evaluate performance of the MTA a from both systems and applications perspectives.

연구과제명 : (9619019) National Computational Science Alliance
기관명 : U of Ill Urbana-Champaign
NSF 프로그램 및 연구분야 : PART FOR ADVANCED COMP INFRA / Other Applications NEC
연구기간 : 1997. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $64,631,801
연구요약 :
This action executes a cooperative agreement between NSF and the National Computational Science Alliance (the Alliance) at the University of Illinois at Urbana-Champaign (UIUC), under the direction of Dr. Larry Smarr via NSF award ASC 9619019. The cooperative agreement will be operational for a period of five years and is the result of a proposal submitted to NSF solicitation, "Partnerships for Advanced Computational Infrastructure" (PACI), NSF 96-31. The PACI program builds on and replaces the NSF Supercomputer Centers Program established in 1985 The program focuses on newly emerging opportunities in high performance computing and communications, providing flexibility, both to adapt to rapidly evolving circumstances and to meet the need for high-end computation, in order to enable continued U.S. world leadership in computational science and engineering. NSF, through this program, will provide access for researchers to high performance computing systems, with associated highly trained staff and researchers necessary to develop and optimize their use. The emergence of scalable parallel systems, high performance networking and high bandwidth and large capacity mass storage systems creates the opportunity for a national infrastructure consisting of a number of geographically distributed sites strongly coupled to high end computational resources and to each other via high speed communications networks. The National Center for Supercomputing Applications has joined with its partners to create an Alliance whose principal mission is the integration of the many computational, visualization and information resources into a national-scale "Grid". The Grid links the Alliance together and provides access to its wide variety of resources to the national scientific research community. Using high performance

networking the Grid will link the highest performing systems to mid-range versions of these architectures, and then to the end-users' workstations, thereby creating a national Power-Grid. The Allia nce Grid will interconnect dozens of visualization and virtual reality displays, massive data stores, and remote instruments, while Alliance developed software "glue" unifies them for collaborative problem solving. The Alliance will also create integrating structures for information and resources distributed on the Grid, making its content useful for education, training and outreach. Special emphasis will be placed on outreach to underrepresented minorities, women and other pertinent areas. The partnership members have been chosen because of their individual commitments to work together as a team, enabling advances to be achieved by a new level of national-scale multidisciplinary collaborative research. The Alliance will concentrate on providing advanced hardware, enabling technology, leading edge work in application technology, education, training and outreach. Included in this award is the first incremental payment to UIUC and its partners for FY98 which covers general operating expenses including equipment.

연구과제명 : (9619020) National Partnership for Advanced Computational Infrastructure
기관명 : U of Cal San Diego
NSF 프로그램 및 연구분야 : PART FOR ADVANCED COMP INFRA / Other Applications NEC
연구기간 : 1997. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $67,799,924
연구요약 :
This action executes a cooperative agreement between NSF and the National Partnership for Advanced Computational Infrastructure (NPACI) at the University of California - San Diego (UCSD), under the direction of Dr. Sid Karin via NSF award ASC 9619020. The cooperative agreement will be operational for a period of five years and is the result of a proposal submitted to NSF solicitation, "Partnerships for Advanced Computational Infrastructure" (PACI), NSF 96-31. The PACI program builds on and replaces the NSF Supercomputer Centers Program established in 1985 The program focuses on newly emerging opportunities in high performance computing and communications, providing flexibility, both to adapt to rapidly evolving circumstances and to meet the need for high-end computation, in order to enable continued U.S. world leadership in computational science and engineering. NSF, through this program, will provide access for researchers to high performance computing systems, with associated highly trained staff and researchers necessary to develop and optimize their use. The emergence of scalable parallel systems, high performance networking and high bandwidth and large capacity mass storage systems creates the opportunity for a national infrastructure consisting of a number of geographically distributed sites strongly coupled to high end computational resources and to each other via high speed communications networks. NPACI will lead the deployment and evolution of a national-scale metacomputing environment that will benefit the national user community in all fields of computational science and engineering. This infrastructure will integrate compute and data servers, and employ the talents of computer and computational

scientists to guide its evolution. It will leverage the activities of many projects. The metacomputing environment will be extended to enable not only numerically intensive but also data-intensive computing. To that end, infrastructure will be developed and deployed to enable analysis of extremely large data collections from application output, remote-sensing and instrumentation-derived data, and data in widely scattered, discipline-specific databases. Three technology areas which are central to creating a metacomputing environment will initially be the basis for NPACI : Adaptable, Scalable Tools/Environments; Data-intensive Computing; and Interaction Environments. Several scientific applications have also been chosen that will motivate, guide, and validate development and integration of the NPACI infrastructure. Molecular Science, Neuroscience, Earth Systems Science, and Engineering will initially be focused on as areas ripe for scientific discovery and technology development. NPACI will integrate computational science and engineering education activities into the infrastructure, building on successful education and outreach efforts within the partnership. Particular emphasis will be placed on outreach to underrepresented minorities, women, and new communities. The Partnership will concentrate on providing advanced hardware, enabling technology, leading edge work in application technology, education, training and outreach. Included in this award is the first incremental payment to UCSD and its partners for FY98 which covers general operating expenses including equipment.

② Advanced Networking Infrastructure and Research (9개 과제)

연구과제명 : (9616754) Gigabit Network Technology Distribution Program
기관명 : Washington University
NSF 프로그램 및 연구분야 : NETWORKING & COMMUN RES PROGRM / Telecommunications
연구기간 : 1996. 9. 15. - 2000. 8. 31.(추정)
전체연구비(추정) : $3,087,515
연구요약 :

In recent years research in networking, distributed systems, and high performance computing has been hampered by the research community's limited access to high performance networking equipment, and more importantly, the detailed technical information needed to use it effectively in experimental systems research programs. This project provides gigabit network technology to U.S. universities for use in research and education. This technology is distributed in the form of Gigabit Network Kits, each kit consisting of a high performance ATM switch (supporting link speeds of up to 2.4 Gb/s), six network interface cards for workstations or PCs, software (including source), extensive documentation, including hardware design information. The kits are designed to permit flexible use in a variety of different systems research contexts (networking, operating systems, multimedia and high performance computing), and can be modified at both the software and hardware levels. In addition to the hardware and software, the program provides initial user training in the form of a two week intensive course and ongoing support through a users' group, an electronic mailing list and a WWW site providing access to software, documentation, announcements of contributed research products, bug reports and a FAQ page. Hardware support is also provided. The program also provides for a series of user workshops, (one every six months), allowing users to share experiences and demonstrate results from their work.

연구과제명 : (9710738) California Research and Education Network-2 (CalREN-2) Phase 1
기관명 : U of Calif, Pres, Oakland
NSF 프로그램 및 연구분야 : NETWORK INFRASTRUCTURE / Telecommunications
연구기간 : 1997. 7. 1. - 1999. 12. 31.(추정)
전체연구비(추정) : $5,275,600
연구요약 :
This award is made under the high performance connections portion of NCRI's "Connections to the Internet" announcement, NSF 96-64. It provides partial support for two years for OC-3 connections for eleven institutions to an OC-48 California statewide network. The network will be connected to the vBNS in two places : the Los Angeles Basin, and the San Francisco Bay area. The eleven institutions are : University of California campuses at Berkeley, Davis, Irvine, Riverside, San Francisco, Santa Barbara and Santa Cruz; Stanford; CalTech; University of Southern California and the Information Sciences Institute. The over 40 applications cover fields such as metacomputing; distributed interactive simulation; remote telescope operation, microscopy and tele-imaging for health care; digital libraries; and projects in physics, biology and communications. Collaborating institutions include Oak Ridge National Lab, Rice, Argonne National Laboratory, Los Alamos National Laboratory, Syracuse University, University of Tennessee and the University of Texas.

연구과제명 : (9711092) A Cooperative Association for Internet Data Analysis (CAIDA)
기관명 : U of Cal San Diego
NSF 프로그램 및 연구분야 : NETWORK INFRASTRUCTURE / Telecommunications
연구기간 : 1997. 9. 15. - 2000. 8. 31.(추정)
전체연구비(추정) : $3,177,580
연구요약 :
This award supports a three year project to promote greater industry cooperation in architecting and managing the global Internet infrastructure. It addresses global engineering concerns that are highly dependent upon cross-ISP coordination, particularly those requiring measurement of Internet metrics. It addresses ISPs' emerging need for technical meahnaisms to facilitate service guarantees and financial settlements between providers. Specifically, the CAIDA endeavors to : identify, develop and deploy measurement tools across the Internet; work with commercial providers to provide them with a neutral, confidential vehicle for data sharing and analysis; provide networking researchers and the general Internet community with current data on Internet traffic flow patterns; assist in the introduction/deployment of emerging Internet technologies

such as multicast, Ipv6, web caching, bandwidth reservation protocols, etc; and enhance communications between commercial Internet service providers and the broader Internet communities. The goal is to have both government and industry participate in the project's creation and operation. The project is envisioned as a supporting framework for active tasks to be defined by researchers in conjunction with CAIDA members. Tasks will be defined through proposals by CAIDA researchers to one or more CAIDA sponsoring members; jointly proposed by CAIDA researchers and CAIDA sponsoring members; or solicited by one or more sponsoring members of CAIDA. It is expected that the government's role in funding the project will diminish as industry support increases.

연구과제명 : (9712163) Net Scout Internet Resource Discovery and Search Technologies
기관명 : U of Wisconsin Madison
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications
연구기간 : 1997. 5. 1. - 2000. 4. 30.(추정)
전체연구비(추정) : $3,182,578
연구요약 :
The Net Scout project is an Internet resource location and technology service oriented primarily to the higher education community. It currently provides four services that are used by thousands of faculty, staff, and students in higher education : the Scout Report, Net Happenings, the Scout Toolkit, and the KIDS Report. The Scout Report is a weekly electronic newsletter summarizing the best new Internet resources of use to higher education. Net Happenings is an electronic service that provides immediate notification of 50-70 Internet announcements each day via a mailing list, a newsgroup, and a Web site. The Scout Toolkit summarizes the best Internet search services and other tools needed by researchers and educators to use the Internet effectively. The KIDS Report is a biweekly newsletter written by students in elementary, middle, and high school classrooms who select and describe the Web sites they find the most interesting and useful. The Net Scout project will continue and expand these services in two ways : First, to provide additional services, including publication of three biweekly Scout Reports produced by specialists in the specific areas of Science and Engineering, Social Sciences, and Business and Economics, and, second, to implement new tools which aid in the location of Internet resources in a specific subject area. A prototype service will be built using as its initial base the three year archive of the highly selective resources that have been included in the Scout Report. Specialized authenticated collections of quality resources at higher education institutions will also be identified and included in the prototype. http://wwwscout.cs.wisc.edu/

연구과제명 : (9730201) TransPAC : A High Performance Network Connection for Research and Education Between the vBNS and the Asia-Pacific Advanced Network (APAN)
기관명 : Indiana U Bloomington
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications

연구기간 : 1998. 8. 1. - 2004. 1. 31.(추정)
전체연구비(추정) : $10,127,214
연구요약 :
This award to Indiana University, entitled "TransPAC : A High-Performance Network Connection for Research and Education between the vBNS and APAN" provides support for a High Performance International Internet Services connection between the networks of the Asia-Pacific Advanced Networking consortium (APAN) and NSF's very high-performance Backbone Network Services (vBNS). APAN presently involves advanced networks in Japan, Korea, Singapore and Australia and is expected soon to involve other countries in the Asia-Pacific region. The overall consortium (APAN plus Indiana University) is called TransPAC. TransPAC proposed to provide a 35 Mbps link between the Tokyo node of APAN and the vBNS via the NSF-funded international connection point for high-performance networks, STAR TAP, in Chicago. TransPAC will initially provide a high performance connection for about 50 joint US/Asia-Pacific projects that will leverage an estimated $200 million of research over the period of the TransPAC award.

연구과제명 : (9730202) EuroLink : High Performance International Internet Services between Research and Education Institutions in the United States and Europe/Israel
기관명 : U of Illinois Chicago
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications
연구기간 : 1999. 4. 1. - 2003. 3. 31.(추정)
전체연구비(추정) : $9,494,256
연구요약 :
This award to the University of Illinois at Chicago, (UIC) entitled"EuroLink : High Performance International Internet Services between Research and Education Institutions in the United States and Europe/Israel" provides support for a High Performance International Internet Services connection between the advanced networks of the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), France, Netherlands, Israel and NSF's very high-performance Backbone Network Services (vBNS). The overall consortium (European networks plus UIC) is called EuroLink. EuroLink proposed to provide four links, each nominally at 45 Mbps, between the European NRNs and the vBNS via the NSF-funded international connection point for high-performance networks, STAR TAP, in Chicago. It is anticipated that other European countries may join EuroLink in the future. Round-the-clock operational support will be provided under subcontract to the Indiana University Network Operations Center (NOC). The Indiana NOC also serves under a companion HPIIS award to TransPAC for Asia-Pacific collaborations, and it also provides operational support to the Internet2/Abilene network.

연구과제명 : (9730330) University of Tennessee, Knoxville High Performance International Internet Services

기관명 : U of Tennessee Knoxville
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications
연구기간 : 1998. 7. 1. - 2003. 12. 31.(추정)
전체연구비(추정) : $4,021,205
연구요약 :
This award to University of Tennessee, Knoxville, entitled "MirNET : High-Performance International Internet Services" (MirNET-HPIIS) provides support for a High Performance International Internet Services connection between high-performance research institutions attached to the Russian Backbone Network (Rbnet) and the vBNs.

연구과제명 : (9980480) STAR TAP2 : Science, Technology and Research Transit Access Point
기관명 : U of Illinois Chicago
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications
연구기간 : 2000. 5. 1. - 2003. 10. 31.(추정)
전체연구비(추정) : $3,013,238
연구요약 :
The Science, Technology and Research Transit Access Point (STAR TAP) was funded by NSF ANI-9712283 for the period May 1,1997-April 30, 2000. The current award funds a three-year continuation of the pivotal infrastructure services provided by STAR TAP. STAR TAP services will be expanded in depth to take account of dynamic changes that have taken place in high performance networking since the inception of the Next Generation Internet (NGI) Program as well as related domestic (e.g., Internet 2) and foreign (e.g., Canada, Japan, Singapore, Netherlands, Israel, Nordic countries and others to follow) initiatives. The nature of the effort, however, is substantially unchanged, namely to support global collaborations on progressing high performance networking and advanced networked applications by providing persistent, reliable interconnections between domestic and international partner advanced academic networks.

연구과제명 : (9980537) NSF Advanced Networking Project With Minority-Serving Institutions (AN-MSI)
기관명 : Educause
NSF 프로그램 및 연구분야 : ADVANCED NET INFRA & RSCH / Telecommunications
연구기간 : 1999. 9. 15. - 2003. 8. 31.(추정)
전체연구비(추정) : $5,968,356
연구요약 :
This award to Educause provides support for a series of activities designed to enable minority-serving institutions to prepare for and then participate in national advanced networking initiatives, including Internet2 and NGI. Included are workshops and training programs intended to assist administrators in devising technology strategies and financing plans for their institutions. Similar programs will develop the human support infrastructure in these colleges

and universities. Yet other activites are aimed at preparing the faculty and students in the use of the high performance networks. An important aspect of this latter array of activities is the involvement of the Education, Outreach, and Training (EOT) program that is part of NSF's Partnerships for Advanced Computational Infrastructure (PACI). Coupled with and integral to all of these programs and activities will be experiments with and prototypes of advanced, innovative network technologies for Internet access or for vBNS or Abilene access. In particular, these advanced technologies will seek to attack the problems of cost and access for locations that have limited telecommunications options.

③ Experimental and Integrative Activities (3개 과제)

연구과제명 : (9720359) Learning and Intelligent Systems : CIRCLE : Center for Interdisciplinary Research on Constructive Learning Environments
기관명 : U of Pittsburgh
NSF 프로그램 및 연구분야 : CISE RESEARCH INFRASTRUCTURE / Other Applications NEC
연구기간 : 1997. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $4,997,797
연구요약 :
The Center has three main goals. First, the Center seeks to understand an extremely effective pedagogy, human tutoring. This will be achieved by using protocol analysis, eye tracking and controlled experiments to study human tutors and contrast them to existing computer tutors. The overarching hypothesis is that students learn best when they construct knowledge for themselves. The second goal of the Center is to build and test new generation of computer tutoring systems that encourage students to construct the target knowledge instead of telling it to them. The student's self-construction may need to be delicately guided via prompting, Socratic questioning or other means, This goal will be achieved by adding advanced planning and natural language components to existing intelligent tutoring systems and testing the new tutors in collaborating schools. The Center's third goal is to help integrate this new technology into existing educational practices. This goal will be achieved by working with practitioners and schools throughout the development process, by upgrading tutors that are already in use by thousands of students, and by forming partnerships with other projects, centers and industries. Achieving the three Center goals will impact multiple disciplines. Understanding why human tutors are so effective should have a significant impact on the psychology of learning. Computer science will be advanced by developing systems that can reactively plan natural language hints and questions that get a student to learn. Education will be improved as the Center's constructivist technology and instructional methods prove to be effective in actual use and become widely available.

연구과제명 : (9720384) Learning and Intelligent Systems : Center for Innovative Learning Technologies
기관명 : SRI International
NSF 프로그램 및 연구분야 : CISE RESEARCH INFRASTRUCTURE / Other Applications NEC
연구기간 : 1997. 10. 1. - 2001. 9. 30.(추정)
전체연구비(추정) : $5,800,000
연구요약 :
The Center for Innovative Technologies (CILT) stimulates the development and implementation of important, technology-enabled solutions to critical problems in K-14 science, mathematics, engineering, and technology learning. Four institutions-SRI International; the University of California at Berkeley; Vanderbilt University; and the Concord Consortium-provide Center leadership and infrastructure. "Theme teams" conduct the Center's research, development, and implementation activities. Participants drawn both from the founding organizations and from elsewhere will represent the best possible mix of expertise. Theme teams will include computer scientists and engineers; experts in science, mathematics and engineering instruction, policy, and research; and industry leaders. Participants will work together in national workshops and on-line discussions to review their research results, identify critical challenges and potential breakthroughs in their theme area, and select prototype collaborative projects for CILT sponsorship. These prototype projects serve as"seed" efforts that,can transform the use of learning technologies in education. The Center's initial themes are Virtual Learning Communities; Visualization and Modeling; Low-Cost, Ubiquitous Computing; and Assessment. CILT provides the infrastructure for synthesizing learning technology R&D and implementation lessons across projects, stimulating multidisciplinary collaboration and rapid innovation, and fostering communication among technology supports for mathematics and science learning. CILT will train postdoctoral scholars from multiple disciplines to lead the field of learning technologies in the future.

연구과제명 : (9975020) Next Generation Software : Grid Application Development Software (GrADS)
기관명 : William Marsh Rice Univ
NSF 프로그램 및 연구분야 : NEXT GENERATION SOFTWARE PROGR / Other Applications NEC
연구기간 : 1999. 10. 1. - 2004. 9. 30.(추정)
전체연구비(추정) : $5,599,994
연구요약 :
This proposal will make it possible to have advances in networking technologies to use the global information infrastructure in a qualitatively different way-as a computational resource as well as and information resource. This idea for an integrated computation and information resource called the Computational Power Grid has been described by the recent book entitled The Grid : Blueprint for a New Computing Infrastructure [40]. The Grid will connect the nation's computers, databases, instruments, and people in a seamless web, supporting emerging computation-rich application concepts such as remote computing, distributed supercomputing, tele-immersion, smart instruments, and data-mining. To realize this vision, significant scientific

and technical obstacles must be overcome. Principal among these is usability. Because the Grid will be inherently more complex than existing computer systems, programs that execute on the Grid will reflect some of this complexity. The Grid resources will be useful and accessible to scientist and engineers requiring new software tools that embody major advances in both the theory and practice of building Grid applications. The goal of the Grid Application Development Software (GrADS) Project is to simply distribute heterogeneous computing in the same way that the World Wide Web simplified information sharing over the Internet. The GrADS projects will explore the scientific and technical problems that must be solved to make Grid application development and performance tuning for real applications an everyday practice.

④ Information and Intelligent Systems (6개 과제)

연구과제명 : (9817353) DLI-Phase 2 : Re-inventing Scholarly Information Disseminati on and Use
기관명 : U of Cal Berkeley
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Information Systems
연구기간 : 1999. 4. 1. - 2004. 3. 31.(추정)
전체연구비(추정) : $5,000,000
연구요약 :
This Project is a component of the InterLib collaboration between University of California at Berkeley, the University of California at Santa Barbara, and Stanford University. The combined interLib technologies will be demonstrated on the emerging California Digital Library (CDL), and on a testbed developed by the San Diego Supercomputer Center. The Project will attempt to develop tools and technologies that support highly improved models of information dissemination and access. A goal is to facilitate moving from the current centralized, discrete publishing model, to a distributed, continuous, self-publishing model, while at the same time preserving and enhancing the best aspects of the current model. In the envisioned model, information can be disseminated prior to publishing; it can be disseminated and composed continually; it will also have a significant non-textual data component. The model is consistent with the changing economics of academic publishing, yet has the potential to drastically alter the cost structure of scholarly information dissemination. To promote such an improved paradigm, it is planned to (i) develop a set of enabling technologies, (ii) develop related technologies that exploit the paradigm to support functionality not readily available in the traditional model, (iii) experimentally develop publishing models and digital collections in line with the new paradigm, (iv) conduct studies on economic models of alternative information paradigms, and (v) conduct user studies to help evaluate the impact of the work.

연구과제명 : (9817432) DLI Phase 2 : Alexandria Digital Earth Prototype
기관명 : U of Cal Santa Barbara
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Information Systems

연구기간 : 1998. 9. 1. - 2004. 8. 31.(추정)
전체연구비(추정) : $5,400,000
연구요약 :
This is the first year funding of a five year Cooperative Agreement award. This Project is a component of the InterLib collaboration between University of California at Berkeley, the University of California at Santa Barbara, and Stanford University. The combined interLib technologies will be demonstrated on the emerging California Digital Library (CDL), and on a testbed developed by the San Diego Supercomputer Center. The Alexandria Digital Earth Prototype (ADEPT) Project will develop digital library environments and services that are based on the Digital Earth Metaphor. The services will support access to, and use of, heterogeneous digital information distributed across the Internet on the basis of georeference as well as other criteria. In particular the system will support the construction and use of personalized digital information collections called Iscapes (Information Landscapes). A variety of services will be provided that allow Iscapes to be developed as information service layers in which diverse information resources can be organized, accessed, and used. A characteristic feature of Iscapes is the creation of special meta-information resources indicating the joint usability of the items in the personalized collections. The project will focus on developing services that support the construction and use of Iscapes for use in learning contexts and for the creation of knowledge across a range of disciplines, including the arts, humanities, and social, physical,] and biological sciences. The Project will focus specific attention on evaluating the effect of ADEPT services on learning in undergraduate classroom situations.

연구과제명 : (9817434) DLI-Phase 2 : A Patient Care Digital Library : Personalized Retrieval Summarization of Multimedia Information
기관명 : Columbia University
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Human Subjects
연구기간 : 1999. 9. 1. - 2004. 8. 31.(추정)
전체연구비(추정) : $5,002,375
연구요약 :
This is the first year funding of a five year Cooperative Agreement award. Healthcare consumers and providers both need quick and easy access to a wide range of online resources. The goal of this project is to provide personalized access to a distributed patient care digital library through the development of a system, PERSIVAL (Personalized Retrieval and Summarization of Image, Video And Language resources). PERSIVAL will tailor search, presentation, and summarization of online medical literature and consumer health information to the end user, whether patient or healthcare provider. PERSIVAL will utilize the secure online patient records available at Columbia Presbyterian Medical Center (CPMC) as a sophisticated, pre-existing user model that can aid in predicting user's information needs and interests. Key features of the proposed work include personalized access to distributed, multimedia resources

available both locally and over the Internet, fusion of repetitive information and identification of conflicting information from multiple relevant sources, and presentation of information in concise multimedia summaries that cross-link images, video, and text. When the latest medical information is provided at the point of patient care, it can help practicing clinicians to avoid missed diagnoses and minimize impending complications. When expressed in understandable terms, it can empower patients to take charge of their healthcare.

연구과제명 : (9817485) DLI-2 : A National Gallery of the Spoken Word
기관명 : Michigan State University
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Information Systems
연구기간 : 1999. 9. 1. - 2004. 8. 31.(추정)
전체연구비(추정) : $3,599,989
연구요약 :
This the first year funding of a five year Cooperative Agreement award. The National Gallery of the Spoken Word (NGSW) will preserve and, within the limits of copyright law, make historically significant voice recordings freely available and easily accessible via the Internet. The NGSW will create a significant, fully searchable, online database of spoken word collections that span the 20th century. A collaborative project among the humanities, engineering, education and library science, this gallery will provide the first large-scale repository of its kind. . Participants in this project include researchers who are recognized leaders in the development of aural search capabilities. The NGSW will also create a repository of high quality digital versions of key spoken material with standard bibliographic and metadata access while developing a set of best practices for future development of sound on the web, including methods for conversion, preservation, access, and copyright compliance.

연구과제명 : (9817496) DLI Phase 2 : Informedia-II : Integrated Video Information Extraction and Synthesis for Adaptive Presentation and Summarization from Distributed Libraries
기관명 : Carnegie Mellon University
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Information Systems
연구기간 : 1999. 5. 1. - 2003 4. 30.(추정)
전체연구비(추정) : $4,000,000
연구요약 :
DLI Phase 2 : Informedia-II : Integrated Video Information Extraction and Synthesis for Adaptive Presentation and Summarization from Distributed Libraries. The Informedia-II Project continues the pursuit of search and discovery in the video medium. This phase will transform the paradigm for accessing digital video libraries through meaningful, manipulable overviews of video document sets, multimodal queries, and adaptive summarizations of very large amounts of video from heterogeneous distributed sources. Video information collages are the key technology in Informedia-II and will be built by advancing information visualization research to effectively

deal with multiple video documents. A video information collage is a presentation of text, images, audio, and video derived from multiple video sources in order to summarize, provide context, and communicate aspects of the content for the originating set of sources. The collages to be investigated include chrono-collages emphasizing time, geo-collages emphasizing spatial relationships, and auto-documentaries which preserve video's temporal nature. Users will be able to interact with the video collages to generate multimodal queries across time, space, and sources. Together with external partners, the project will also create an accessible, lasting digital video archive of historical, political and scientific relevance. Vast collections of video and audio recordings have captured the events of the last century, yet these remain a largely untapped resource of historical and scientific value.

연구과제명 : (9817799) DLI-Phase 2 : Stanford InterLib Technologies
기관명 : Stanford University
NSF 프로그램 및 연구분야 : SPECIAL PROJECTS (IIS) / Information Systems
연구기간 : 1999. 4. 1. - 2004. 3. 31.(추정)
전체연구비(추정) : $4,297,585
연구요약 :
This Project is a component of the InterLib collaboration between University of California at Berkeley, the University of California at Santa Barbara, and Stanford University. The combined interLib technologies will be demonstrated on the emerging California Digital Library (CDL), and on a testbed developed by the San Diego Supercomputer Center. The Stanford Project will attempt to develop base technologies to overcome critical barriers to effective digital libraries. These include : heterogeneity of information and services; lack of powerful filtering mechanisms that let users find truly valuable information; insufficient availability of interfaces and tools that effectively operate on portable devices; and lack of a solid economic infrastructure that encourages providers to make information available, and gives users privacy guarantees.

(3) 엔지니어링 (17개 과제)

① Civil & Mechanical Structures (1개 과제)

연구과제명 : (9728805) Institute for Civil Infrastructure Systems
기관명 : New York University
NSF 프로그램 및 연구분야 : GEOMECHAN, GEOTECH & GEOENVIRN / Urban Problems, Regional & Environmental
연구기간 : 1998. 1. 15. 2002. 12. 31.(추정)
전체연구비(추정) : $4,992,104
연구요약 :
The current state of infrastructure services and facilities relative to public expectations underscores the need for an institutional mechanism to bring together diverse groups to provide

an integrative framework for infrastructure. New York University, with three collaborators - Cornell University, the University of Southern California, and the Polytechnic University of New York - will establish an Institute for Civil Infrastructure Systems (ICIS) within NYU's Wagner School of Public Service. This Institute builds on partnering institution expertise in infrastructure engineering, management, and social science, and incorporates a diverse set of participating organizations and individuals. The Institute's vision is to facilitate, build partnerships and networks, supported by a strong educational initiative and information technology to organize and transfer information to the CIS community. The ICIS will be an incubator for ideas and a marketplace for information to promote connectivity. It is a new approach, combining technical and social science expertise critical to the future direction of American's infrastructure. The ICIS strategic plan is organized around sustainability and coordinated renewal, education and learning, community awareness and participation, performance measurement assessments, and research needs assessment programs. Sustainability is central to other program operations. ICIS outputs include white papers, and electronic information system to support connectivity; conferences/forums to set ICIS agendas; and demonstration/pilot projects for education and community outreach. Self-evaluation and development functions are included. The organization includes a director, and executive committee coordinating program work and technical advisory, management oversight, and development boards. The ICIS is chartered by NSF to function for up to five years with NSF support.

② Design, Manufacture, & Industrial Innovation (1개 과제)

연구과제명 : (9696175) Agile Manufacturing Enterprise Forum (AMEF)
기관명 : Agility Forum
NSF 프로그램 및 연구분야 : INTEGRATION ENGINEERING / Industrial Technology
연구기간 : 1996. 5. 1. - 2002. 3. 31.(추정)
전체연구비(추정) : $9,626,790
연구요약 :
The purpose of this forum is to develop further a vision of agile manufacturing, to assess the current state of implementation, to identify and prioritize needed changes in practices and related technology, and to influence the research agenda on agile manufacturing. The forum will carry out strategic analyses of the technical and business issues affecting agile manufacturing. It will serve as an industry voice in defining and prioritizing research needs in support of agile manufacturing. The forum will provide recommendations as requested on the entire Agile Manufacturing Initiative (AMI) including the Agile Manufacturing Research Institutes and related demonstration projects. The forum will evaluate industry training needs in agile manufacturing against available courses and materials. This forum plays a central role in the success of the AMI which provides an industry-led institute. The forum will work as a catalyst to assist in the dissemination and adoption of the agile manufacturing research results. Rapid deployment of this

research is seen as an important manufacturing strategy for the country. Enterprises which adopt agile manufacturing concepts are expected to change a broad range of operating characteristics quickly. This will enable them to take advantage of new manufacturing technologies, and to facilitate timely response to unanticipated market opportunities.

③ Electrical & Communications Systems (2개 과제)

연구과제명 : (9731293) Renewal Proposal for the National Nanofabrication Users Network
기관명 : Cornell University-Endowed
NSF 프로그램 및 연구분야 : ELECT, PHOTONICS, & DEVICE TEC / Telecommunications
연구기간 : 1999. 1. 1. - 2003. 12. 31.(추정)
전체연구비(추정) : $11,520,000
연구요약 :
The National Nanofabrication Users Network (NNUN) was established by NSF in 1994 as a partnership of advanced user facilities providing the national research and development community with access to state-of-the-art micro- and nanofabrication facilities, instrumentation, processes, and expertise. The Network is composed of a consortium of five universities : Cornell University, Stanford University, University of California at Santa Barbara, Howard University, and Pennsylvania State University. The NNUN is supported by the Directorates for Engineering (ENG), Mathematical and Physical Sciences (MPS), Biological Sciences (BIO), and Computer and Information Science and Engineering (CISE). The NNUN's mission is to provide opportunities for the nation's scientists, engineers and educators to move innovative ideas in nano-scale science and technology to the laboratory to develop prototype structures, devices and systems. The network serves a broad and diverse engineering and scientific community in academia, industry and government, and is committed to education, training and technical outreach. The experimental activities carried out at the NNUN facilities impact a wide range of scientific and technical fields including biology, chemistry, physics, electronics, magnetics, superconductivity, materials, MEMS, nanostructures, and optics. The NNUN facilities are hands-on user facilities where researchers, with minimal training, can perform individual state-of-the-art projects with tools otherwise inaccessible to them. Research activities undertaken at NNUN may range in duration from a day or so, to an extended period of time. In some cases, research projects can be undertaken remotely, with NNUN personnel assisting with fabrication processes for network users. Under new 5-year Cooperative Agreements, NNUN will continue to operate as five university nodes and will enhance the capability and infrastructure to support an increasing number of external users in traditional and in emerging new fields that are impacted by micro- and nanofabrication. The NNUN will continue to support and enhance its mission in the integration of research and education through the training of students, outreach activities and topical workshops. The URL is http://www.nnun.org/ to obtain information about the National Nanofabrication Users Network.
연구과제명 : (9731294) Renewal Proposal for National Nanofabrication Users Network

기관명 : Stanford University
NSF 프로그램 및 연구분야 : ELECT, PHOTONICS, & DEVICE TEC / Telecommunications
연구기간 : 1999. 1. 1. - 2003. 12. 31.(추정)
전체연구비(추정) : $10,480,000
연구요약 :

The National Nanofabrication Users Network (NNUN) was established by NSF in 1994 as a partnership of advanced user facilities providing the national research and development community with access to state-of-the-art micro- and nanofabrication facilities, instrumentation, processes, and expertise. The Network is composed of a consortium of five universities : Cornell University, Stanford University, University of California at Santa Barbara, Howard University, and Pennsylvania State University. The NNUN is supported by the Directorates for Engineering (ENG), Mathematical and Physical Sciences (MPS), Biological Sciences (BIO), and Computer and Information Science and Engineering (CISE). The NNUN's mission is to provide opportunities for the nation's scientists, engineers and educators to move innovative ideas in nano-scale science and technology to the laboratory to develop prototype structures, devices and systems. The network serves a broad and diverse engineering and scientific community in academia, industry and government, and is committed to education, training and technical outreach. The experimental activities carried out at the NNUN facilities impact a wide range of scientific and technical fields including biology, chemistry, physics, electronics, magnetics, superconductivity, materials, MEMS, nanostructures, and optics. The NNUN facilities are hands-on user facilities where researchers, with minimal training, can perform individual state-of-the-art projects with tools otherwise inaccessible to them. Research activities undertaken at NNUN may range in duration from a day or so, to an extended period of time. In some cases, research projects can be undertaken remotely, with NNUN personnel assisting with fabrication processes for network users. Under new 5-year Cooperative Agreements, NNUN will continue to operate as five university nodes and will enhance the capability and infrastructure to support an increasing number of external users in traditional and in emerging new fields that are impacted by micro- and nanofabrication. The NNUN will continue to support and enhance its mission in the integration of research and education through the training of students, outreach activities and topical workshops. The URL is http://www.nnun.org/ to obtain information about the National Nanofabrication Users Network.

④ Engineering Education & Centers (13개 과제)

연구과제명 : (9630951) GREENFIELD COALITION FOR NEW MANUFACTURING EDUCATION
기관명 : Wayne State University
NSF 프로그램 및 연구분야 : ENGINEERING EDUCATION / Other Applications NEC
연구기간 : 1996. 3. 1. - 2001. 2. 28.(추정)
전체연구비(추정) : $10,400,000

연구요약 :

연구과제명 : (9701471) Earthquake Engineering Research Center for Advanced Technologies in Earthquake Loss-Reduction
기관명 : SUNY Buffalo
NSF 프로그램 및 연구분야 : EARTHQUAKE ENGINEER RESRCH CTR / Earthquake
연구기간 : 1997. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $6,000,000
연구요약 :
The Center for Advanced Technologies in Earthquake Loss-Reduction (ATEL) is a nine-institution consortium, closely linked under an integrated research and management framework using modern communication networks. The thrust of this center will be the development and application of advanced and emerging technologies for design, construction, and intelligent engineering renewal of buildings and civil infrastructure in reducing earthquake losses. An integral part of the research is associated with loss-reduction : removal of socio-economic barriers; and development of incentives for new knowledge and technology. This EERC will carry out an integrated research, education and outreach program that will be built on three major elements : (a) performance assessment of the built environment; (b) rehabilitation of critical facilities; and (c) response and recovery using new loss estimation methodologies and advanced technologies. The technological foci of the research are : high-performance computing; site remediation; structural control and monitoring; smart and high-performance materials; condition assessment; robotics systems; and decision-making systems. A comprehensive education plan for graduate and undergraduate students, K-12, professionals and the public sector is integrated with the research plan and is supported by two user networks focused upo n : (a) advanced computation; and (b) experimental facilities. An innovative outreach program will be implemented to promote and develop : public awareness; professional training and re-education; and partnerships for knowledge/technology transfer and utilization. The Center for ATEL is one of three EERC's networked with an overarching governing board to provide synergism in creating new knowledge and technology, educating the next generation of earthquake engineers and scientists, and providing outreach to industry, government, pre-college schools and potential user groups.

연구과제명 : (9701568) Pacific Earthquake Engineering Research Center
기관명 : U of Cal Berkeley
NSF 프로그램 및 연구분야 : EARTHQUAKE ENGINEER RESRCH CTR / Earthquake
연구기간 : 1997. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $6,074,480
연구요약 :

The PEER Center is a consortium of nine core institutions, closely linked and regularly interacting through electronic networks. The focus of PEER is to develop urban earthquake risk reduction technologies within a performance-based earthquake engineering framework. The research program contains five basic thrust areas : (1) policy, planning and economics; (2) seismic hazards; (3) performance assessment; (4) systems reliability; and (5) innovative technologies. PEER serves as a problem-focused, integrative center that bridges disciplinary gaps and barriers. In addition, project applications provide research focal points, a business and industrial partnership program should attract funding, and urban demonstration projects will test the applicability of research results. Education and partnership programs are used to educate students and attract qualified under-represented minorities to earthquake engineering, and include innovations such as the Engineering Undergraduate Scholars Course, the K-12 Public Education Program and a WWW page. The PEER Center is one of three EERCs networked with an overarching governing board to provide synergism in creating new knowledge and technology, educating the next generation of earthquake engineers and scientists, and providing outreach to industry, government, pre-college schools and potential user groups.

연구과제명 : (9701785) Mid-America Earthquake Center
기관명 : U of Ill Urbana-Champaign
NSF 프로그램 및 연구분야 : EARTHQUAKE ENGINEER RESRCH CTR / Earthquake
연구기간 : 1997. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $6,000,000
연구요약 :

The primary objective of the Mid-America Earthquake (MAE) Center is to reduce potential earthquake losses in the central and eastern United States by concentrating on problems associated with low-frequency seismic events and the consequences these have for the people, economy, and civil infrastructure. Research and implementation projects are in two focus areas : (a) identification and evaluation of possible seismic hazards; and (b) development of loss reduction strategies for the built environment. Research projects address seismic source modeling, ground motions (i.e., synthesis, instrumentation, catalogs), site characterization and response, ground failures, soil-structure interaction, assessment and strengthening of foundations and structures, risk and reliability, societal response, and economic impact. The initial focus is on essential facilities (i.e., buildings that support functions related to post-earthquake emergency response and disaster management) and transportation networks (i.e., highways, railroad systems, major waterways and shipping facilities, and airports). Research teams will use recent advances in networking technology to interact. The MAE Center's World Wide Web communications link the core institutions, as well as earthquake research centers around the world, and include public education features. Center goals include educating the next generation of seismologists and earthquake engineers, attracting under-represented minorities and women to these technical disciplines, and implementing research results in practice. The MAE Center will be one of three EERC's networked with an overarching governing board to provide synergism in creating new knowledge, educating the next generation of earthquake engineers and scientists, and providing outreach to industry, government, pre-college schools and potential user groups.

연구과제명 : (9727411) Southeastern University and College Coalition for Engineering Education (SUCCEED)
기관명 : University of Florida
NSF 프로그램 및 연구분야 : ENGINEERING EDUCATION / Other Applications NEC
연구기간 : 1997. 9. 15. - 2002. 8. 31.(추정)
전체연구비(추정) : $7,850,000
연구요약 :

연구과제명 : (9727413) Gateway Engineering Education Coalition
기관명 : Drexel University
NSF 프로그램 및 연구분야 : ENGINEERING EDUCATION / Other Applications NEC
연구기간 : 1997. 9. 15. - 2002. 8. 31.(추정)
전체연구비(추정) : $8,300,000

연구과제명 : (9731643) ERC : Research Center for the Engineering of Living Tissues
기관명 : GA Tech Res Corp - GIT
NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Health
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)
전체연구비(추정) : $12,500,000
연구요약 :
This award initiates the Engineering Research Center for the Engineering of Living Tissues. The lead institution is the Georgia Institute of Technology and the Emory University School of Medicine is a core partner institution. The award funds the first five years of effort under a new cooperative agreement, with a potential duration of ten years. This ERC will address an area of great importance to health and health care at an opportune time. The tissue engineering industry is at a nascent stage, and many of the developments in the field are based on empiricism or art. This center will bring a more fundamental understanding of the underlying biological and engineering principles to the area of tissue engineering, filling the gap that currently exists between academic understanding and industrial reduction to practice. Equally, if not more importantly, this Center will produce well trained engineers with a strong background in the biological and medical sciences who have worked closely with clinical practitioners and industry. This ERC focuses on the design and development of tissue substitutes that replace, enhance or maintain natural tissue function. The Center's research program is organized into three thrusts that represent a continuum of the challenges of tissue engineering : cell technology, cell

construct technology (prototype organ or tissues structures) and integration into living systems. Integrated with expertise in medical theory and practice, the ERC will carry out research on the underlying biology and immune response of tissue cells, the application of fundamental engineering design concepts to the growth and function of cell structures or constructs, and the incorporation of these constructs into living systems. This Center promises to produce breakthroughs in both the underlying understanding of tissue function and the technology required for tissue replacement. The two institutions will develop a joint program of bioengineering in support of th e ERC. ERC outreach will involve Spellman College and Morehouse College, local historically Black institutions, and a special program to involve local high school teachers and their students. Industry will be actively involved through a group of firms, representing both emerging start-up and well-established firms. This award is the outcome of the entry of this ERC's pre-proposal in the FY 1997-98 Engineering Research Centers Competition under the ERC Program Announcement, NSF 97-5.

연구과제명 : (9731677) ERC : Center for Power Electronics Systems
기관명 : VA Polytechnic Inst & St U
NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Energy Research & Resources, Transportation
연구기간 : 1998. 8. 15. - 2003. 7. 31.(추정)
전체연구비(추정) : $12,350,000
연구요약 :
This award initiates the Center for Power Electronic Systems, an Engineering Research Center (ERC). The lead university for the ERC is the Virginia Polytechnic Institute and State University and the following universities are core partners : the University of Wisconsin at Madison, the Rensselaer Polytechnic Institute, the North Carolina A&T State University, and the University of Puerto Rico at Mayaguez. The award funds the first five years of effort under a new cooperative agreement, with a potential duration of ten years. The vision of the proposed Center for Power Electronics System (C-PES) is to provide the nation with the technological capabilities to become a world leader in Power Electronics. The Center's vision for power vision for power electronics technology will make the US the most efficient user of electrical energy in the world through the widespread use of power electronics systems, improve industrial productivity and competitiveness, eliminate the roadblock to further advancements in computer and telecommunication technologies, and enable the hybrid electric vehicle technology. The C-PES strategy is to integrate research in a systems-level approach the form of Integrated Power Electronics Modules (IPEMs), and to focus upon the lower power range of power electronics (1kW-200kW), for example, packaged drivers foor air conditioning and refrigeration for domestic and industrial applications, hybrid electric vehicles, high performance adjustable speed drives for industrial automation, distributed power supply systems for ultra-low voltage and high speed very large scale integrated circuits (VLSI) and future generation of processors. The ERC will

create an affiliate program of industrial partners to initiate a demonstration program in each of the applications areas, joint with industrial partners, and concurrently transfer technology to industry. The ERC will create an education program including curriculum developments and collaboration, cross-linking distan ce-learning (satellite, video and the Internet), joint team teaching, co-operative Ph.D. programs, a wider range of options for students, an exchange program, a Virtual Corporation. This Engineering Research Center will significantly increase in the number of students graduating with expertise in power electronics. The collaboration with the North Carolina A&T State University and the University of Puerto Rico at Mayaguez will play a strong role in increasing the number of graduates from under-represented minorities in the field. This action is the outcome of the entry of this ERC's pre-proposal in the FY 1997-1998 Engineering Research Centers Competition under the ERC Program Announcement, NSF 97-5.

연구과제명 : (9731680) ERC : Center for Advanced Engineering Fibers and Films
기관명 : Clemson University
NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Materials Research
연구기간 : 1998. 8. 1 - 2003. 7. 31(추정)
전체연구비(추정) : $12,000,000
연구요약 :
This award established an Engineering Research Center (ERC) for Advanced Engineering Fibers and Films at Clemson University with Massachusetts Institute of Technology as a partner institution. The vision of the ERC is to provide an integrated environment for the system-oriented study of next generation fibers and films. The research program emphasizes the use of computation/visualization tools to overcome the barriers of experimental development, structure/property relationships, and control of structures. The research is organized under three thrust areas : Computer-based Product and Process Development, New Fiber and Film Products, and Advanced Fiber and Film Processes. The investigations will target liquid-crystalline systems, metallo-organic systems, and intractable polymer systems. The new processes will include supercritical solution processing, in-situ processing, and self-assembly processing. The ERC will produce software for new film and fiber formulation and processing design. The ERC's interdisciplinary, systems oriented education program will provide the students with a holistic education in fiber and film science and technology. The graduate education will include industrial residency for in-plant research experience. The first year industrial partnership will include seventeen companies. This award is the outcome of the Engineering Research Centers Competition under ERC Program Announcement, NSF 97-5. The funds for the first five years is recommended with a potential duration of ten years under a cooperative agreement.

연구과제명 : (9731725) Marine Bioproducts Engineering Center
기관명 : U of Hawaii Manoa

NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Materials Research
연구기간 : 1998. 11. 1. - 2003. 10. 31.(추정)
전체연구비(추정) : $12,400,000
연구요약 :
This award initiates the Engineering Research Center for Marine Bioproducts Engineering. The lead institution is the University of Hawaii at Manoa with the University of California, Berkeley as a core partner institution. The award funds the first five years of effort under a new cooperative agreement, with a potential duration of ten years. The vision of the ERC for Marine Bioproducts Engineering is to build the foundations of engineering research and education for a 21st century marine biotechnology business devoted to high-value products destined for the chemical, pharmaceutical, nutraceutical, cosmetic, food, feed, and life sciences industries. The ERC brings together two disparate topics, marine sciences and process engineering, in order to address apreviously under-utilized bioproducts resource, the world's'oceans. The Center builds on well-established expertise in marine sciences at the University of Hawaii and in bioprocessing at the University of California, Berkeley, the open ocean collection resources at the University of Hawaii, and the Center's partnership with the nascent marine biotechnology industry. The world's oceans represent a great, and largely untapped, resource of marine organisms containing products or the raw materials for products that are of use in many different industries. The Center's research spans from exploration of the oceans for new product leads, through the development of production processes, such as bioreactors and separation technologies, to the formulation and stability of newly discovered marine bioproducts through combinatorial chemistry and other techniques. The research program involves chemists, oceanographers, biologists, bioengineers and chemical engineers. By introducing marine concepts into undergraduate and graduate courses taught at both institutions, the Center will produce marine biotechnology engineers who have theoretical and practical engineering expertise and a working knowledge of marine and life scie nces disciplines and practices. The Center will also provide training for professional marine bioengineers, will outreach to K-12 school children and the general public through the Bishop Museum in Honolulu, and will partner with community colleges. The Center will collaborate with industrial partners from Hawaii, the U.S. Mainland and the Pacific Rim. It also will have support from banks and venture capital firms that fund the nascent marine biotechnology industry in Hawaii. This award is the outcome of the entry of the ERC's preproposal in the FY 1997-98 Engineering Research Centers Competition under the ERC Program Announcement, NSF 97-5.

연구과제명 : (9731748) ERC : Engineering Research Center for Computer-Integrated Surgical Systems and Technology
기관명 : Johns Hopkins University
NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Information Systems
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)

전체연구비(추정) : $12,889,603
연구요약 :
This award initiates the Engineering Research Center for Computer-Integrated Surgical Systems and Technology (CISST). The lead institution is Johns Hopkins University in partnership with Carnegie Mellon University and Shadyside Hospital, and Massachusetts Institute of Technology and Brigham & Women's Hospital. The award funds the first five years of effort under a new cooperative agreement, with a potential duration of ten years. The vision of the ERC is to advance knowledge and technology needed to develop a new generation of minimally invasive surgery techniques for the 21st century, which will dramatically impact health care in the U.S., reaping substantial economic and social impacts. Critical to the vision are two core concepts : 1) Computer-assisted surgical planning/computer assisted surgical execution systems will integrate accurate patient-specific models, surgical plan optimization permitting the plans to be carried out accurately, safely, and with minimal invasiveness; 2) Surgical Assistant Systems will work cooperatively with surgeons in carrying out precise and minimally invasive surgical procedures. The center's research program is multidisciplinary and designed to produce fundamental advances in core technologies of modeling and analysis and interfacial technologies for surgical systems. These will be integrated into a robust, modular family of systems and subsystems promoting rapid prototyping of multi-surgical testbed applications, as well as facilitating transfer to end use within commercialized systems. A multidisciplinary educational program will facilitate the training of engineers, scientists, and clinicians to advance all phases of this work from basic research to deployed systems. Practitioners and industry will be actively involved in the center. NSF funds will be used for the fundamental research needed to explore and advance these concepts, clinical work will be supported through other sources. This award is the outcome of the entry of this ERC's preproposal in the FY 1997-98 Engineering Research Centers Competition under the ERC Program Announcement, NSF 97-5.

연구과제명 : (9802942) Foundation Engineering Education Coalition
기관명 : Texas Engineering Exp Sta
NSF 프로그램 및 연구분야 : ENGINEERING EDUCATION / Other Applications NEC
연구기간 : 1998. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $14,960,462
연구요약 :
This Coalition of 7 universities : University of Alabama; Arizona State University; rose-Hulman Institute of Technology; Texas A&M University; College Station; Texas A&M University, Kingsville; University of Massachusetts, Dartmouth; and University of Wisconsin-Madison, together with 7 affiliated institutions : Maricopa Community College District; Texas Woman's University; University of Pittsburgh; University of Texas at El Paso; South Dakota Schools of Mines and Technology; Instituto Technologico y de Estudios Superiores de Monterrey (Mexico); and Universidade Federal de Sant Catarina (Brazil) have been awarded a 5 year renewal of their

award to complete their activities to change the practice and culture of undergraduate engineering education. While the affiliates participate in the work of the Coalition, they are not supported in this by any Federal funds. The Foundation Engineering Education Coalition's vision is to be a recognized leader in creating a new engineering education culture that is responsive to technological changes and societal needs. To build on their work to date, the Coalition will develop further its engineering education innovations and work to have these institutionalized on the campuses of their members and affiliates. They will also participate in a multi-coalition effort to disseminate the product and practices of this and the other engineering education coalitions, to the engineering education community at large. Details of the work of this and other Engineering Education Coalitions are available on the World Wide Web at http://www.needs.org/coalitions/. Information on the Foundation Coalition can also be found at http://foundation.ua.edu/.

연구과제명 : (9843342) Biotechnology Process Engineering Research Center
기관명 : MIT
NSF 프로그램 및 연구분야 : ENGINEERING RESEARCH CENTERS / Industrial Technology
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)
전체연구비(추정) : $4,800,000
연구요약 :
This award renews funding for the Engineering Research Center (ERC) for Biotechnology Process Engineering at the Massachusetts Institute of Technology. The award funds the second five years of effort under a new cooperative agreement, with a total duration of eleven years. The vision of the Biotechnology Process Engineering Center (BPEC) is to promote and enhance U.S. biotechnology research. Over the past year, BPEC has shifted its primary research direction from therapeutic protein biotechnology, an area in which BPEC has made significant advances and for which it has built up a strong industrial partnership, to therapeutic gene biotechnology, a nascent area of research. This new area will focus on the delivery of genes, as opposed to gene discovery or production, which many believe is the crucial bottleneck in gene therapy. Currently, the expression of therapeutic genes delivered to cells within a living system is either too short in duration, not repeatable, not selective or not properly regulated. By combining engineering with molecular cell biology and by building on its track record of developing strong teams, producing excellent cross-disciplinary students, and creating long-lasting industrial partnerships, BPEC is well positioned to make major progress in addressing these challenges in the gene biotechnology field. The goal of the therapeutic protein work is to provide the underlying science and engineering knowledge and technology required to produce and deliver therapeutic proteins of high quality in quantities large enough and within formulations stable enough to be economically viable. The new gene biotechnology research area will focus on two complimentary methods of delivery of genes to cells. The first approach is the use of retroviruses to transfect genes into stem cells ex vivo, followed by re-implantation of these cells into a patient. The second approach is the use of synthetic molecular conjugates to transfect

genes into already differentiated c ells in vivo. A new Division of Bioengineering and Environmental Health is currently being created at MIT, in part because of the influence of BPEC, which greatly facilitated the break down of the traditional cultural barriers between biology and engineering. This Division will be a source of both undergraduate and graduate students for BPEC, and will offer a Biomedical Engineering Minor, a 5-year BS/MS Bioengineering Degree, a Ph.D. in Bioengineering, and a Ph.D. in Toxicology. BPEC has a strong industrial partnership in the area of protein therapeutics. This group is very enthusiastic about both the research and the students produced over the past thirteen years. Within the last 12 months, BPEC has also put together a second industrial group that focuses on gene biotechnology. This group as very active in helping BPEC develop its gene biotechnology research strategy over the past year, and is very interested in continuing to partner with BPEC in this area.

(4) 지구과학 (31개 과제)

① Atmospheric Sciences (10개 과제)

연구과제명 : (9714593) Millstone Hill Observatory Investigations of Earth's Upper Atmosphere
기관명 : MIT
NSF 프로그램 및 연구분야 : UPPER ATMOSPHERIC FACILITIES / Space
연구기간 : 1997. 11. 1. - 2002. 10. 31.(추정)
전체연구비(추정) : $7,450,000
연구요약 :
The Millstone Hill Observatory, an incoherent scatter radar facility, continues its radar and optical research activities of the earth's upper atmosphere. Extensive ionospheric observations capabilities encompass mid-latitude, sub-auroral, and auroral features and processes. The Observatory's radar operations support programs like World Day, CEDAR and GEM in community-directed research. In addition, it supports optical experiments and Fabry-Perot interferometer and photometer observations, in conjunction with radar experiments addressing neutral atmospheric dynamics and temperatures. Resulting radar and optical data is deposited in the CEDAR database at the National Center for Atmospheric Research, where it can be accessed by students and external investigators.

연구과제명 : (9813556) Sondrestrom Facility into the Next Millennium
기관명 : SRI International
NSF 프로그램 및 연구분야 : UPPER ATMOSPHERIC FACILITIES / Space
연구기간 : 1999. 3. 1 - 2007. 9. 30(추정)
전체연구비(추정) : $10,706,479
연구요약 :

The investigators will continue operations and scientific studies associated with the Sondrestrom Radar Facility located near Kangerlussuaq, Greenland. The tasks include the management, operation, and maintenance of the facility, including all technical aspects of the incoherent scatter radar, the Rayleigh lidar, the new resonance lidar, and the all-sky imager. The five-year effort emphasizes the evolutionary development of the facility with continuing implementation of modern pulse-coding techniques, data acquisition and processing schemes, as well as further advancements in lidar performance and upgrades to the existing telescience capability. Continued involvement of scientists is included to provide an environment that promotes education, establishes new ideas for facility development, and maintains expertise in related sciences conducted at the facility. Specific tasks include (1) operating the radar for 1200 hours per year and the lidars for 300 hours per year, (2) assisting facility users in carrying out experiments at the site, (3) maintaining and upgrading the instrumentation, (4) maintaining high quality, easily accessible data products, (5) developing and improving data analysis software, (6) collaborating with other scientists, and (7) maintaining good relations with the Greenland Home Rule Government and the Danish Commission for Scientific Research in Greenland. Scientific research to be conducted include studies of F-region plasma structure, polar cap arcs and patches, D- and E-region electron temperature enhancements, high latitude electrodynamics, electromagnetic energy coupling to the magnetosphere, auroral arc dynamics, geomagnetic storms, ion and neutral layers in the middle atmosphere, arctic noctilucent clouds, and atmospheric gravity waves.

연구과제명 : (9814295) Predictability and Variability of the Present Climate
기관명 : Inst of Global Environ Soc
NSF 프로그램 및 연구분야 : CLIMATE DYNAMICS PROGRAM / Climate Related Activities
연구기간 : 1999. 3. 1. - 2004. 2. 29. (추정)
전체연구비(추정) : $4,700,000
연구요약 :
The main objective of this grant research is to establish a scientific basis for, and to advance our understanding of the variability and predictability of the present climate using comprehensive and realistic models of the climate system. The primary emphasis is to simulate, understand and demonstrate the predictability of seasonal-to-interannual climate variations using coupled models of the atmosphere, ocean and land system. Understanding and predicting seasonal-to-interannual variability requires modeling and understanding variability on interdecadal time scales; therefore, the PIs will investigate some aspects of the decadal variability and predictability of climate.

연구과제명 : (9820037) Support of the National Center for Atmospheric Research
기관명 : UCAR
NSF 프로그램 및 연구분야 : NAT CENTER FOR ATMOSPHERIC RES / Other Applications NEC
연구기간 : 1998. 10. 1. - 2004. 9. 30.(추정)

전체연구비(추정) : $80,646,545
연구요약 :
The University Corporation for Atmospheric Research (UCAR) operates the National Center for Atmospheric Research (NCAR). NCAR, with UCAR's leadership, will contribute to strengthening the atmospheric sciences. NCAR and UCAR will also continue to contribute strongly to the overarching goals in NSF's strategic plan. NCAR's priorities over the next five years fall into six main areas : (1) Fundamental Research. In keeping with the mission of NSF, the foundation of NCAR's program is fundamental research, particularly research of sufficient complexity to command the resources of a national center. This program includes solar physics, fluid dynamics and turbulence, cloud and precipitation physics, atmospheric chemistry mesoscale meteorology, and climate. (2) Understanding and Predicting the Earth System. Building on the broad base of fundamental research, NCAR and its many university collaborators will carry out major crosscutting efforts toward understanding and predicting the earth system. This includes research on prediction of weather on short temporal and small spatial scales, longer-term prediction of monthly and seasonal means, and studies of the influence of human, solar, and other forcing processes on weather and climate. (3) Advanced Scientific Facilities. NCAR will continue to put a high priority on developing new and cutting-edge scientific facilities that can be efficiently and cost-effectively supplied by a national center. This effort will include computing systems, instruments and observing systems, community models, datasets, advanced networking and communications tools, and provision of these facilities to the community. (4) Human Dimensions and Societal Impacts. NCAR will place increasing emphasis on studying the impacts of climate and weather on society; on human influences on the climate system; on society's ability to cope with weather- and climate-related impacts; and on the use and value of meteorological, climate, and other atmospheric-related information in a variety of contexts. (5) Education and Training. NCAR will continue and strengthen its efforts in education. The Advanced Study Program will support a strong postdoctoral fellowship program and graduate research assistantships to encourage the development of creativity, independence, and breadth in young scientists. Other educational activities will increase diversity in the atmospheric sciences. (6) Applications and Technology / Information Transfer. NCAR will transfer information, technology, and research results to the public and private sectors and to university colleagues and constituents in three major ways. Through direct transfer, public domain access to make information freely available to the broadest audience, and licensing.

연구과제명 : (9901154) Joint Office for Science Support
기관명 : UCAR
NSF 프로그램 및 연구분야 : NAT CENTER FOR ATMOSPHERIC RES / Other Applications NEC
연구기간 : 1999. 3. 1. - 2004. 9. 30.(추정)
전체연구비(추정) : $3,732,593
연구요약 :

연구과제명 : (9901155) UCAR Educational Outreach Program and Other UCAR Activities
기관명 : UCAR
NSF 프로그램 및 연구분야 : NAT CENTER FOR ATMOSPHERIC RES / Other Applications NEC
연구기간 : 1998. 11. 15. - 2000. 10. 31.(추정)
전체연구비(추정) : $10,782,019

연구과제명 : (9905580) Mesa Lab Refurbishment Project
기관명 : UCAR
NSF 프로그램 및 연구분야 : NAT CENTER FOR ATMOSPHERIC RES / Other Applications NEC
연구기간 : 1999. 4. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $4,000,000
연구요약 :
The purpose of this award is to support the Mesa Lab Refurbishment Project. Funds will be used to upgrade, renovate, and bring into code compliance, the NCAR Mesa Laboratory in Boulder, Colorado. These upgrades are well overdue and is greatly needed to maintain its rare architectural structure.

연구과제명 : (9906463) Wyoming King Air as a National Facility
기관명 : University of Wyoming
NSF 프로그램 및 연구분야 : LOWER ATMOSPHER OBSER FACILITI / Other Applications NEC
연구기간 : 1999. 1. 1. - 2003. 12. 31.(추정)
전체연구비(추정) : $3,579,455
연구요약 :
This cooperative agreement continues to operate the Wyoming King air as a national facility. The King Air aircraft facility is a unique facility that provides a platform for observational science and education for the NSF supported scientific community and the geosciences community in general. The aircraft would be maintained in a flight ready condition to support NSF approved atmospheric research projects that require the capability of the twin-engine turboprop. The agreement provides base funding for the management, staffing, operation, maintenance, testing and some enhancements of the King Air aircraft and instrumentation. It covers both the scientific and technical support for planning and data reduction phases of field projects. The agreement will also include the deployment of the facility under supplemental awards from the NSF's lower atmospheric research facilities deployment pool funding. The aircraft has been operated as an NSF national facility since December 1987. The facility has flown on average about five to six field programs per year. During its lifetime (since 1977) the aircraft has flown over 3000 research flight hours, of which about 1800 have been devoted to NSF sponsored scientists. There is no current suitable replacement aircraft that could perform the same type of data collection for NSF-sponsored research.

연구과제명 : (9907233) Collaborative Research Network - A Network for Global Change Research in the Americas
기관명 : Global Change Research
NSF 프로그램 및 연구분야 : REGIONAL INST-GLOBAL CHNGE,ATM / Other Applications NEC
연구기간 : 1999. 6. 15. - 2004. 5. 31.(추정)
전체연구비(추정) : $10,000,000
연구요약 :
The Inter-American Institute for Global Change Research (IAI) was created by the Agreement Establishing the Inter American Institute for Global Change Research, done at Montevideo on May 13, 1992. The IAI was created to coordinate and promote scientific research related to global change in the Americas. The Institute has an evolving Scientific Agenda identifying particular areas for research. The US has played a leading role in the creation of the IAI and has been an active participant in the IAI since its creation. The IAI proposes to carry out a plan of research according to a Science Agenda that has been defined by the scientific community of the Americas in a series of meetings held over the last five years, and has been agreed upon by the member States. The Scientific Agenda is complementary to the research priorities of the US Global Change Research Program. The IAI will supervise fourteen research teams that in total sum ninety-eight separate research institutions that will carry out Collaborative research on Scientific Agenda items. The fourteen teams are led by the following institutions, and will carry out the following projects : 1. Centro de Investigaciones Cientificas y de Educacion Superior de Ensenada (Mexico) : An Eastern Pacific Consortium for Research on Global Change in Coastal and Oceanic Regions 2. Escuela Politecnica del Litoral (Ecuador) : Multi Objective Study of Climate Variability for Impact Mitigation in the Trade Convergence Climate Complex Region 3. Florida International University (USA) : Andean Amazon Rivers Analysis and Management (AARAM) Project 4. Fundacao Oswaldo Cruz (Brazil) : Diagnostics and Prediction of Climate Variability and Human Health Impacts in the Tropical Americas 5. Scripps Institute of Oceanography/University of California at San Diego (USA) : Enhanced Ultraviolet-B Radiation in Natural Ecosystems as an Added Perturbation Due to Ozone Development 6. The Network for Social Studies on Disaster Prevention in Latin America (Peru) : ENSO Disaster Risk Management in Latin America : A Proposal for the Consolidation of a Regional Network for Comparative Research, Information and Training from a Social Perspective 7. Universidad Autonoma de Mexico (Mexico) : Climate Variability and its Impacts in the Mexican, Central American and Caribbean Regions 8. Universidad de Buenos Aires (Argentina) : Development of a Collaborative Research Network for the Study of Regional Climate Variability and Changes, their Prediction and Impact in the MERCOSUR Area 9. Universidad de Buenos Aires (Argentin a) : The Effects of Biodiversity on Ecosystem Functioning : A Comparison Across the Americas 10. Universidad de los Andes (Venezuela) : Comparative Studies of Global Change Effects on the Vegetation of Two Tropical Ecosystems : the High Mountain and the Seasonal Savanna 11. Universidade do Sao Paulo (Brazil) : An International Consortium for the Study of Global and Climate Changes in the Western South Atlantic 12. University of Florida (USA) : Cattle, Land

Use and Deforestation in the Amazon : A Comparative Study 13. University of Saskatchewan (Canada) : Biogeochemical Cycles Under Land Use Change in the Semiarid Americas 14. University of Western Ontario (Canada) : The Assessment of Present, Past and Future Climate Variability in the Americas from Treeline Environments The teams were selected on the basis of submitted proposals evaluated for technical merit using a peer-review system. Twelve of these teams have US scientists involved as co-Investigators, and all have US scientists indirectly involved as affiliated researchers. Results from this research will be available to the US scientific community, as a condition of US funding, through an electronic data and information system connected to the Internet. The IAI receives additional support for its activities from the other Parties to the Agreement Establishing the IAI : Argentina, Bolivia, Brazil, Canada, Colombia, Costa Rica, Chile, Cuba, the Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru, Uruguay, and Venezuela. This additional support takes the form of direct contributions to the IAI Budget, in-kind contributions, or in-kind contribution pledges made at the time of proposal submission in the form of investigator salaries, ship-time, computer time, logistical support, etc.

연구과제명 : (9908505) United States Global Change Research Program
기관명 : UCAR
NSF 프로그램 및 연구분야 : NAT CENTER FOR ATMOSPHERIC RES / Other Applications NEC
연구기간 : 1999. 5. 1. - 2004. 9. 30.(추정)
전체연구비(추정) : $3,249,820
연구요약 :
This proposal will support the United States Global Change Research Program Coordination Office in serving, coordinating, and representing the USGCRP as an integrated, coordinated program. The objective of this office is to be the coordinator of the interagency process. This involves a diverse array of activities to carry out the mission given to the Subcommittee on Global Change Research (SGCR), and which are not strictly within the purview of any of the individual participating agencies.

② Earth Science (3개 과제)

연구과제명 : (9615720) International Continental Scientific Drilling Program (ICDP)
기관명 : GeoForschungsZentrum Potsd
NSF 프로그램 및 연구분야 : CONTINENTAL DYNAMICS PROGRAM / Other Applications NEC
연구기간 : 1996. 9. 1. - 2001. 8. 31.(추정)
전체연구비(추정) : $3,500,000
연구요약 :
This award transfers funds to the GeoforschungsZentrum (GFZ) in Germany for NSF's membership fee in the International Continental Scientific Drilling Program (ICDP). On February

26, 1996, the NSF and the GFZ (a Governmentally funded, public law Foundation of the Federal Republic of Germany) signed a Memorandum of Understanding on Implementation, Management and Operation of the ICDP. This MOU is an Annex to the Agreement between the NSF and the Federal Ministry for Education, Science, Research and Technology of the Federal Republic of Germany (BMBF) on "Cooperation in Research in the Geosciences." The MOU stipulates that each member of ICDP will pay an annual membership fee to the Executive Agency (the GFZ) which will be commingled to provide the base funding for the ICDP. These funds will be used for support of overall scientific planning, management, and operation of the ICDP.

연구과제명 : (9903413) Support of UNAVCO and Related Activities
기관명 : UCAR
NSF 프로그램 및 연구분야 : FACILITY SUPPORT / Other Applications NEC
연구기간 : 1999. 1. 15. - 2004. 9. 30.(추정)
전체연구비(추정) : $3,656,100
연구요약 :

연구과제명 : (9906456) GeoSoilEnviroCARS : A National Resource for Earth, Planetary, Soil and Environmental Science Research at the Advanced Photon Source
기관명 : University of Chicago
NSF 프로그램 및 연구분야 : INSTRUMENTATION & FACILITIES / Other Applications NEC
연구기간 : 1999. 10. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $4,202,000
연구요약 :
This award provides partial funding support for the operation and maintenance of the GeoSoilEnviroCARS (GSECARS; CARS = Consortium for Advanced Radiation Sources). GSECARS is located at the Advanced Photon Source (APS) in Argonne National Laboratory. The APS is a synchrotron electron/positron storage ring used to generate brilliant X-radiation for materials research. GSECARS operates two X-ray beamlines used primarily for applications in the earth sciences. The research conducted at GSECARS makes use of the capabilities of brilliant, highly collimated, X-ray beams to advance knowledge of the composition, structure, and properties of earth materials. Specific techniques employed by GSECARS users include : (1) high-pressure/temperature crystallography of samples in a diamond anvil cell or in a multi-anvil large volume press; (2) powder, single crystal, and interface diffraction techniques; (3) X-ray absorption fine structure analysis (XAFS); (4) X-ray fluorescence microprobe analysis, and; (5) X-ray computer assisted microtomography.

③ Ocean Sciences (18개 과제)

연구과제명 : (9622441) Ship Operations
기관명 : Woods Hole Ocean Inst
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1996. 1. 1. - 1998. 12. 31.(추정)
전체연구비(추정) : $9,076,906
연구요약 :
In 1996 Woods Hole Oceanographic Institution will operate the research vessels ATLANTIS II, KNORR and OCEANUS in support of NSF-sponsored research. The KNORR will finish the WOCE Indian Ocean work in early 1996. Two multibeam cruises will utilize the new multibeam capability of the ship. The Knorr will support a chemistry cruise off the coast of Brazil before heading to the "Rainbow Site" off Barbados. The Navy will use the vessel in the Baltic and then it will return to WHOI for an extended maintenance period. OCEANUS will support a variety of cruises in the northeast Atlantic and one cruise off Bermuda. The vessel will support 211 operational days of which 75 are in support of NSF-sponsored programs. The remaining 136 days are in support of Navy and DOE programs. ATLANTIS II provides support for the Deep Submergence Vehicle ALVIN, all 1996 AII cruises are in support of the unmanned submersible. The schedule begins with two cruises off the coast of California with a 2 month stand-down period between the cruises. The vessel will support a series of cruises off the East Pacific Rise before transiting to the Atlantic to support cruises off the east coast of the US and one cruise off Bermuda. The vessels operated by WHOI are part of a fleet of ships used by the National Science Foundation in support of marine science. Oceanography requires highly specialized equipment that is required to be permanently installed on the vessel, thus specialized ships. These vessels do not operate in the same general mode as cargo/fishing vessels. As a result, NSF supports the operation of a variety of vessels specifically dedicated to oceanographic research that are operated by universities and institutions around the country.

연구과제명 : (9622783) Ship Operations Support
기관명 : Harbor Branch Ocean Inst
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1996. 1. 1. - 1998. 12. 31(추정)
전체연구비(추정) : $4,349,000
연구요약 :
University of Alaska will operate the R/V ALPHA HELIX during 1996 as a general oceanographic research vessel in support of NSF-funded projects. The R/V ALPHA HELIX is a 133′ general research vessel owned by the National Science foundation and constructed in 1966. The ship is scheduled for 174 operating days in 1996, of which 123 days are in support of NSF-sponsored projects. The cruises will be primarily in the north Pacific Ocean but include

significant research cruise legs to the Aleutian, Bering, and Chukchi Sea regions during minimum ice conditions in late summer. This vessel is part of a fleet used by NSF and other research agencies to support oceanographic research. Most oceanographic research requires specialized equipment that must be permanently installed on the research vessel. Trained crew members are also required to support the equipment systems and research operations. This is the first year of a planned three year award.

연구과제명 : (9623204) Ship Operations
기관명 : Columbia University
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1996. 1. 1. - 1998. 12. 31(추정)
전체연구비(추정) : $4,671,000
연구요약 :
In 1996, Columbia University, Lamont-Doherty Earth Observatory will operate the research vessel MAURICE EWING in support of NSF-sponsored research. The EWING is a 230′ general purpose research vessel with specialized capability in marine geology and geophysics. The vessel is owned by the National Science Foundation and operated by Lamont-Doherty through a 5-year charter agreement. The EWING is capable of operating world wide and will support cruises in the south Pacific Ocean and the north Atlantic Ocean in 1996. The ship is scheduled for 319 operational days in 1996, of which 315 are in support of NSF-sponsored marine geology and geophysics programs. This vessel is part of a fleet used by the National Science Foundation in support of oceanographic research. Most oceanographic projects require highly specialized equipment and extensive support from the ship's crew members. Increasingly research projects require equipment which must be permanently installed on the vessel, thus requiring specialized vessels. These vessels do not operate the same as general cargo/fishing vessels, therefore NSF supports the operation of a variety of vessels specifically dedicated to oceanographic research that are operated by universities and research institutes around the country.

연구과제명 : (9627160) Deep Submergence Operations - ALVIN
기관명 : Woods Hole Ocean Inst
NSF 프로그램 및 연구분야 : SUBMERSIBLE SUPPORT / Oceanography
연구기간 : 1996. 1. 1. - 2000. 12. 31.(추정)
전체연구비(추정) : $9,190,349
연구요약 :
In 1996 Woods Hole Oceanographic Institution will operate the Deep Submergence Vessel ALVIN. The submersible is certified for a depth of 4,500M and is designated a national asset. The ALVIN is supported by the research vessel ATLANTIS II (AII). Both vehicles have been operated effectively and safely by the institute for a wide variety of NSF-sponsored research projects. Through a Memorandum of Agreement between ONR, NOAA and NSF the submersible

is operated in support of projects funded by these agencies. The 1996 schedule for ALVIN is lighter than the vessel is capable of performing with a projected operational schedule of 161 days. Of these days 123 are proposed to support NSF-sponsored programs. NSF-supported cruises will take place in both the Atlantic and Pacific in support of biological and marine geological and geophysical research. The ALVIN schedule is light due to the ABS and Navy requirements for a major overhaul and recertification being scheduled in 1996 for the DSV. This overhaul normally requires approximately 6 to 8 months to complete. Since it will be a light year for the submersible the use of remotely operated vehicles (ROV's) will be used to provide deep submergence access to the community. Three cruises are scheduled for the WHOI DS/ROV's. Two of these cruises will be in the Pacific and one in the Atlantic.

연구과제명 : (9701522) Ship Operations
기관명 : U of Hawaii Manoa
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30(추정)
전체연구비(추정) : $5,449,745
연구요약 :
The University of Hawaii will operate the R/V MOANA WAVE in 1997 as a general oceanographic vessel in support of NSF-funded research projects. The MOANA WAVE is a 210' research vessel owned by the U.S. Navy and operated as a UNOLS vessel in support of academic research. The ship is scheduled for 190 days of which 170 are in support of NSF-sponsored programs. All of the cruises are in the Pacific with three NSF cruises in the vicinity of Guam. The remaining NSF cruises are of short duration out of Hawaii in support the Hawaii Time Series project. In addition the vessel will support three short cruises for NOAA. The MOANA WAVE is part of the academic fleet used by NSF to support oceanographic research. Most oceanographic research requires highly specialized equipment that must be permanently installed on a ship for which the ship must be specifically designed. This equipment also requires highly trained crew members for maintenance and operation. These vessels do not operate in the same manner as general cargo or fishing vessels, therefore, NSF supports the operation of a variety of vessels specifically dedicated to oceanographic research that are operated by universities and research institutions around the country.

연구과제명 : (9703848) Ship Operations Support
기관명 : U of Alaska Fairbanks
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $3,795,079
연구요약 :
University of Alaska will operate the R/V ALPHA HELIX during 1997 as a general

oceanographic research vessel in support of NSF-funded projects. The R/V ALPHA HELIX is a 133′ general research vessel owned by the National Science Foundation and constructed in 1966. The ship is schedules for 112 operating days in 1997, of which 65 days are in support of NSF-sponsored projects. The cruises include significant research cruise legs to the Aleutian, Bering, and Chukchi Sea regions during minimum ice conditions in late summer. This vessel is part of a fleet used by NSF and other research agencies to support oceanographic research. Most oceanographic research requires specialized equipment that must be permanently installed on the research vessel. Trained crew members are also required to support the equipment systems and research operations. This is the first year of a planned two year cooperative award.

연구과제명 : (9707084) Ship Operations - 1997
기관명 : Woods Hole Ocean Inst
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $20,585,866
연구요약 :
In 1997 Scripps Institute of Oceanography will operate research vessels MELVILLE, NEW HORIZON and ROBERT GORDON SPROUL and the new age AGOR 24, RODGER REVELLE, in support of NSF-sponsored oceanographic research. The R/V MELVILLE will support a cruise in the Indian Ocean for WOCE and 2 cruises South of Australia in support of Marine Geology and Geophysical. The vessel will than work its way back to San Diego doing an MGG cruise. Following a cruise to the Gulf of Alaska for NAVO, the MELVILLE ends the year with 2 cruises off the coast of California and Mexico. The R/V REVELLE schedule has gone through many iterations. In the current schedule the vessel will start 1997 by supporting two cruise off NOAA cruise. The vessel will undergo final contract trials for the pending. The REVELLE will end 1997 in support of JGOFS in the southern oceans. The R/V NEW HORIZON will support a variety of biological and physical oceanography projects off the west coast of the US and Mexico. R/V ROBERT GORDON SPROUL will do short cruises off the coast of California and one cruise in the Columbia River estuary. The SIO vessels are part of a fleet utilized by the National Science Foundation in support of oceanographic research. Most oceanographic projects require highly specialized equipment and extensive support from the ship′s crew members. Increasingly research projects require equipment which must be permanently installed on the vessel, thus requiring specialized ships. The ships do not operate the same as general cargo/fishing vessels, therefore, NSF supports the operation of a variety of vessels specifically dedicated to oceanographic research that are operated by universities and research institutes around the country.

연구과제명 : (9707131) Ship Operations
기관명 : U of Washington
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography

연구기간 : 1997. 1. 1. 2000. 6. 30.(추정)
전체연구비(추정) : $5,895,234
연구요약 :
The R/V THOMPSON has a schedule of 265 operational days in 1997 of which 94 are in support of NSF-sponsored programs. In 1997 the vessel will act as the support ship for a variety of scientific programs requiring the use of the deep submergence remotely operated vehicles. Of the 15 THOMPSON cruises 10 will require the use of the ROV JASON, incuding cruises for the UK, Washington State, NOAA and NSF (6 cruises). The remaining 5 cruises are in support of programs for State of Washington, Navy and NSF (2). The THOMPSON will undergo a Navy INSURV inspection in the last quarter of the year. The R/V BARNES is scheduled for a total of 134 days in 1997 of which 106 operational days are in support of NSF-sponsored programs. The NSF days include 57 days off the Columbia River (Oregon) in support of the LMER program. The remainder of the work is in Puget Sound. The THOMPSON and BARNES are part of a fleet of ships used by the National Science Foundation in support of marine science research. Most oceanographic projects require highly specialized equipment permanently installed on the vessel, thus the necessity for specialized ships. These vessels do not operate in the same mode as general cargo/fishing vessels, as a result NSF supports the operation of a variety of vessels specifically dedicated to oceanographic research that are operated by universities and institutions around the country.

연구과제명 : (9707132) Ship Operations
기관명 : U of Cal SD Scripps Inst
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1 - 2000. 6. 30(추정)
전체연구비(추정) : $18,561,483
연구요약 :
This award provides funding to purchase shipboard instrumentation in support of NSF-funded research. The instruments will be used aboard the R/Vs MELVILLE, a 279 foot vessel, NEW HORIZON, a 170 foot vessel, and the SPROUL, a 125 foot vessel. The MELVILLE is owned by the Navy, while the NEW HORIZON and the SPROUL are owned by the University. All the ships are operated by the Institute in support of oceanographic research funded by a variety of Federal, state and private organizations, although NSF is the primary user of all the ships. Instrumentation requested includes both shared-use equipment for specific ships and shared-use instrumentation that will be maintained by the central Ocean Data Facility(ODF) and used aboard a variety of SIO and non-SIO ships. The instrumentation requested is required for support of NSF-funded cruises aboard the MELVILLE, NEW HORIZON and SPROUL during 1996 and will enhance the scientific capability of these vessels in the future.

연구과제명 : (9707198) Ship Operations

기관명 : U of Rhode Island
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $3,601,941
연구요약 :

The University of Rhode Island will operate the research vessels ENDEAVOR in 1997 in support of a variety or oceanographic research programs for the federal agencies. The ENDEAVOR is a 184′ general purpose research vessel with a schedule of 188 operational days in 1997 of which 119 days are in support of NSF-sponsored research. The ship will support cruises in the North Atlantic for NSF and ONR.

연구과제명 : (9707199) Ship Operations for the RV Weatherbird II
기관명 : Bermuda Biol Sta Research
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $3,153,010
연구요약 :

The PI proposes to purchase shipboard instrumentation in support of NSF-funded research. The instruments will be used abroad the R/V Weatherbird II, a general purpose research ship owned and operated by the Bermuda Biological Station for Research (BBSR), Inc., a Bermuda based United States non-profit research and education institution. The proposal concentrates on increasing the reliability and extent of data collection capabilities aboard the Weatherbird II. Instrumentation includes a relative humidity sensor and precipitation gauge for the ships IMET system; backup dissolved oxygen sensor and pump for the CTD package, along with an altimeter for the rosette; backup thermosalinograph, remote temperature sensor and diaphragm pump for the underway system; and a dynamic color correction capability for the liquid scintillation counter.

연구과제명 : (9707200) Ship Operations
기관명 : Columbia University
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography
연구기간 : 1997. 1. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $10,369,759

연구과제명 : (9707819) Ship Operations Support
기관명 : Harbor Branch Ocean Inst
NSF 프로그램 및 연구분야 : SHIP OPERATIONS / Oceanography

연구기간 : 1997. 1. 1 - 2000. 6. 30(추정)
전체연구비(추정) : $6,239,979
연구요약 :
The Harbor Branch Oceanographic Institution will operate the research vessels SEWARD JOHNSON, EDWIN LINK and SEA DIVER in 1997. In addition they operate the submersible JOHNSON SEA-LINK and a Remotely Operated Vehicle (ROV). These systems are operated as effective research platforms for a variety of NSF-sponsored research projects. The SEWARD JOHNSON is a 204′ general purpose research vessel with a schedule of 255 operational days in 1997 of which 179 days are in support of NSF-funded research. The ship will support cruises off Brazil, Barbados, s.Africa and Puerto Rico. The EDWIN LINK is a 168′ general research vessel with a schedule of 218 operational days in 1997 of which 46 days are in support of NSF-funded research. The ship will support cruises for NSF off the Bahamas and the Atlantic coast of the US. The SEA DIVER is a 113′ general research vessel with a schedule of 33 operational days in 1997. None are in support of NSF-funded research.

연구과제명 : (9726921) LTER : Plum Island Sound Comparative Ecosystem Study (Pisces) Effects of Changing land Cover, Climate and Sea Level on Estuarine Trophic Dynamics
기관명 : Marine Biological Lab
NSF 프로그램 및 연구분야 : BIOLOGICAL OCEANOGRAPHY / Oceanography
연구기간 : 1998. 7. 1. - 2004. 6. 30.(추정)
전체연구비(추정) : $3,789,998
연구요약 :
Human activities in rivers and watersheds have altered enormously the timing, magnitude and nature of inputs of materials such as water, sediments, nutrients and organic matter to estuaries. An important but neglected linkage between land and coastal waters is the input of dissolved and particulate organic carbon and organic nitrogen. This long term ecological research (LTER) in land/ocean margin ecosystems will focuses on the question-How will trophic structure and primary and secondary productivity in estuaries be affected by changes in organic matter, nutrient and water fluxes caused by changing land cover, climate and sea level? The project examines this question through 1) short and long term measurements of the fluxes of dissolved and particulate organic carbon and organic nitrogen entering estuaries from land, marshes and the ocean, 2) short and long term manipulative experiments to determine the effects of nutrient and organic matter interactions on the flow of C and N through pelagic and benthic food webs, and 3) modeling the effects of land use changes on food web transformations. The proposed research integrates estuarine biogeochernistry with studies of food webs and population biology of higher trophic levels. The research program will create a legacy of well designed and documented ecological experiments and observations. A data base of research results will be accessible (WWW) to the scientific community. The study builds on the existing long term research record at Plum Island Sound, MA, and at the North Inlet, SC and Wells, ME National

Estuarine Research Reserves. Intensive work will take place at Plum Island Sound, and specific comparative studies at North Inlet and Wells. The research is designed to take advantage of natural differences between these systems to determine the importance of inorganic and organic matter interactions in controlling trophic structure, production and efficiency. The project will make a unique contribution to our understanding of land margin ecosystems by determining how changing nutrient supply interacts with the quality and quantity of organic matter to affect estuarine trophic structure. It will also develop modeling methods to link highly variable physical drivers, here tides, long term sea level rise, river inflow, and water circulation, with the understanding of ecological processes. The dynamic models developed will be useful in a variety of ways for predicting effects of various coastal management options. For example, the spatially explicit models to be developed can be used to predict the effects of changing land use on eutrophication and fish production.

연구과제명 : (9804826) Support of the 1998 National Ocean Sciences Bowl
기관명 : Office of Naval Res
NSF 프로그램 및 연구분야 : OCE SPECIAL PROGRAMS / Oceanography
연구기간 : 1998. 1. 15. - 1999. 12. 31.(추정)
전체연구비(추정) : $3,854,211
연구요약 :
Funds are being provided via an interagency transfer to co- sponsor a National Ocean Science Bowl (NOSB), as part of the commemorative activities of the 1998 United Nations-designated Year of the Oceans (YOTO). NSF joins the Office of Naval Research, the Oceanographer of the Navy, NASA, and NOAA in sponsoring a national competition for high school students on topics related to the study of the oceans. The competition is being managed through the Consortium for Ocean Research and Education (CORE) that represents all the major ocean science research institutions, and the National Marine Educators Association (NMEA). The NOSB will be patterned after the highly successful College Bowl program that is sponsored by DOE. The Bowl will enhance knowledge of the oceans on the part of high school students, their teachers, and parents, and increase the visibility and understanding of ocean science research as sponsored by NSF.

연구과제명 : (9901551) US Support for the International START Secretariat
기관명 : American Geophysical Union
NSF 프로그램 및 연구분야 : INTERNATIONAL SUPPORT / Oceanography
연구기간 : 1999. 4. 15. - 2004. 3. 31.(추정)
전체연구비(추정) : $3,493,062
연구요약 :
START will encourage and promote increased participation by scientists and research institutions of developing countries in global change research research supportive of the World Climate Research Programme (WCRP), especially its emerging Climate Variability study

(CLIVAR); the International Geosphere-Biosphere Programme (IGBP); and the International Human Dimensions Program (IHDP). Specific START activities over a five-year period will focus on : climate variability and change and their impacts, especially on water resources, ecosystems, and biodiversity in the lands of the Kalahari region; modelling of the Asian monsoon system with special emphasis on Asian ecosystems; pilot studies of the relationship between climate variability and agricultural productivity in sub-Saharan and tropical Africa and Southeast Asia; changing land use and climate variability and their impact on water resources and river inputs to coastal areas in Southeast Asia; African contributions to chemical changes in the atmosphere through biomass burning and desertification; acid deposition and health effects of aerosols; greenhouse gas emissions related to land use and land cover change; and industrial transformations and their relationship to sustainability. Capacity building will be promoted through scientific planning and training workshops and related activities and guest lecturer programs. Efforts to improve linkages between research and policy-making will be strengthened through regional fora on science and policy; workshops on the role, planning and use of assessments; and workshops on the synthesis of research results. Data management activities will include development of datasets in CD format for Southeast and Temperate East Asia and development of a data and information management system (DIS) for global change in Southeast Asia.

연구과제명 : (9903687) Deep Submergence Operations - 1999-2001
기관명 : Woods Hole Ocean Inst
NSF 프로그램 및 연구분야 : SUBMERSIBLE SUPPORT / Oceanography
연구기간 : 1999. 4. 1. - 2002. 3. 31(추정)
전체연구비(추정) : $3,293,590
연구요약 :
In 1999 Woods Hole Oceanographic Institution will operate the Deep Submergence Vessel ALVIN and the Remotely Operated Vehicles (ROV) as a National Facility. The ALVIN is supported by the research vessel ATLANTIS. These Vehicles have been operated effectively and safely by the institute for a wide variety of NSF sponsored research projects. Through a Memorandum of Agreement between ONR, NOAA and NSF the submersible and ROVs (JASON, MEDIA, ARGO and DSL120) support projects funded by the three agencies. The 1999 schedule for ALVIN is very heavy at approximately 300 dives. The use of the ROV is Lighter than usual with only 4 cruises. The facilities are scheduled for a total of 408 days of which 302 are NSF, 67 are NOAA, 22 Navy and 17 private. All cruises will take place in the Pacific from 13 degrees south to the Gulf of Alaska in the Northern Pacific.

연구과제명 : (9907884) Collaborative Research : The Role of Wind-Driven Transport in Shelf Productivity-Moorings, Drifters & CODAR
기관명 : U of Cal SD Scripps Inst
NSF 프로그램 및 연구분야 : OCEAN TECH & INTERDISC COORDIN / Oceanography

연구기간 : 2000. 1. 1. - 2004. 12. 31.(추정)
전체연구비(추정) : $3,759,796
연구요약 :
This collaborative project, involving eleven investigators at five institutions is under the auspices of the Coastal Ocean Processes (CoOP) Program, and it focuses on the role of wind-driven transport in shelf productivity. Wind-driven continental shelves represent a paradox in that while they are characterized by high productivity due to upward fluxes of nutrients into the euphotic zone, wind forcing also represents negative physical and biological controls via offshore transport and deep (light-limiting) mixing of primary producers. Specifically, upwelling ecosystems along mid-latitude eastern boundaries of the ocean are well-known for wind forcing and high productivity at lower trophic levels, with concomitant transport of near-surface plankton offshore. The group of researchers will conduct an interdisciplinary study to examine the roles that wind-driven transport plays in productivity over the shelf off northern California. Research will focus on key processes to explain the integrated functioning of highly productive planktonic systems over eastern boundary shelves in response to wind-driven transport, and specifically, to determine the sensitivity of these processes to both wind intensity and the time scales of wind forcing. Work will also identify specific features of the nutrient-phytoplankton-zooplankton (NPZ) food web that lead to greater or lesser secondary productivity in response to changes in wind forcing. To implement the study, part of the work will examine the 3-dimensional wind-driven circulation of water concurrently with size-structured distributions of phytoplankton and zooplankton species. Other efforts will study the key physical and biological processes that control primary production, zooplankton population responses, and offshore transport of plankton and nutrients over the strongly wind-driven shelf and slope off Bodega Bay. An integrated sampling scheme coupled with appropriate physical-biological models designed to synthesize and guide the fieldwork has been developed. The fieldwork will be comprised of fixed station time-series, ship surveys, drifter releases, and satellite remote sensing. There are two parts to the fieldwork - one focusing on the mooring array off Bodega Bay, and a second involving ship surveys and drifters. The mooring array places emphasis on eulerian measurements of cross-shelf circulation, aiming also to resolve up/downwelling fluxes. The surveys and drifters place emphasis on transformations in the water column, specifically the maturation of upwelled water as it moves away from the mooring site. By combining these data with the synoptic measurements available from satellites and the integrative aspects of the modeling, the project seeks to address all the important processes associated with wind-driven transport. This promises to unravel the paradox of how wind-driven transport supports high levels of productivity over eastern boundary shelf regions.

(5) 수학 및 물리학 (57개 과제)

① Astronomical Sciences (5개 과제)

연구과제명 : (9613615) Cooperative Agreement for the Management, Operation and the Maintenance of the National Optical Astronomy Observatories (NOAO)
기관명 : AURA/Nat Optic Astron Obse
NSF 프로그램 및 연구분야 : NAT OPT ASTRONOMY OBSERVS-NOAO / Other Applications NEC
연구기간 : 1997. 4. 1. - 2004. 3. 31.(추정)
전체연구비(추정) : $101,152,512
연구요약 :

연구과제명 : (9613717) Astronomical Research with the Owens Valley Millimeter Array
기관명 : California Inst of Tech
NSF 프로그램 및 연구분야 : UNIV RADIO FACILITIES PROGRAM / Other Applications NEC
연구기간 : 1996. 11. 1. - 1999. 10. 31.(추정)
전체연구비(추정) : $5,652,000
연구요약 :
California Institute of Technology. PI : N. Z. Scoville Astronomical Research with the Owens Valley Millimeter Array This award supports research, technological development and student education at the California Institute of Technology's Owens Valley millimeter array. The array is made up of 6 precision 10.4m-diameter antennas, which currently can be positioned out to maximum spacings of 220m north-south and 200m east-west. All the telescopes are equipped with dual-channel (2.6 and 1.3mm) cryogenic SiS receivers. At the shorter wavelength, the highest angular resolution attainable by the array is 0.7 arcseconds. Approximately 50% of the array's observing time is presently devoted to investigations by non-Caltech astronomers. During the tenure of the past three year grant, the Owens Valley array has obtained aperture synthesis images of molecular emission in domains ranging from comets to the envelopes of evolved stars, to star-forming regions in the Galaxy, as well as the spiral arms and active nuclei of other galaxies. The array has also been used for extensive studies of active galactic nuclei, starburst and ultraluminous galaxies at high redshifts. During the last grant period, the observatory also made a number of technical advances, including the development of the ability to observe simultaneously at 1 and 3mm, doubling the continuum bandwidth to 2 GHz, and installing automated tuning and full LO coverage. An active system to compensate for atmospheric phase fluctuations was also designed and installation begun. In the next three year grant period the observatory's scientific programs will continue to include studies of high redshift extragalactic systems, protostars and star-forming regions and their associated protoplanetary nebulae, the structure of the Milky Way Galaxy, collimated outflows from young stars, interstellar chemistry and a variety of solar system objects.

연구과제명 : (9613998) Astronomy with the BIMA Array
기관명 : U of Cal Berkeley
NSF 프로그램 및 연구분야 : UNIV RADIO FACILITIES PROGRAM / Other Applications NEC
연구기간 : 1997. 1. 1. - 1999. 12. 31.(추정)
전체연구비(추정) : $3,289,720
연구요약 :
The Berkeley-Illinois-Maryland Array (BIMA) is a millimeter-wave interferometer presently made up of 9 six-meter diameter antennas; at least two other antennas will be added to the array during the next 5 years. located at Berkeley's Hat Creek Radio Observatory, BIMA was jointly capitalized and is jointly operated by the University of California at Berkeley, the University of Illinois and the University of Maryland through a combination of NSF and State funding. These awards are for identical proposals submitted simultaneously by each institution, and support astronomical research, technological development and student training carried out at the BIMA array. Astronomical research at BIMA includes high resolution studies of solar system objects, stellar envelopes, star-forming regions in the Galaxy, and molecular clouds in external galaxies. Notable accomplishments during the past three years at BIMA include expansion from 6 to 9 elements, and the extension of the array baselines to provide angular resolutions better than 0.5 arcsecond. These technical advancements permitted BIMA scientists to obtain the first resolved image of a young circumstellar disk, and to discover a molecular bar at the core of the Seyfert galaxy NGC 1068, and to confirm the discovery of interstellar acetic acid. Scientific plans under the new award will focus heavily on exploiting the recently-achieved higher speed and resolution of the array. In the technical domain, BIMA staff will concentrate attempting to use total power fluctuations to remove the phase fluctuations caused by the atmosphere when operating over long baselines.

연구과제명 : (9615025) Astronomical Studies with the Caltech Submillimeter Observatory
기관명 : California Inst of Tech
NSF 프로그램 및 연구분야 : UNIV RADIO FACILITIES PROGRAM / Other Applications NEC
연구기간 : 1996. 12. 1. - 1999. 11. 30.(추정)
전체연구비(추정) : $6,831,000
연구요약 :
This award supports research, technological development and student education at the Caltech Submillimeter Observatory (CSO). The Observatory consists of a precision 10.4m antenna enclosed in a dome located near the summit of Mauna Kea, Hawaii. The CSO's mission is to carry out spectroscopic and continuum observations of astronomical objects in the wavelength range 1mm-350 mm; the opacity of the Earth's atmosphere to radiation at these wavelengths is the reason for the observatory's location at an altitude of nearly 4,300m. The observatory was constructed with funds from the National Science Foundation (NSF) during the period 1984-1987. The CSO is presently the only US facility capable of operations throughout the full submillimeter

atmospheric window. Over the next three years, the CSO will focus on three major goals : 1. The detection and study of the interstellar medium in distant and possibly primeval galaxies. 2. The study of star formation in the interstellar medium, particularly the very early stages of the process. 3. The extension of previously-successful Sunyaev-Zel'dovich measurements to a wide range of galaxy clusters to allow estimates of the Hubble constant.

연구과제명 : (9725951) Astronomy Research at the Five College Radio Observatory
기관명 : U of Massachusetts Amherst
NSF 프로그램 및 연구분야 : UNIV RADIO FACILITIES PROGRAM / Other Applications NEC
연구기간 : 1998. 3. 15. - 2001. 2. 28.(추정)
전체연구비(추정) : $3,200,000
연구요약 :
Funds will be used for the continued support of the astronomical research, technological development, and development of human resources at the Five College Radio Astronomy Observatory (FCRAO) of the University Of Massachusetts. The research program includes studies of external galaxies, astrochemistry and planetary science. FCRAO operates the largest heterodyne focal plane array in the world and plays a major role in astronomical education.

② Chemistry (4개 과제)

연구과제명 : (9810248) Institute for Environmental Bioinorganic Chemistry (IEBIC)
기관명 : Princeton University
NSF 프로그램 및 연구분야 : PROJECTS / Regional & Environmental
연구기간 : 1998. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $5,820,000
연구요약 :
The Center for Environmental BioInorganic Chemistry (CEBIC) at Princeton University, directed by Dr. Francois M. M. Morel, supports an interdisciplinary research program on trace metals in the environment as well as a wide range of educational activities, including summer workshops for K-12 teachers, public lectures, conferences, and a web site. CEBIC is supported as an Environmental Molecular Science Institute (EMSI) and jointly funded by the NSF Division of Chemistry and MPS Office of Multidisciplinary Activities and by the Chemical Sciences Division of the Office of Basic Energy Sciences, Department of Energy. Metalloenzymes affect the behavior of trace metals that are essential for the proper functioning of ecosystems but are also pervasive contaminants emitted by many industries. CEBIC will investigate a number of natural metalloenzymes and metal-binding compounds that influence the behavior of iron in the global carbon cycle. Interdisciplinary teams of CEBIC participants will study intracellular and extracellular binding of metals and their uptake by aquatic microbes, the role of metalloenzymes in the microbial uptake of inorganic carbon and in the respiration of organic carbon, and the role

of enzymes in the use and loss of nitrogen, a key limiting element in marine waters. Results of interconnecting laboratory, field, and modeling studies will be incorporated into an overall model of metal dynamics and carbon cycling. The Institute is expected to have a major impact on applying bioinorganic chemistry methods to the environment and on building a knowledge base for development of new approaches to bioremediation of trace metals. The twenty-three member team of investigators includes ten faculty from four Princeton departments, three from Rutgers University, four from the University of California (Santa Cruz, Santa Barbara, and San Diego), one from McGill (Canada), plus four researchers from Exxon Research and Engineering Co. and one from Brookhaven National Laboratory. Approximately 5 postdoctoral fellows, 11 graduate students, and 5 undergraduates will participate each year.

연구과제명 : (9810367) Environmental Molecular Science Institute on Chemical Sources and Sinks at Liquid/Solid Interfaces
기관명 : Columbia University
NSF 프로그램 및 연구분야 : PROJECTS / Regional & Environmental
연구기간 : 1998. 10. 1. - 2003. 9. 30.(추정)
전체연구비(추정) : $4,068,000
연구요약 :
The Environmental Molecular Science Institute (EMSI) on Chemical Sources and Sinks at Liquid/Solid Interfaces at Columbia University, directed by George W. Flynn and Richard M. Osgood, supports an interdisciplinary research program on the behavior of contaminants in subsurface environments as well as a wide range of educational activities, including special programs for K-12 teachers, high school students, and the public. This Institute is jointly funded by the NSF Division of Chemistry, MPS Office of Multidisciplinary Activities and Directorate for Education and Human Resources and by the Chemical Sciences Division of the Office of Basic Energy Sciences, Department of Energy. The Institute is organized into three collaborative research groups : molecular scale processes on mineral surfaces and in pores; fundamental chemical and biological reactions and transport processes in microscopic porous media; and macroscopic chemical transport and dispersal. The results at the three length scales (molecular, microscopic, macroscopic) will provide input to a chemical and transport model that will be tested in the "real world" by partners at industrial laboratories and at Pacific Northwest National Laboratory (PNNL). Particular emphasis will be placed on organic contaminants on iron oxide surfaces and their degradation by enzymatic or photochemical processes. Examples of some problems that could be addressed more effectively by improved knowledge of subsurface transport are : behavior of pollutants on hydrated metal oxides and soils; mechanism and dynamics of chemical decomposition on surfaces; and migration of organic contaminants. The Institute is expected to have a major impact on the development of new tools to predict and remediate contamination by organic chemicals. The 22-member team of investigators includes 16 faculty from five Columbia departments and the Lamont-Doherty Earth Observatory, plus one

faculty member from Barnard College and five researchers from PNNL. Additional collaborators are located at GE, IBM, DuPont, Exxon, and Inrad. Approximately four postdoctoral associates, 20 graduate students, and 20 undergraduates will participate each year.

연구과제명 : (9810378) Institute for Environmental Catalysis
기관명 : Northwestern University
NSF 프로그램 및 연구분야 : PROJECTS / Regional & Environmental
연구기간 : 1998. 9. 15. - 2003. 8. 31.(추정)
전체연구비(추정) : $6,700,000
연구요약 :
The Institute for Environmental Catalysis (IEC) at Northwestern University, directed by Dr. Peter C. Stair, supports an interdisciplinary research program on selective oxidation catalysis in industry and in the environment as well as a wide range of educational activities, including development of instructional materials and training programs for K-12 teachers. The IEC is supported as an Environmental Molecular Science Institute (EMSI) and jointly funded by the NSF Division of Chemistry, MPS Office of Multidisciplinary Activities and Division of Chemical and Transport Systems, and by the Chemical Sciences Division of the Office of Basic Energy Sciences, Department of Energy. The IEC is organized into four collaborative research groups : molecular science of catalytic oxidation, chemical processing, emissions treatment, and natural environment. Specific catalytic oxidation processes will be studied in the latter three while the first group will develop and provide tools required to obtain the molecular level information needed by the other groups. Because of its importance in a broad range of industrial activities, the catalytic oxidation of organic compounds will be emphasized. Examples of some problems that could be addressed more effectively by improved knowledge of catalysis are : removal of NOX from combustion exhaust, efficiency of fossil fuel combustion, clean production of many useful chemicals, removal of pollutants from waste water streams, and transformation of pollutants to biodegradable forms. The Institute is expected to have a major impact on improving process efficiency and reducing chemical waste from industrial processes and to serve as a national resource on environmental catalysis. The 49-member team of investigators includes 21 faculty from four Northwestern departments plus nine researchers from Argonne and Pacific Northwest National Laboratories, and 19 researchers from five (Allied Signal, Dow Chemical, Engelhard, Union Carbide, and UOP) industrial laboratories. Approximately four postdoctoral fellows, 20 graduate students, and five undergraduates will participate each year.

연구과제명 : (9909502) National High Field FT-ICR Mass Spectroscopy Facility
기관명 : Florida State University
NSF 프로그램 및 연구분야 : CHEMICAL INSTRUMENTATION / Other Applications NEC
연구기간 : 2000. 1. 1. - 2004. 12. 31.(추정)
전체연구비(추정) : $5,760,558

연구요약 :
With support from the Chemistry Research Instrumentation and Facilities (CRIF) Program, Alan G. Marshal, Christopher L. Hendrickson and Mark R. Emmett of Florida State University (FSU) and John R. Eyler of the University of Florida will continue to operate the Fourier-Transform Ion Cyclotron Resonance/Mass Spectrometry (FT-ICR/MS) Facility, housed in the National High Magnetic Field Laboratory (NHMFL) at FSU. Studies to be carried out using the FT-ICR/MS facility during the next grant period include isotopic resolution of proteins; highly accurate mass spectra of complex mixtures such as petroleum feedstocks; analysis of environmental mixtures (oil spills; bioremediation); and studies exploring the use of magnetic fields to control ion/molecule reactions. Design and development efforts will focus on the installation of a matrix-assisted laser desorption/ionization (MALDI) FT-ICR/MS instrument into an 11 tesla magnet; installation of an electrospray ionization (ESI) FT-ICR/MS instrument using a 17 tesla magnet; and the development of mass-selective external ion accumulation, which should lead to improvements in sensitivity and dynamic range. The PIs also plan further development of optical spectroscopy of mass-selected gas phase molecular ions using FT-ICR. They will continue to provide access and services to the external user community, including provision of funds for visiting graduate students and postdocs; and mass analysis for non-FT-ICR MS experts and industrial concerns. Education and outreach efforts will continue, such as regular publication of newsletters, organization of biennial conferences, and participation of undergraduates in summer research programs. The Fourier Transform-Ion Cyclotron Resonance/Mass Spectrometry Facility at Florida State University is a unique national resource that provides state-of-the-art analytical instrumentation and mass spectral analysis to chemists and biochemists in US academic and industrial institutions. Studies that are carried out at the facility lead to a better understanding of the behavior of biomolecules, and the structure of biomolecules, complex mixtures important in environmental chemistry, and petroleum products. This facility also makes an important contribution to the training and education of significant numbers of graduate students and postdoctoral fellows in the use of advanced mass spectrometry.

③ Materials Research (23개 과제)

연구과제명 : (9632275) MRSEC : Materials Science and Engineering Research Center
기관명 : Cornell University-Endowed
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 2. 28.(추정)
전체연구비(추정) : $14,008,661
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Cornell University supports interactive research in four interdisciplinary groups. The theme of the MRSEC is the understanding and control of materials at the nanostructural level. The Center supports an extensive program of research experience for undergraduates and a new program of outreach to

pre-college students in upstate New York, including collaborative efforts with a local science museum. The Center will also support seed funding for exploratory research and emerging areas of materials science. The MRSEC suppor ts enhanced collaboration with industry and extensive shared experimental facilities that also support research not directly funded by the MRSEC. As part of the Center's search for new materials, the molecular inorganic-organic composites group will focus on innovative approaches for preparing and characterizing novel nanoscale inorganic-organic molecular composites. The group studying thin films on glass proposes systematic studies of disordered surfaces and thin film deposition on glass. The research addresses a rich array of phenomena that are not currently understood, and has potential application for large area electronics, a growing segment of the communications and display industry. Thin film deposition by energetic ion and atom beams can alter thin film growth substantially, leading to new structures, new compositions, and smooth ultra-thin films with improved properties. This group seeks to understand the microscopic processes underlying these effects. Uniquely structured nanoscale materials that isolate a few defects (or even a single one) will be used by the metallic nanostructure group to elucidate fundamental issues arising from defects and impurities. Magnetic interactions, defects and impurities can produce dramatic effects in quantum systems. The Center currently supports about 35 senior investigators, 8 postdoctoral research associates, 12 technicians or other professionals, 36 graduate students, and 25 undergraduates. The MRSEC is directed by Professor John Silcox. The Materials Research Science and Engineering Center (MRSEC) at Cornell University supports interactive research in four interdisciplinary groups. The theme of the MRSEC is the understanding and control of materials at the nanostructural level. The Center supports an extensive program of research experience for undergraduates and a new program of outreach to pre-college students in upstate New York, including collaborative efforts with a local science museum. The Center will also support seed funding for exploratory research and emerging areas of materials science. The MRSEC supports enhanced collaboration with industry and extensive shared experimental facilities that also support research not directly funded by the MRSEC. As part of the Center's search for new materials, the molecular inorganic-organic composites group will focus on innovative approaches for preparing and characterizing novel nanoscale inorganic-organic molecular composites. The group studying thin films on glass proposes systematic studies of disordered surfaces and thin film deposition on glass. The research addresses a rich array of phenomena that are not currently understood, and has potential application for large area electronics, a growing segment of the communications and display industry. Thin film deposition by energetic ion and atom beams can alter thin film growth substantially, leading to new structures, new compositions, and smooth ultra-thin films with improved properties. This group seeks to understand the microscopic processes underlying these effects. Uniquely structured nanoscale materials that isolate a few defects (or even a single one) will be used by the metallic nanostructure group to elucidate fundamental issues arising from defects and impurities. Magnetic interactions, defects and impurities can produce dramatic effects in q uantum systems. The Center currently supports about 35 senior investigators, 8 postdoctoral research associates, 12 technicians or other professionals, 36 graduate students, and 25 undergraduates. The MRSEC is directed by Professor John Silcox.

연구과제명 : (9632472) Materials Research Science and Engineering Center
기관명 : Northwestern University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 2. 28.(추정)
전체연구비(추정) : $10,868,687
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Northwestern University supports interactive research in five interdisciplinary groups. The unifying theme of the research is the design and characterization of structured materials with unique properties for potential technological applications. One group investigates electroactive and magnetoactive molecular materials by designing molecular materials for specific electroresponsive or magnetoresponsive properties. A second group studies narrow bandgap strained-layer semiconductor materials and focuses on the synthesis, stability, and properties of these materials. Strain and/or ordering is used to tailor the band structure, and hence the optical properties. This work has high potential impact on the area of room temperature infrared lasers and improved infrared detectors. Other applications include optical communications and optical computers which take advantage of the highly non-linear optical constants of these materials. A hird group investigates optically functional polymers and molecular assemblies, bringing to bear a combination of synthesis, materials characterization, and theoretical approaches on problems of fundamental and applied significance in the area of polymers with optical nonlinearities. A fourth group studies ultrahard coatings with the goal of stabilizing and/or nucleating normally unstable phases, specifically certain nitrides, epitaxially on carefully chosen substrates. A fifth group working on functional electroceramic thin films will synthesize and characterize thin ceramic films for advanced dielectric and nonlinear optical applications and will extend the deposition and characterization techniques to novel transparent conducting oxides. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by unde rgraduates. The Center supports an educational outreach program aimed at pre-college science education through development of the Materials World Modules, and a program featuring research experiences for science teachers. The Center also administers an industrial outreach program. The Center currently supports 35 senior investigators, 5 postdoctoral research associates, 7 technicians or other professionals, 34 graduate students, and 16 undergraduates. The MRSEC is directed by Professor R.P.H. Chang. The Materials Research Science and Engineering Center (MRSEC) at Northwestern University supports interactive research in five interdisciplinary groups. The unifying theme of the research is the design and characterization of structured materials with unique properties for potential technological applications. One group investigates electroactive and magnetoactive molecular materials. A second group studies narrow bandgap strained-layer semiconductor materials. This work has high potential impact on the area of room temperature

infrared lasers and improved infrared detectors. Other applications include optical communications and optical computers which take advantage of the highly non-linear optical constants of these materials. A third group investigates optically functional polymers and molecular assemblies, while a fourth group studies ultrahard, specifically certain nitrides. A fifth group working on functional electroceramic thin films will synthesize and characterize thin ceramic films for advanced dielectric and nonlinear optical applications. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by undergraduates. The Center supports an educational outreach program aimed at pre-college science education through development of the Materials World Modules, and a program featuring research experie nces for science teachers. The Center also administers an industrial outreach program. The Center currently supports 35 senior investigators, 5 postdoctoral research associates, 7 technicians or other professionals, 34 graduate students, and 16 undergraduates.

연구과제명 : (9632521) Materials Research Science and Engineering Center on Oxide Thin Films, Probes and Surfaces
기관명 : U of MD College Park
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 5. 31.(추정)
전체연구비(추정) : $7,027,400
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Maryland supports interactive research in two interdisciplinary groups focusing on oxides, thin films, and novel surface spectroscopic probes. One of the research groups emphasizes fundamental materials issues in ferroelectric thin film heterostructures, related device problems of technological relevance, and fundamental materials physics of perovskite materials that exhibit unusually large ("colossal") magneto-resistance. The second group investigates the structure of surfaces on length scales from nanometers to microns, with the goal of developing a predictive understanding of surface morphology. The work may ultimately find practical application in micro-electronics, thin film growth, lubrication, catalysis, and other areas. A common theme for both groups is the development, optimization and utilization of novel surface sensitive tools to measure structural, magnetic, and electrical properties at microscopic length scales. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by undergraduates. The Center is associated with an educational outreach program designed to enlighten pre-college and undergraduate students about science and the role of the center's research program in the modern world. The MRSEC also supports enhanced collaboration with industry, shared experimental facilities that also support research not directly funded by the MRSEC, and seed funding for exploratory research. The Center currently supports about 15 senior investigators, 7 postdoctoral research associates, 1 technician or other

professional, 12 graduate students, and 8 undergraduates. The MRSEC is directed by Professor Ellen D. Williams. The Materials Research Science and Engineering Center (MRSEC) at the University of Maryland supports interactive research in two interdisciplinary groups focusing on oxides, thin films, and novel surface spectroscopic probes. One of the research groups emphasizes fundamental materials issues in ferroelectric thin film heterostructures, related device problems of technological relevance, and fundamental materials physics of perovskite materials that exhibit unusually large ("colossal") magneto-resistance. The second group investigates the structure of surfaces on length scales from nanometers to microns, with the goal of developing a predictive understanding of surface morphology. The work may ultimately find practical application in micro-electronics, thin film growth, lubrication, catalysis, and other areas. A common theme for both groups is the development, optimization and utilization of novel surface sensitive tools to measure structural, magnetic, and electrical properties at microscopic length scales. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by undergraduates. The Center is associated with an educational outreach program designed to enlighten pre-college and undergraduate students about science and the role of the center's research program in the modern world. The MRSEC also supports enhanced collaboration with industry, shared experimental facilities that also support research not directly funded by the MRSEC, and seed funding for exploratory research. The Center currently supports about 15 senior investigators, 7 postdoctoral research associates, 1 technician or other professional, 12 graduate students, and 8 undergraduates. The MRSEC is directed by Professor Ellen D. Williams.

연구과제명 : (9632524) Materials Research Science and Engineering Center
기관명 : Brown University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 4. 30.(추정)
전체연구비(추정) : $4,226,500
연구요약 :

The Materials Research Science and Engineering Center (MRSEC) at the Brown University supports interactive research in one interdisciplinary group focusing on advanced materials for structural and electronic applications. The research group emphasizes the development of a new generation of capabilities for measuring and modeling mechanical response at the microscopic level. Advanced measurement and modeling techniques will be used. The goal will be to develop methodologies to realize predictive capabilities and to understand the performance and limitation of particular icrostructures at micron and atomic length scales. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by undergraduates. The Center develops educational modules consisting of interactive demonstrations and laboratory projects to be used by mathematics and science teachers. The

MRSEC also supports enhanced collaboration with industry, shared experimental facilities that also support research not directly funded by the MRSEC, and seed funding for exploratory research. The Center currently supports about 12 senior investigators, 2 postdoctoral research associates, 3 technician or other professional, 12 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Rodney Clifton. The Materials Research Science and Engineering Center (MRSEC) at the Brown University supports interactive research in one interdisciplinary group focusing on advanced materials for structural and electronic applications. The research group emphasizes the development of a new generation of capabilities for measuring and modeling mechanical response at the microscopic level. Advanced measurement and modeling techniques will be used. The goal will be to develop methodologies to realize predictive capabilities and to understand the performance and limitation of particular microstructures at micron and atomic length scales. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and fosters research participation by undergraduates. The Center develops educational modules consisting of interactive demonstrations and laboratory projects to be used by mathematics and science teachers. The MRSEC also supports enhanced collaboration with industry, shared experimental facilities that also support research not directly funded by the MRSEC, and seed funding for exploratory research. The Center currently supports about 12 senior investigators, 2 postdoctoral research associates, 3 technician or other professional, 12 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Rodney Clifton.

연구과제명 : (9632527) Materials Research Science and Engineering Center on Nanostructured Materials and Interface
기관명 : U of Wisconsin Madison
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 4. 30.(추정)
전체연구비(추정) : $8,390,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) on Nanostructured Materials and Interfaces at the University of Wisconsin, Madison supports research in three interdisciplinary groups focusing on film growth by chemical vapor deposition, grain boundaries and current percolation in high-temperature superconductors, and nanostructured magnetic oxides. The first group investigates the fundamental mechanisms underlying film growth by chemical vapor deposition, with a focus on the growth of Si and Ge and their alloys. The second group focuses on the role that grain boundaries and the electronic structure play in determining the critical current density of polycrystalline high temperature superconductors. The third group addresses the fabrication, characterization, and understanding of the properties of perovskite-like magnetic oxides with potential device applications. The MRSEC supports shared experimental facilities for materials research, exploratory research through seed funding, and collaborations

with industry and with other universities. Educational outreach programs include development of instructional materials for high school science teachers and outreach visits to local schools. The Center supports 15 senior investigators, 8 postdoctoral research associates, 16 graduate students, 7 technicians or other professionals, and 10 undergraduates. The MRSEC is directed by Professor T. F. Kuech. The Materials Research Science and Engineering Center (MRSEC) on Nanostructured Materials and Interfaces at the University of Wisconsin, Madison supports research in three interdisciplinary groups. The first group investigates the fundamental mechanisms underlying the growth of semiconductor films with focus on the growth of the technologically important materials silicon and germanium and their alloys. The second group focuses on the role structural defects play in determining the critical current density of polycrystalline high-temp erature superconductors. The third group addresses the fabrication, characterization, and understanding of the properties of magnetic oxides with potential device applications. The MRSEC supports shared experimental facilities for materials research, exploratory research through seed funding, and collaborations with industry and with other universities. Educational outreach programs include development of instructional materials for high school science teachers and outreach visits to local schools. The Center supports 15 senior investigators, 8 postdoctoral research associates, 16 graduate students, 7 technicians or other professionals, and 10 undergraduates. The MRSEC is directed by Professor T. F. Kuech.

연구과제명 : (9632556) Materials Research Science and Engineering Center : The Mesoscale Interface Mapping Project
기관명 : Carnegie Mellon University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 5. 31.(추정)
전체연구비(추정) : $3,056,258
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Carnegie Mellon University supports research on the study of crystalline interfaces at a mesoscopic scale. The effort concentrates on grain and subgrain boundaries in two-component polycrystals and is complimentary to investigations at the atomic and continuum scales. The seminal concept of the project is that a bridge can be constructed between the character of grain boundaries and certain of their intrinsic properties. This bridge will encompass the very large space of all physically distinctive grain boundaries, known as fundamental zone. The mission is to construct mappings using automated microscopy which link the intrinsic materials properties of individual grain boundaries to their character and chemistry over the entire fundamental zone. The mesoscale of interest lies approximately between 100 microns and 100 nanometer. The anticipated progress is likely to accelerate the world-wide effort towards a unified structure-properties theory, linking structure-properties relations from the atomic scale upwards to the continuum scale. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It fosters research participation by undergraduates and pre-college

students, and is developing strong industrial relationships. The Center currently supports 8 senior investigators, 3 postdoctoral research associates, 8 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Brent L. Adams. The Materials Research Science and Engineering Center (MRSEC) at Carnegie Mellon University supports research on the study of crystalline interfaces at a microscopic scale, also known as mesoscale. The seminal concept of the project is that a bridge can be constructed between the character of grain boundaries and certain of their intrinsic properties. The anticipated progress is likely to accelerate the world-wide effort towards a unified structure-properties theory, linking structure-properties relations from the atomic scale upwards to the continuum scale. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It fosters research participation by undergraduates and pre-college students, and is developing strong industrial relationships. The Center currently supports 8 senior investigators, 3 postdoctoral research associates, 8 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Brent L. Adams.

연구과제명 : (9632570) Materials Research Science and Engineering Center
기관명 : SUNY Stony Brook
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 4. 30.(추정)
전체연구비(추정) : $3,141,350
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of New York at Stony Brook supports research in the area of thermal spray processing and associated materials. Thermal spray coatings are crucial to the economic, safe, and efficient operation of a wide variety of engineering components. The Center has a focus on key scientific issues which are likely to play a role in thermal spray processing. The research is carried out in two interdisciplinary research groups. One group integrates diagnostics and modeling of the plasma spray process in order to develop tools for generating process designs and intelligent control strategies. A second group concentrates on basic understanding of the relationship between processing, microstructure, and properties of the thermal spray product. Details of the microstructures will be linked through modeling to activities in the first group. Special emphasis is placed on measurement of mechanical properties and on application of a variety of sophisticated characterization tools. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and emerging areas, and fosters research participation by undergraduates. The MRSEC has strong industrial links and an educational outreach program from the pre-college to the graduate level. The Center currently supports 13 senior investigators, 3 postdoctoral research associates, 1 technician, 8 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Herbert Herman. The Materials Research Science and Engineering Center (MRSEC) at the University of New York at Stony Brook supports research

in the area of thermal spray processing and associated materials. Thermal spray coatings are crucial to the economic, safe, and efficient operation of a wide variety of engineering components. The Center has a focus on key scientific issues which are likely to play a role in thermal spray processing. The research is carried out in two interdisciplinary research groups. One group integrates diagnostics and modeling of the plasma spray process in order to develop tools for generating process designs and intelligent control strategies. A second group concentrates on basic understanding of the relationship between processing, microstructure, and properties of the thermal spray product. Details of the microstructures will be linked through modeling to activities in the first group. Special emphasis is placed on measurement of mechanical properties and on application of a variety of sophisticated characterization tools. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and emerging areas, and fosters research participation by undergraduates. The MRSEC has strong industrial links and an educational outreach program from the pre-college to the graduate level. The Center currently supports 13 senior investigators, 3 postdoctoral research associates, 1 technician, 8 graduate students, and 4 undergraduates. The MRSEC is directed by Professor Herbert Herman.

연구과제명 : (9632598) Materials Research Science and Engineering Center
기관명 : U of Pennsylvania
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 2. 28.(추정)
전체연구비(추정) : $10,795,532

연구과제명 : (9632635) A Materials Research Science and Engineering Center
기관명 : Arizona State University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 4. 30.(추정)
전체연구비(추정) : $3,342,145
연구요약 :
The Material Research Science and Engineering Center (MRSEC) at Arizona State University supports research on the synthesis of new families of materials, with a focus on the synthesis of materials at high pressures. The research combines experimental and theoretical studies to predict the stability, properties, and appropriate pressure range for the synthesis of novel target phases of nitride glasses, oxide perovskites, carbon nitrides, and chalcogenides. Additional research efforts address the process of vitrification in amorphous materials and the synthesis and characterization of epitaxial nitride films. The MRSEC supports shared experimental facilities for materials research, exploratory research through seed funding, and collaborations with industry and other academic institutions. Educational outreach programs include development of educational modules on materials science for middle school students and a collaborative research

program with the College of Eastern Utah. The Center supports 13 senior investigators, 4 postdoctoral research associates, 12 graduate students, 1 technician, and 5 undergraduates. The MRSEC is directed by Prof. Paul McMillan. The Material Research Science and Engineering Center (MRSEC) at Arizona State University supports research on the synthesis of new families of materials, with a focus on the synthesis of materials at high pressures. The MRSEC supports shared experimental facilities for materials research, exploratory research through seed funding, and collaborations with industry and other academic institutions. Educational outreach programs include development of educational modules on materials science for middle school students and a collaborative research program with the College of Eastern Utah. The Center supports 13 senior investigators, 4 postdoctoral research associates, 12 graduate students, 1 technician, and 5 undergraduates. The MRSEC is directed by Prof. Paul McMillan.

연구과제명 : (9632667) Materials Research Science and Engineering Center on Advanced Oxides and Related Materials
기관명 : U of Houston
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 4. 30.(추정)
전체연구비(추정) : $3,640,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Houston supports research on the synthesis and characterization of oxide materials that have technologically important applications in ionic devices in one interdisciplinary research group. The devices include membrane and electrocatalytic reactors, solid oxide fuel cells, and chemical sensors. The devices promise major advances in industrial chemical processes by improving product selectivity, process efficiency and environmental compatibility. Special emphasis is on complex oxides that are active catalysts for hydrocarbon oxidation and oxygen reduction and have the high ionic conductivity and electronic conductivity required for ionic devices. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research, fosters research participation by undergraduates and pre-college students, and is developing strong industrial relationships. The Center currently supports 11 senior investigators, 3 postdoctoral research associates, 10 graduate students, and 6 undergraduates. The MRSEC is directed by Professor Paul C.W. Chu. Changing needs in transportation fuels, increasing availability of natural gas, and the emphasis on energy efficient, environmentally benign processes are driving new demands for advanced catalytic and ceramic materials. These trends suggest new opportunities for improved catalytic and separation processes that apply novel oxide materials in new energy production approaches. The Materials Research Science and Engineering Center (MRSEC) at the University of Houston supports research on the synthesis and characterization of oxide materials that have technologically important applications. The MRSEC supports the development, operation and

maintenance of shared experimental facilities for materials research. It provides seed funding for explora tory research, fosters research participation by undergraduates and pre-college students, and is developing strong industrial relationships. The Center currently supports 11 senior investigators, 3 postdoctoral research associates, 10 graduate students, and 6 undergraduates. The MRSEC is directed by Professor Paul C.W. Chu.

연구과제명 : (9632716) Materials Research Science and Engineering Center
기관명 : U of Cal Santa Barbara
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1996. 9. 15. - 2001. 3. 31.(추정)
전체연구비(추정) : $11,026,560
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of California Santa Barbara supports research in the area of complex materials in four interdisciplinary groups. One group investigating complex fluids is focused on the creation and control of biomolecular materials. The emphasis is on biomolecular materials whose microstructure can be controlled for possible applications to the development of heat-proof proteins, artificial tissue, novel drug delivery systems, and biogels. A second group investigating solution synthesis of inorganics at molecular and atomic interfaces seeks to understand basic mechanisms of these processes and to explore the synthesis of new materials with applications to electro-optics, catalysis, and biotechnology. Heterogeneous polymeric structures are investigated by a third group. These structures include heterogeneous block copolymers for potential biomedical applications and network blends for polymer light-emitting electrochemical cells. Strongly non-equilibri um phenomena in complex materials are investigated by a fourth group that has a strong theoretical component focused on issues of practical importance in the materials area with a common theme of nonlinearity. Planned studies include fundamental mechanisms of friction, dynamics of fracture, including both conventional fracture and seismic events, the structural evolution of thin films, and phase transitions in reacting polymers. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and emerging areas, and fosters research participation by undergraduates. The MRSEC has strong industrial links and an educational outreach program. The educational program includes the Science Partnership for School Innovation and an internship program involving instructors and students from a local city college. The Center currently supports 30 senior investigators, 10 postdoctoral research associates, 5 technicians or other professionals, 35 graduate students, and 25 undergraduates. The MRSEC is directed by Professor Anthony K. Cheetham. The Materials Research Science and Engineering Center (PARSEC) at the University of California Santa Barbara supports research in the area of complex materials in four interdisciplinary groups. One group investigating complex fluids is focused on the creation and control of biomolecular materials

whose microstructure can be controlled for possible applications to the development of heat-proof proteins, artificial tissue, and novel drug delivery systems. A second group investigating synthesis of inorganics at molecular and atomic interfaces seeks to understand basic mechanisms of these processes and to explore the synthesis of new materials with applications to electro-optics, catalysis, and biotechnology. Heterogeneous polymeric structures are investigated by a third groupwith potential biomedical applications and polymer light-emitting electrochemical cells. Strongly non-equilibrium phenomena in complex materials are investigated by a fourth group that has a strong theoretical component focused on issues of practical importance in the materials area. Planned studies include fundamental mechanisms of friction, dynamics of fracture, including both conventional fracture and seismic events, the structural evolution of thin films, and phase transitions in reacting polymers. The MRSEC supports the development, operation and maintenance of shared experimental facilities for materials research. It provides seed funding for exploratory research and emerging areas, and fosters research participation by undergraduates. The MRSEC has strong industrial links and an educational outreach program. The educational program includes the Science Partnership for School Innovation and an internship program involving instructors and students from a local city college The Center currently supports 30 s enior investigators, 10 postdoctoral research associates, 5 technicians or other professionals, 35 graduate students, and 25 undergraduates. The MRSEC is directed by Professor Anthony K. Cheetham.

연구과제명 : (9713424) Operation of the Cornell High Energy Synchrotron Radiation Laboratory (CHESS)
기관명 : Cornell University-Endowed
NSF 프로그램 및 연구분야 : NATIONAL FACILITIES / Materials Research
연구기간 : 1998. 4. 1. - 2003. 3. 31.(추정)
전체연구비(추정) : $12,302,500
연구요약 :
The Cornell High Energy Synchrotron Source (CHESS) operated by Cornell University since 1978, is a national user facility that provides high energy X-ray synchrotron radiation services to the scientific community. Experimental studies carried out at CHESS impact the scientific fields of condensed matter physics, chemistry, materials science and engineering, biology, and geology. Integral parts of the CHESS program are MacCHESS, the NIH-funded macromolecular resource, and the NSF-based National Facility for High Pressure Research. The program at CHESS is designed to enhance the national science infrastructure by taking advantage of unique aspects of the CHESS environment to provide research capabilities not available at other synchrotron x-ray sources. CHESS is a user oriented facility which accepts proposals from all qualified investigators on a comptetive basis. In addition to providing operating costs, this project supports the development of synchrotron radiation facilities using high power photon levels provided by the Cornell Electron Storage Ring (CESR). At present, more than 500 individuals per year from universities, industries, and national laboratories, conduct research on the public

experimental stations provided by CHESS. Under this award CHESS staff will continue to operate CHESS to build on current user programs. These programs include enhancing existing capability, providing new user capabilities in materials and biological sciences, the development of advanced instrumentation, and the integration of research and education through the training of students.

연구과제명 : (9808595) Materials Research Science and Engineering Center
기관명 : University of Chicago
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2002. 8. 31.(추정)
전체연구비(추정) : $7,200,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Chicago supports a broad research program carried out in three interdisciplinary research groups and exploratory seed projects, as well as a wide range of educational activities, including the K-8 Partners in Science Program with outreach to Chicago area public schools. The Center is raising public awareness of materials science through a new partnership with Chicago's Museum of Science and Technology. The Center supports well maintained shared experimental facilities, which are accessible to outside users and also supports interactive efforts with industry and other sectors. One of the three interdisciplinary research groups is exploring the self-assembly of ultra-small structures. The materials of interest include polymer films, colloids, and semiconductor nanocrystals. A second group is carrying out experimental and theoretical studies of certain physical properties of solids with broad implications for an improved understanding of the condensed state of matter. The properties include quantum phases, transitions, and fluctuations of complex systems. The materials of interest include disordered ferromagnets, organic conductors and conducting polymers. The third group studies macroscopic motion in granular materials and liquids. Potential applications of these problems can be found in the construction of highways and dams, movement of grain and coal, design of ink jet printers, turbulence, avalanches, and bubble formation. A seed initiative on molecular overlayers examines fundamental issues in the surface properties of molecular overlayers, including self-assembled monolayers. A second seed initiative on bio-interfacial science is concerned with understanding the properties of interfaces in biological environments. This knowledge is important for the design of implants, cell culture and preservation, and the construction of sensors that combine biological and engineered components. Participants in the Center currently include 26 senior investigators, 7 postdoctoral associates, 20 graduate students, 14 undergraduates, and 9 technicians and other support personnel. Professor Steven J. Sibener directs the MRSEC.

연구과제명 : (9808677) Center on Polymer Interfaces and Macromolecular Assemblies (CPIMA)
기관명 : Stanford University

NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 2. 28.(추정)
전체연구비(추정) : $8,850,000
연구요약 :
This Materials Research Science and Engineering Center (MRSEC) is a collaboration between Stanford University, the University of California at Davis and IBM Almaden Research Center. The MRSEC focuses on the interface science of polymeric and surface-active molecules that will enable advances in information technologies. The Center also provides seed funding for new opportunities in materials research. The Center supports regional, national and international outreach efforts that impact education at all levels, including summer research experiences for undergraduates, international exchanges of students and faculty, development of instructional materials for high school students and materials science education of the general public through a regional museum. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and broad industrial outreach efforts. Research in this Center, which has been named the Center on Polymer Interfaces and Macromolecular Assemblies, is organized into two interdisciplinary research groups. One group investigates the structure, dynamics and properties of polymers confined to surfaces and interfaces with the goal of understanding lubrication and adhesion processes at the molecular level. A second group emphasizes the development of thin film polymeric membranes as biomolecular materials for sensor and diagnostic applications. Participants in the Center currently include 17 senior investigators, 11 postdoctoral associates, 13 graduate students, 10 undergraduates, and 3 technicians and other support personnel. Professor Curtis W. Frank directs the MRSEC.

연구과제명 : (9808941) MIT Materials Research Science and Engineering Center
기관명 : MIT
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1 - 2003. 8. 31(추정)
전체연구비(추정) : $18,275,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the Massachusetts Institute of Technology supports a broad research program organized through five interdisciplinary research groups. The Center has an extensive educational program, ranging from K-12 through the graduate and postdoctoral level. These activities include a Summer Research Experience for Undergraduate program, which is nationally advertised and highly competitive. The MRSEC has developed an innovative Science and Engineering Day Camp targeted at seventh and eighth grade students from underrepresented minority groups attending nearby public schools. The Center supports well maintained shared experimental facilities which are made available to the broader scientific community. The MRSEC addresses emerging scientific opportunities by supporting a vigorous program of competitively selected seed projects.

There are extensive collaborations with other academic institutions, industry, National Laboratories, and other sectors. The interdisciplinary research group investigating microphotonic materials and structures is seeking to develop a new class of materials which aims to replace electrons with light as the chief carrier of information in optical devices. These materials, called photonic crystals, will allow the control of the propagation of light in very small dimensions. The group uses theoretical and experimental techniques to develop and test novel approaches. A second group is investigating nanostructured polymers to determine how electronically active polymers organize and behave at the molecular level. The objective of the group is to develop the chemistry and processing needed to achieve the materials properties desired for novel optical and electrical applications. A third group is focusing on mesoscopic semiconductor systems. These systems, involving perhaps a few hundred or thousand atoms, are models for the electronic semiconductor devices of the future. The group seeks to understand the fundamental physical principles which underlie the electronic transport through and between such nanostructures. A fourth group is investigating the microstructure and mechanical properties of polymeric materials. The goal of the group is to achieve large improvements in mechanical properties by tailoring the microstructure of structural polymeric materials. Fundamental physical phenomena are investigated by a fifth group, which focuses on substances called Mott insulators. These materials include high temperature superconductors. These materials hold significant, but yet unrealized, technological promise but also are extremely important from a basic scientific viewpoint. The group seeks to study the effect of doping these solids with other constituents, which will increase the fundamental understanding of these materials and the ability to develop them for technological applications. Participants in the Center currently include 43 senior investigators, 14 postdoctoral associates, 41 graduate students, 47 undergraduates, and 19 technicians and other support personnel. Professor Robert J. Silbey directs the MRSEC.

연구과제명 : (9809363) Materials Research Science and Engineering Center
기관명 : Harvard University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)
전체연구비(추정) : $7,625,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Harvard University supports a broad research program organized through three interdisciplinary research groups, as well as a wide range of educational activities, including project TEACH (The Educational Activities of Cambridge-Harvard) which aims to interest seventh grade students in preparing for college. The MRSEC is supporting the introduction of "peer instruction" in area public schools and supports a nationally advertised Research Experience for Undergraduates (REU) program. The Center supports well maintained shared experimental facilities which are accessible to outside users and also supports interactive efforts with industry and other sectors. One of the three interdisciplinary research groups is investigating artificially structured materials and

electronic microsystems. This group supports work on atomic surface transport, nanowires, soft lithography, and atom lithography. The goal of some of this work is the fabrication of small structures without the use of visible light projection and patterning. A second group is exploring the interfaces between synthetic and biological systems with opportunities in sensors, biocompatible devices, and tools for molecular and cell biology research. The third group investigates thermo-mechanical properties at small length scales of diverse systems such as carbon nanotubes, multi-layer metal-semiconductor assemblies, and novel microsystems made with soft lithography. Participants in the Center currently include 22 senior investigators, 8 postdoctoral associates, 21 graduate students, 14 undergraduates, and 10 technicians and other support personnel. Professor Robert M. Westervelt directs the MRSEC.

연구과제명 : (9809364) Materials Research Science and Engineering Center for Hybrid Materials
기관명 : U of Minnesota-Twin Cities
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 2. 28.(추정)
전체연구비(추정) : $7,735,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Minnesota supports a broad research program foucsed on hybrid materials. The Center is organized through two interdisciplinary research groups, and pursues exploratory research in several seed projects. The MRSEC supports an educational outreach program to the Native American community in a four-state area surrounding the University of Minnesota. The Center maintains shared experimental facilities which are accessible to outside users, and also supports interactive efforts with industry and other sectors. One of the two interdisciplinary research groups is investigating the microstructure of macromolecular materials. This group seeks to employ block co-polymers as key ingredients, but rarely as sole ingredients, in order to control the structure and function of new hybrid polymers. The goal of the second group is to develop a fundamental understanding of the materials science of artificial tissues and to develop materials for use in biosystems. An important aspect of this work is to define systematically the relationships betweeen composition, structure, and mechanical properties of arificial tissues. Participants in the Center include approximately 20 senior investigators, 9 postdoctoral associates, 21 graduate students, 10 undergraduates, and 1 support person. Professors Michael D. Ward and Frank S. Bates serve as Center Directors

연구과제명 : (9809365) Materials Research Science and Engineering Center on Polymers
기관명 : U of Massachusetts Amherst
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2002. 12. 31.(추정)
전체연구비(추정) : $5,980,000

연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Massachusetts-Amherst focuses on fundamental problems in polymer science and engineering. The Center also provides seed funding for new opportunities in polymer research. The Center supports education outreach efforts that include collaborations with nearby women's colleges and with minority institutions, development of curricular materials for middle-school students and outreach to the general public through the National Plastics Museum. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and broad industrial outreach efforts. Research in this MRSEC is organized into two interdisciplinary research groups. One group emphasizes the manipulation of polymer morphology by controlled interfacial interactions. A second group explores the use of environmentally benign supercritical carbon dioxide to enhance the efficiency of polymer processing. Participants in the Center currently include 24 senior investigators, 6 postdoctoral associates, 23 graduate students, 10 undergraduates, and 2 technicians and other support personnel. Professor Thomas P. Russell directs the MRSEC.

연구과제명 : (9809483) Materials Research Science and Engineering Center
기관명 : Princeton University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 2. 28.(추정)
전체연구비(추정) : $11,163,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Princeton University addresses fundamental problems in the science and engineering of complex materials. Research in this Center, which has been named the Princeton Center for Complex Materials, is organized into four interdisciplinary research groups. The Center also provides seed funding for new opportunities in materials research. The Center supports efforts in materials education at all levels including summer undergraduate research experiences, a topical summer institute for graduate students working on materials-related areas, and outreach to the pre-college level via an internet-based software developed by the Center and prototyped in a nearby science museum. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and has strong research collaborations with industry and national laboratories. A common theme in the four interdisciplinary research groups of the MRSEC is fundamental understanding of the links between molecular structure or mesoscopic texture and macroscopic properties with the goal of rationally designing materials for technological purposes. One group investigates the unusual phases and excitations in low-dimensional electronic materials, including high temperature superconductors and semiconductor heterostructures. A second group explores engineered structures based on semiconducting organic thin films for application to optoelectronic devices. A third group pursues

the materials science of organic molecules that order spontaneously in solutions or melts with an outlook on advanced lubricant and novel lithographic applications. A fourth group emphasizes the development of nanostructured composites with improved mechanical and dielectric properties by mimicking biological composite materials. Participants in the Center currently include 26 senior investigators, 8 postdoctoral associates, 16 graduate students, 14 undergraduates, and 3 technicians and other support personnel. Professor William B. Russel directs the MRSEC.

연구과제명 : (9809555) Ferroelectric Liquid Crystal Materials Research Center
기관명 : U of Colorado Boulder
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)
전체연구비(추정) : $3,100,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Colorado supports a research program on ferroelectric liquid crystals, as well as a wide range of educational activities, including K-8 outreach. The Center supports well maintained shared experimental facilities, which are accessible to outside users and also supports interactive efforts with industry and other sectors. The research is focused on three areas. These include the study of the molecular structure and macroscopic properties of liquid crystals; the control of interfaces and surfaces of liquid crystals with the goal to advance potential device applications; and the study of polymers and gels, which seeks to develop glassy liquid crystals for nonlinear optical applications. Participants in the Center currently include 10 senior investigators, 2 postdoctoral associates, 10 graduate students and 12 technicians and other support personnel. Professor Noel A. Clark directs the MRSEC.

연구과제명 : (9809686) MRSEC : Advanced Carbon Materials Center
기관명 : U of Kentucky Res Fdn
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2002. 12. 31.(추정)
전체연구비(추정) : $3,500,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at the University of Kentucky focuses on the synthesis, characterization and applications of carbon nanotubes, carbon fibers, and nanotube and fullerene composites. The Center also provides seed funding for new opportunities in related areas. The Center supports efforts in materials education at all levels, including summer undergraduate research experiences and short courses and workshops on carbon materials. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and has strong research collaborations with other universities and industrial laboratories. Research in the University of Kentucky MRSEC is

organized in an interdisciplinary research group that addresses the science and applications of advanced carbon materials. Participants in the Center currently include 10 senior investigators, 3 postdoctoral associates, 18 graduate students, and 1 administrative support staff. Professor Robert C. Haddon directs the MRSEC.

연구과제명 : (9809687) Materials Research Science and Engineering Center : "Mixed Organic/Inorganic Materials and Structured Thin Films"
기관명 : Columbia University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2003. 2. 28.(추정)
전체연구비(추정) : $4,300,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Columbia University focuses on organic/inorganic materials, with an emphasis on materials chemistry. The Center also provides seed funding for new opportunities in materials research. The Center supports efforts in materials education at all levels, including summer undergraduate research experiences and research experiences for high school science teachers. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and has strong research collaborations with other universities and industrial laboratories in the New York City metropolitan area. Research in the Columbia MRSEC is organized in an interdisciplinary research group that addresses the science of inorganic nanocrystal arrays within polymer or organic media. Participants in the Center currently include 12 senior investigators, 4 postdoctoral associates, 12 graduate students, 16 undergraduates and 1 administrative support personnel. Professor Irving P. Herman directs the MRSEC.

연구과제명 : (9809688) A Materials Research Science and Engineering Center : Sensor Materials For Control and Diagnostics
기관명 : Michigan State University
NSF 프로그램 및 연구분야 : MATERIALS RSCH SCI & ENG CENT / Materials Research
연구기간 : 1998. 9. 1. - 2002. 12. 31.(추정)
전체연구비(추정) : $5,033,000
연구요약 :
The Materials Research Science and Engineering Center (MRSEC) at Michigan State University focuses on sensing materials for control and diagnostics. The Center also provides seed funding for new opportunities in sensor materials. The Center supports education outreach efforts that include research experiences for undergraduates and outreach to the pre-college level through hands-on workshops for junior high school science teachers. The MRSEC also supports shared experimental facilities that are accessible to center participants and to outside users, and broad industrial outreach efforts. Research in this MRSEC is organized into two interdisciplinary

research groups. One group emphasizes optical probes of processes critical to engine diagnostics and sensing. A second group explores various transduction methods for transforming chemical and physical information into electrical signals. Participants in the Center currently include 21 senior investigators, 3 postdoctoral associates, 11 graduate students, 8 undergraduates, and one administrative support personnel. Professor Brage Golding directs the MRSEC.

④ Mathematical Sciences (7개 과제)

연구과제명 : (9615854) Mathematical Sciences : VIP/Virtual Integrated Prototyping for Epitaxial Growth
기관명 : U of Cal Los Angeles
NSF 프로그램 및 연구분야 : APPLIED MATHEMATICS / Other Applications NEC
연구기간 : 1997. 7. 1. - 2000. 6. 30.(추정)
전체연구비(추정) : $3,742,658
연구요약 :
Simulation of the models and experimental studies of MBE, using in situ diagnostics (RHEED and PEO) and ex situ microscopy (STM), will be used to determine the effects of strain, flux rates and temperature on surface morphology. Modeling at different levels, analysis of the connections between levels, and experimental validation are important for determination of the essential growth modes and their rates. Finally we will develop a control method based on a new continuum model (the "island dynamics model"), using the in situ diagnostic (RHEED) signal as the measurement variables and flux rates and temperature as control variables. An important general result of this project will be a methodology that can be followed for a wide class of thin film growth problems. In particular, for MBE we will determine the instrumentation sensitivity required for control of nanoscale morphology. Specific products of this project will include a set of computational tools capable of providing parameters for a growth recipe, and a real-time control algorithm for the AlSb/InAs prototype system. Funding for this activity will be provided by the Division of Mathematical Sciences, the MPS Office of Multidisciplinary Activities, the NSF Engineering Directorate, and by DARPA.

연구과제명 : (9701653) Institute for Mathematics and Its Applications
기관명 : U of Minnesota-Twin Cities
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 1997. 9. 1. - 2000. 8. 31.(추정)
전체연구비(추정) : $5,707,684
연구요약 :
This award provides support for the research and programmatic activities of the Institute for Mathematics and Its Applications (IMA) at the University of Minnesota. The IMA is a unique institute addressing a national need. The programs of the IMA are designed to foster linkages among the mathematical sciences, other sciences, and industrial research by identifying problems

and stimulating research in various interface areas of mathematical sciences and to encourage the participation of mathematical scientists in areas of application by providing an atmosphere coducive to multidisciplinary research. Yearly IMA programs are carefully chosen to provide a meeting ground for mathematical scientists with engineers and scientists from academia, industry, and government laboratories. The interaction of senior and mid-level scholars and postdoctoral fellows is designed to provide an environment where new ideas can be developed and explored. The IMA places a high priority on the training of postdoctoral researchers, including both individuals associated with the annual program and those participating in the industrial postdoctoral program. The IMA also supports summer research and training programs for graduate students, as well as an ongoing seminar on industrial problems. Efforts are made to schedule programs of timely research interest and where opportunities exist for cross-disciplinary and programmatic collaboration and scientific exchange. In addition to National Science Foundation support, the IMA is supported by 29 Participating Universities and 12 Participating Corporations.

연구과제명 : (9701755) Mathematical Sciences Research Institute
기관명 : Math Sci Res Inst
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 1997. 7. 1. - 2000. 8. 31.(추정)
전체연구비(추정) : $10,194,700
연구요약 :
This award provides core support to the Mathematical Sciences Research Institute located in Berkeley, California. The fundamental goal of the Mathematical Sciences Research Institute (MSRI) is to stimulate research in the mathematical sciences by bringing together, in a programmatically focused scientific environment, the top mathematical scientists, nationally and internationally, in given research subjects. The interaction of senior and mid-level scholars and the very best postdoctoral fellows in a given field produces a stimulating environment where new ideas can be exploited and developed. The training of postdoctoral researchers is a priority of MSRI, and the scientific structure and budgetary allocations of funds reflect this. Normally, two academic-year scientific research programs take place each year. In addition to these academic year programs, MSRI conducts workshops and conferences. MSRI also supports summer research and training programs for graduate students. Programs are scheduled that reflect imely research interest and opportunities for cross-programmatic collaboration and scientific exchange.

연구과제명 : (9729992) Basic Research in Mathematics
기관명 : Inst For Advanced Study
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 1998. 9. 1. - 2003. 8. 31.(추정)

전체연구비(추정) : $7,250,000
연구요약 :
The School of Mathematics of the Institute for Advanced Study (IAS) was formed in 1930 at the founding of the IAS. The initial goal of the School was to provide a haven for scholars where they could work in an environment that was exceptionally favorable for conducting research. Over the years, other roles have emerged and the School has assumed additional responsibilities including guiding junior visitors in their research and organizing special programs that widen the School's coverage of mathematics. Although it has functioned in an international context, the main impact of the Institute has been on the U.S. mathematical community, with a majority of its visitors having come from or been absorbed by it. The Institute frequently conducts programs in special areas of mathematics. During the last few years, there have been numerous seminars in such diverse areas as kinetic theory, weak turbulence, quantum algebraic geometry, geometry, and modular varieties. There have also been workshops in materials science, mathematical problems in finance, fluid dynamics, kinetic theory, quantum computing, discrete isoperimetric inequalities, and turbulence. Future programs will include geometric methods in representation theory and analytic theory of automorphic forms and L-functions. This project will support postdoctoral and mid-career visiting researchers at the School of Mathematics of the Institute for Advanced Study with the goal of supporting a wide spectrum of mathematical research at the highest level. This activity will provide these researchers unique opportunities for consultation and collaboration.

연구과제명 : (9810282) Institute for Pure and Applied Mathematics
기관명 : U of Cal Los Angeles
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 1999. 10. 1. - 2005. 6. 30.(추정)
전체연구비(추정) : $12,750,000
연구요약 :
The Institute for Pure and Applied Mathematics (IPAM) is an institute at the University of California-Los Angeles, and is directed by Dr. Eitan Tadmor and Dr. Mark Green. This institute is designed to encourage cross-fertilization between pure and applied mathematics and other areas of science. IPAM is supported as a Mathematical Sciences Research Institute and is funded by the Division of Mathematical Sciences. IPAM will host two or three intensive scientific programs each year designed to forge links across fields. Each program will bring in four experts and ten postdoctoral scholars interested in learning the area. Half of these will be mathematicians and half will come from the scientific disciplines related to the program. Each program will have two streams, one with a mathematical flavor and the other focusing on the scientific problems addressed. A program will consist of tutorials from both streams, followed by seminars and conferences, and culminating in a one-week conference at Lake Arrowhead. IPAM will have no permanent faculty. A vertically integrated group of fourteen scholars from the

mathematics and scientific community will spend an intensive ten-week period at IPAM being exposed to an interdisciplinary topic. This group will be supplemented by a hundred visitors coming for shorter periods of time.

연구과제명 : (9977134) VIGRE : The University of Chicago's Vertical Integration Program
기관명 : University of Chicago
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 2001. 6. 1. - 2005. 5. 31.(추정)
전체연구비(추정) : $3,020,593
연구요약 :
Vertical integration of teaching and research has been a tradition of the Department of Mathematics at Chicago for decades, and the very term "vertical integration" has been in use for over twenty-five years. Our program is based on both formal and informal institutionalization of interactions among people at different levels. The logic of vertical integration is based on the principle that people in our educational and research programs should learn from those more advanced and teach those less advanced. The VIGRE program will allow us to implement the principle more fully at several levels. The program consists entirely of direct support of postdocs, graduate students, and undergraduates. On average, 6 postdocs, 12 graduate students, and 18 undergraduates will be supported each year. This support will be used to further the training of these young people, to enhance vertical integration of the existing core research and educational programs of the Department of Mathematics, and to better integrate these programs with the outreach programs of the Department. We will briefly describe the Department's programs and VIGRE's impact on them, working from the top level down. At the highest level, it is departmental tradition that the advanced seminars and research level graduate courses are a communal exercise of tenured faculty, nontenured faculty, and graduate students. The form this has taken has intensified dramatically this year, with several year long topical seminars with a broad mixture of participants. The Department provides an environment in which postdocs and graduate students can maximize their potential to become productive research mathematicians. Most of our graduate students obtain first jobs at major research universities, and most major research departments have hired new Chicago PhD's in the last few years. The VIGRE grant will greatly aid in this by providing postdocs and graduate students with release time from teaching that enables them to focus more fully on research. VIGRE postdocs will have a decreased teaching load, and VIGRE graduate students will have periods free of teaching duties. We expect that this will allow greater numbers of them to complete their Ph.D.s in a more timely fashion. Our graduate program begins with an intensive first year of basic courses, and first year students have no teaching duties. There are no course assignments or examinations for graduate students beyond their first year. One relatively weak link has been in our second year graduate program, where there have been insufficient course offerings intermediate between the first year courses and the advanced courses at or near the frontier of research. We intend to offer some VIGRE supported postdocs the opportunity to run seminars in their field on the

second year graduate level in lieu of regular teaching. The postdocs and the students will present essential basic material in informal talks. This will have the salutary effect of giving these young people a good first opportunity to present lectures at a higher level than undergraduate teaching, and it will foster interaction between postdocs and graduate students. Undergraduate teaching at the University of Chicago is very explicitly based on a system of vertical integration. It is a truism that mathematics can be intimidating. People need to feel comfortable to ask questions. They need patient help to reach understanding. They must not be afraid to show their ignorance. We use vertical integration to provide maximal opportunities for learning to take place in a friendly and unstressful setting. It is usually the case that people find those just a few years older than themselves to be less intimidating teachers than people considerably senior. This is certainly not always the case, and it is not an argument for lack of involvement of senior faculty in teaching at all levels. Rather it is an argument for collaborative teaching, where an older and younger teacher work together. Our teaching is done in small classes taught by faculty with graduate student assistants or by graduate students with assistance from undergraduates. This method of teaching fosters strong ties between faculty and graduate students and between graduate students and undergraduate students.The idea of second year graduate seminars run by postdocs described above is an extension of this idea. Undergraduate classes usually have no more than 25 students, and over 200 quarter courses are taught each year. Upper level undergraduate courses are taught exclusively by junior and senior faculty. They are assisted by "College Fellows," who are second year graduate students serving as apprentice teachers. The College Fellows sit in on classes, hold problem and review sessions, have office hours, and teach occasional classes. They provide feedback to the faculty that allows immediate review and amplification of material that has not been well assimilated. Lower level courses, below honors calculus, are taught primarily, but not exclusively, by graduate students. They are assisted by undergraduates who serve as tutors and graders. In the lowest of our three tracks of calculus courses and in a few other lower level courses, there are several tutors per class. The tutors work with small groups of students, typically 8-10 students to a tutor, helping them gain confidence and mastery in an open and nonthreatening environment. This method of teaching makes it possible to teach students with relatively weak mathematical background while retaining our traditional level of mathematical rigor. The tutors find that the process of tutoring enhances their own mathematical understanding. Again, the tutors report back to the teachers when students are having trouble with any aspect of the material, allowing immediate feedback and course correction. The graduate students supervising these tutors obtain experience in supervising others. Undergraduates also play a major teaching role in one of our most distinctive outreach programs, one which brings around 100 gifted Chicago area high school and middle school students to the department each July. The program, which is an outgrowth of the NSF's Young Scholars Program, offers these students a diversity of material inmathematics, computer science, and physics. It is run on several tracks with rotating subject material, so that students canparticipate and encounter new material over six summers.Undergraduate counselors are central to the success of this program. Undergraduates serving as counselors also participate in REU-type mathematical programs that consist of mixes of lectures, study groups, and research projects. The experience of tutoring in lower level undergraduate courses and teaching gifted grade school students has enticed many mathematics majors at the University of Chicago into teaching careers. The VIGRE program will allow us to offer the proven combination of REU-type activities with outreach service to many more undergraduates than has been possible in the past. Our students are eager for the opportunity. In recent years, many have been frustrated by the fact thatthe quarter schedule of the University of Chicago has prevented themfrom participating in REU programs elsewhere. The REU activities will be organized and run by senior faculty members, who will give lecture series and provide supervision. The study groups and research projects will be carried out by groups of four or five undergraduates mentored by VIGRE supported Dickson Instructors and graduate students. This mentoring will both significantly enhance the REU programs and significantly enhance the training of Dickson Instructors and graduate students as college teachers. On a voluntary basis, VIGRE supported postdocs and graduate students will have the opportunity to participate in the RE

연구과제명 : (9977371) VIGRE - An Integrated Program of Mathematics Research and Education at The University of Michigan
기관명 : University of Michigan
NSF 프로그램 및 연구분야 : INFRASTRUCTURE PROGRAM / Other Applications NEC
연구기간 : 1998. 10. 1. - 2004. 9. 30.(추정)
전체연구비(추정) : $4,795,501
연구요약 :
The University of Michigan VIGRE program aims to accelerate the evolution of an integrated program of education and research in the setting of a highly rated research program at a large state university with a long tradition of concern for education at all levels. In order to make maximal use of the great diversity of strengths and interests in our department, we have designed a decentralized program consisting of a network of interconnected smaller scale activities. Our plans are informed by the belief that close contact among different groups in the department- particularly with senior faculty-is the most effective catalyst for the intellectual and professional development of our students and junior colleagues, and we attempt to foster and maximize these contacts at all levels. Our VIGRE program connects with and augments several existing departmental initiatives and activities, notably a new doctoral program in Applied and Interdisciplinary Mathematics, and flourishing actuarial and REU programs. At the undergraduate level, we plan first to extend and unify the existing REU program through the appointment of several REU Integrators to bring students together during the summer, and to provide greater opportunities for students to continue their projects during term time. Extended possibilities for teaching apprenticeships and internships are also part of the program. At the graduate level, our goal is to immerse students more quickly and fully in the mathematical culture of the department, and to expand their view of the mathematical profession. We intend to accomplish this through three mechanisms : Pro-Seminars, Teaching or Research Apprenticeships, and Non-Traditional Experiences in Mathematics Communication, Teaching or Research. The

pro-seminars will involve informal weekly meetings of first and second year graduate students with a spectrum of senior faculty. Incoming VIGRE Trainees will complete teaching or research apprenticeships, again overseen by senior faculty. The research apprenticeships will involve participating in integrated research groups consisting of students, postdocs and faculty working together on related problems with a common focus. Finally, advanced VIGRE Trainees will complete a non-traditional project in mathematical communication, teaching or research. For example, students can fulfill this requirement by preparing a significant piece of written or oral mathematical exposition, or by serving as REU Integrators. We also intend to institute a weekly VIGRE seminar aimed at advanced undergraduate and graduate students. At the postdoctoral level, VIGRE will enhance an already very active program of postdoctoral scholars in the department. Modest and varied teaching duties will give our junior colleagues experience in a variety of classroom situations, while leaving ample time to focus on research and to benefit maximally from the very active mathematical life of the department. VIGRE Fellows will participate in a series of Pro-Seminars, led by senior faculty, designed to help them "learn the ropes" of the profession. As a mechanism to help postdocs develop independent research programs, senior faculty will direct participating seminars focusing on open problems.

⑤ Physics (18개 과제)

연구과제명 : (9600258) Theoretical Physics
기관명 : Princeton University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE THEORY / Other Applications NEC
연구기간 : 1996. 8. 15. - 2001. 7. 31.(추정)
전체연구비(추정) : $3,305,000
연구요약 :
The Princeton group will continue their broad and outstanding program of research in theoretical physics. This will involve continued study of superstring theories, of two and higher dimensional quantum gravity, of nonperturbative approaches to string theory, of the new symmetries of string theory that are now being revealed and of the phenomenology of string theory. They will also study QCD, focusing on numerical investigation, the construction of an effective string theory of hadronic flux tubes and on the large N limit, and will carry out a continue study of the physics of the standard model and unified theories that can produce large scale structure in the universe. In addition they will study turbulence bringing to bear on this problem new insights from quantum field theory. This group's research has had an enormous impact on modern theoretical physics. They have created a true center of excellence of international renown.

연구과제명 : (9602872) Studies of Nuclear Structure and Nuclear Processes at Intermediate Energies
기관명 : Indiana U Bloomington
NSF 프로그램 및 연구분야 : INDIANA UNIV (CYCLOTRON FACIL) / Other Applications NEC
연구기간 : 1997. 4. 15. - 2001. 9. 30.(추정)

전체연구비(추정) : $29,500,000
연구요약 :
Research in intermediate energy, hadronic nuclear physics will be carried out at the Indiana University Cyclotron Facility (IUCF). IUCF is a national user facility, with research being carried out by faculty, staff, postdocs, and students from Indiana University, as well as from other universities in the US and abroad, from US national laboratories, from other federal agencies, and from industry. Proposals are made to IUCF for use of accelerator beam time and for other specialized resources needed to carry out the research. All such proposals are reviewed by a national program advisory committee, which in turn makes recommendations to award beam time or to decline a proposal. The IUCF operations staff provides about 4000 hours of accelerator beam time per year during a 6 to 7 month running cycle. The research program will center around the use of proton and other light ion beams with energies up to 500 million electron volts, and has several broad themes : the study of the meson-nucleon basis for the nucleon-nucleon force; the study of few-nucleon systems, in particular searching for manifestations of many-body forces; the study of modifications of the nucleon-nucleon force in the nuclear medium as a potential manifestation of the underlying quark- gluon basis of the strong interaction; and tests of fundamental symmetries. The data produced will challenge current theories of the nucleon-nucleon force, its modification in nuclei, and the fundamental symmetries which it obeys. In addition, IUCF serves a strong user community studying accelerator physics, specifically non-linear particle beam dynamics and de-polarization phenomena in cyclic accelerators. These data will extend our knowledge of particle accelerators and the limits of sustainable beam intensities and beam polarizations. Lastly, IUCF provides beam to applied researchers in materials and biological radiation effects. Education of students and postdocs is a strong component of the IUCF mission.

연구과제명 : (9630172) Stanford Advanced Gravitational-Wave Laser Interferometer Program
기관명 : Stanford University
NSF 프로그램 및 연구분야 : SUPPORT OF LIGO RESEARCH / Other Applications NEC
연구기간 : 1996. 9. 1. - 1999. 8. 31.(추정)
전체연구비(추정) : $3,900,000
연구요약 :
Investigators associated with the Galileo Project will perform research leading to the development of advanced interferometric receivers of gravitational radiation. The research is intended to be useful eventually for advanced detectors to be used at the Laser Interferometer Gravitational- Wave Observatory currently under construction. Three areas will be emphasized : 1) table-top interferometer studies; 2) high power laser development and laser noise reduction; and 3) suspension systems, thermal noise and interferometer control.

연구과제명 : (9722468) ATLAS Experiment at the LHC

기관명 : Columbia University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1997. 8. 15. - 2000. 7. 31.(추정)
전체연구비(추정) : $5,352,599
연구요약 :
A Toroidal Large Apertune Spectrometer (ATLAS) is a general-purpose detector that will exploit the full potential of the Large Hadron Collider (LHC) proton-proton collision program. The LHC will provide 10 times higher center-of-mass energy and 1000 times higher proton-proton collision rates than previous colliders. This opens up new frontiers of physics which ATLAS will explore. The Standard Model, which is the established theoretical description of the basic building blocks of matter and of the fundamental interactions, has several unexplored aspects, all well within the reach of ATLAS. ATLAS will greatly increase the resolving power with which the size of the building blocks of matter, the quarks and leptons, can be measured. The discovery of the Z and W particles was a large step forward in the understanding of fundamental interactions. ATLAS will be able to discover and measure particles with similar properties but with masses up to 50 times larger than those of the W and Z. ATLAS is designed for a large discovery potential and for precision measurements. The detector designs are based on extensive R&D within the collaboration and display many innovative features. Over a period of six years, prototypes of progressively increasing scale, together with simulations, have been used to optimize the performance to meet the ATLAS requirements. An international collaboration of 1500 scientists, from 145 institutes in 31 countries, including 250 physicists from 28 US institutions, will construct and use the ATLAS detector. ATLAS has, in addition to detector coordinators, an education coordinator who, with an ATLAS education task group, intends to develop a significant program integrating research and education.

연구과제명 : (9722537) Construction of the U.S. ATLAS Detector at the LHC
기관명 : Columbia University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1999. 1. 1. - 2003. 12. 31.(추정)
전체연구비(추정) : $60,800,000
연구요약 :
A Toroidal Large Aperture Spectrometer (ATLAS) is a general-purpose detector that will exploit the full potential of the Large Hadron Collider (LHC) proton-proton collision program. The LHC will provide 10 times higher center-of-mass energy and 1000 times higher proton-proton collision rates than previous colliders. This opens up new frontiers of physics which ATLAS will explore. The Standard Model, which is the established theoretical description of the basic building blocks of matter and of the fundamental interactions, has several unexplored aspects, all well within the reach of ATLAS. ATLAS will greatly increase the resolving power with which the size of the building blocks of matter, the quarks and leptons, can

be measured. The discovery of the Z and W particles was a large step forward in the understanding of fundamental interactions. ATLAS will be able to discover and measure particles with similar properties but with masses up to 50 times larger than those of the W and Z. ATLAS is designed for a large discovery potential and for precision measurements. The detector designs are based on extensive R&D within the collaboration and display many innovative features. Over a period of six years, prototypes of progressively increasing scale, together with simulations, have been used to optimize the performance to meet the ATLAS requirements. An international collaboration of 1500 scientists, from 145 institutes in 31 countries, including 250 physicists from 28 US institutions, will construct and use the ATLAS detector. ATLAS has, in addition to detector coordinators, an education coordinator who, with an ATLAS education task group, intends to develop a significant program integrating research and education.

연구과제명 : (9722552) A Proposal for the Borexino Solar Neutrino Experiment
기관명 : Princeton University
NSF 프로그램 및 연구분야 : LOW ENERGY NUCLEAR SCIENCE / Other Applications NEC
연구기간 : 1998. 8. 15. - 2003. 7. 31.(추정)
전체연구비(추정) : $5,122,872
연구요약 :
A detector of solar neutrinos will be constructed for the purpose of measuring the flux of neutrinos from the decay of beryllium-7 in the solar interior. This decay rate is central to understanding the reactions thought to power the sun. The detector is based on the use of approximately 100 tons of liquid scintillator to detect recoil electrons following neutrino-electron interaction in the detector volume. A large array of photomultiplier tubes will sense the light produced in the liquid scintillator by the recoil electron. Because of the very low rate of events, great attention will be paid to reducing backgrounds from cosmic rays and naturally occurring radioisotopes in the detector proper and the surrounding material. In order to reduce cosmic ray backgrounds, the detector will be located underground. The site chosen is the Gran Sasso underground tunnel in Italy. Construction of this detector, known as Borexino, is an international project involving Italy, Germany, and the US. Results from this experiment will test the standard solar model and help place constraints on the mass of the neutrino. These topics are of great current scientific interest because of earlier results which hint at a substantial reduction in the solar neutrino flux due to neutrino mass and oscillations which are thought to take place in the sun whereby neutrinos change from one so-called flavor into another, i.e. from an electron neutrino into a muon or tau neutrino. The joint NSF/DOE Nuclear Science Advisory Committee highlighted this science in its 1996 Long Range Plan. Education of students and postdocs is a strong component of this experimental program. This project is jointly supported by the Division of Physics, Division of Astronomy and the MPS Office of Multidisciplinary Activities.

연구과제명 : (9722562) Construction of the U.S. CMS Detector at the LHC
기관명 : Northeastern University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1999. 3. 1. - 2004. 2. 29.(추정)
전체연구비(추정) : $20,199,996
연구요약 :
The Compact Muon Solenoid (CMS) is one of two US supported experiments to be built at the CERN Large Hadron Collider (LHC). The primary physics goal of CMS is to discover the origin of electroweak symmetry breaking. To that end, the basic philosophy of CMS is to enclose the tracking and calorimetry inside a strong Solenoidal magnet. This design allows for a Compact design allowing optimal Muon detection without compromise to the electromagnetic calorimetry because of inert material. In general CMS is optimized for detection of electrons, photons, muons, neutrinos and jets. The Standard Model predicts the existence of the Higgs Particle, the missing component of the model. Reconstruction of the Higgs decay modes predicted by theStandard Model requires excellent lepton detection. At the highluminosities to be used at the LHC, the lepton of choice is the muon due to its relatively clean signature. There are about 1500 physicists in the CMS Collaboration who plan to build the detector. The detector is to be constructed from 1998 until data taking in mid 2005. The composition of CMS is roughly 50% physicists from member states, 25% from Russia and other non member states, and 25% US groups. During 1994 a US CMS Collaboration of about 320 physicists and engineers from 40 institutions (4 national labs) was formed. The collective goal of this group is to pursue high energy physics at the highest energy frontier which will be available at LHC. Their experience on previous hadron collider experiments at Fermilab and CERN and on the R&D associated with the SSC makes it possible for US physicists to have a major impact on the design of CMS. They have been assigned distinct and coherent managerial and construction responsibilities. including the management for the hadron calorimetry (HCAL), the endcap muon system (EMU), the trigger system (TRIG), construction responsibilities in electron calorimetry (ECAL), tracking, data acquisition (DAQ) and computing and software. The present design of the HCAL barrel and the EMU are the result of US CMS redesigning those parts of the detector. CMS has appointed, in addition to detector coordinators, an education coordinator who, with a CMS education task group, intends to develop a sustained program integrating research and education.

연구과제명 : (9722706) Research in Elementary Particle Physics
기관명 : University of Chicago
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1997. 9. 1. - 2000. 8. 31.(추정)
전체연구비(추정) : $6,678,000
연구요약 :
The NSF-supported experimental Elementary Particle Physics (EPP) group at the University of

Chicago consists of several research teams which involve themselves in the four experiments discussed below : The 'Kaon at the Tevatron' (KTEV) experiment is now running at Fermilab. Its intent is to study CP violation and the rare decays of long-lived K-mesons. CP violation is thought to be the origin of the a symmetry between matter and antimatter in the universe. KTEV is an experiment of fundamental importance to our understanding of the origins and evolution of the universe. At the Collider Detector at Fermilab' (CDF) experiment, the focus is to study high momentum transfer events in proton-antiproton collisions at 1.8 TeV (the highest energy available in the world today). The Chicago group has the responsibility of constructing the electronic systems for the first level calorimeter trigger and the silicon tracker processor. The CDF experiment is being upgraded so that it can exploit the higher luminosity to be provided by the new main injector ring now under construction. The CDF experiment was one of the co-discoverers of the top quark. The 'Omni-Purpose-Apparatus-at-LEP' (OPAL) collaboration at the Large Electron-Positron collider (LEP) at CERN has completed a program that uses Z boson decays to conduct several important tests of the 'Standard Model' of particle physics : a measurement of the Weinberg angle, a study of various B-meson decays, and a search for exotic particles that would indicate physics beyond the 'Standard Model'. The collaboration is now taking data at 'LEP200', where with double its present energy, the accelerator can make W meson pairs and hence obtain direct measurements of the W mass. Searches for new particles are also being conducted at these higher energies. ATLAS (A Toroidal Large Angle Spectrometer) will be a general-purpose detector designed to exploit the potential of the future LHC proton-proton collider. LHC will provide 10 times higher center-of-mass energy and 100 times higher proton-proton collision rates than previous colliders, thus opening up a new frontier of physics. Discovery of the mass-generating mechanism or spontaneous symmetry breaking, which predicts the existence of a scalar particle, the Higgs boson is a primary objective of ATLAS. The Chicago group is the leading group in the EPP program in its education and outreach activities.

연구과제명 : (9801158) LIGO Advanced Detector R&D Program Proposal (Group Proposal)
기관명 : California Inst of Tech
NSF 프로그램 및 연구분야 : LIGO, OPERATIONS & ADVANC R&D / Other Applications NEC
연구기간 : 1998. 9. 15. - 2002. 8. 31.(추정)
전체연구비(추정) : $8,900,000
연구요약 :
The goal of the Laser Interferometer Gravitational-Wave Observatory (LIGO) is to detect gravitational radiation and to open the entirely new field of gravitational-wave astrophysics. The R&D in support of the construction of LIGO will be completed in FY 1998, about 80% of the total construction funds have been expended, and the integration of the systems has begun. By the end of 2001, after a period of commissioning and pre-operations, the facility is expected to reach its initial design goal of 10^-21 in strain sensitivity. A scientific run lasting about two years is scheduled to begin in early 2002. However, the full scope of LIGO science will require

that LIGO be equipped with gravitational-wave detectors that are more sensitive than those installed initially. Caltech and MIT will conduct a program of research and development, leading to significant improvements in the sensitivity of the initial LIGO interferometer subsystems. This activity, together with coordinated activities among other participants in the LIGO scientific program, is in preparation for the fabrication of new, more sensitive subsytems to be installed over a period of about five years beginning as early as 2004. With these upgrades the sensitivity of LIGO will be improved by a factor of 10 to 100.

연구과제명 : (9802484) Theoretical Physics
기관명 : Princeton University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE THEORY / Other Applications NEC
연구기간 : 1998. 8. 1. - 2003. 2. 28.(추정)
전체연구비(추정) : $3,075,000
연구요약 :
A broad program of research centered on the foundations of string and quantum field theory is proposed. Much of the effort is devoted to the nonperturbative dynamics of strings and the applications of these advances to quantum gravity, black hole entropy and information loss problems. A second focus is to increase understanding of nonabelian gauge theory in order to examine physics beyond the standard model. Finally, research will be carried out using the tools of conformal field theory to problems in turbulence.

연구과제명 : (9809799) Support of the Cornell Electron Storage Ring (CESR) Facility
기관명 : Cornell University-Endowed
NSF 프로그램 및 연구분야 : SUP OF CORNELL ELEC RING (CESR) / Other Applications NEC
연구기간 : 1999. 5. 1. - 2003. 10. 31.(추정)
전체연구비(추정) : $88,183,000
연구요약 :
This grant to run the CESR facility and to perform high energy physics research with the CLEO detector will support studies of the b quark, one of the six types of quark known to exist. The b quark is the heaviest quark which is stable under strong interactions. Only the top quark is heavier. This fact allows many studies to be made of its properties. An understanding of the quark couplings and of the couplings between different types of quark is basic to an understanding of the particles and forces of nature. The ultimate goal of this experimental program is to understand how basic symmetries, e.g. CP, are violated in nature, which leads, for example, to the mechanism by which the Universe becomes composed largely of matter and not anti-matter.

연구과제명 : (9813383) Experimental Particle Physics Research Program at the Columbia University Physics Department Nevis Laboratories

기관명 : Columbia University
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1998. 5. 1. - 2002. 1. 31.(추정)
전체연구비(추정) : $7,810,000
연구요약 :
A broad program of research in elementary particle physics and an associated education and outreach program is proposed by a research group of the Columbia University Physics Department at Columbia's Nevis Laboratory. Their program includes : the ATLAS detector construction project, which will be at the energy frontier at CERN's Large Hadron Collider; the D0 collaboration that shared in the discovery of the top quark at the Fermilab proton-antiproton collider; the ZEUS collaboration that is investigating the form factors of nucleons using the electron-proton collider at the DESY laboratory in Hamburg, Germany; the NuTeV experiment at Fermilab, that explores the proton in a complementary way by using neutrinos; and the proposed MiniBoone experiment at Fermilab, that will better measure reported neutrino masses.

연구과제명 : (9870280) Research in Low Energy Nuclear Physics
기관명 : SUNY Stony Brook
NSF 프로그램 및 연구분야 : HEAVY ION NUCLEAR SCIENCE / Other Applications NEC
연구기간 : 1998. 8. 1. - 2002. 3. 31.(추정)
전체연구비(추정) : $3,505,229
연구요약 :
Research in Low Energy Nuclear Physics A broadly based program is proposed to study properties of nuclei and atoms using the Stony Brook superconducting linac as well as state of the art facilities available elsewhere such as Gammasphere. The program emphasizes frontier issues in nuclear structure physics (smooth band termination, physics near the proton drip line near A=3D100, M1 excitations, superdeformed and other large deformation shapes in the A=3D80 region, and the competition between particle and gamma-ray emission at the limits of stability). Another venue of research utilizesthe decay of giant resonances to study properties of nuclear matter (nuclear dissipation, superconducting-to-liquid drop phase transition, nu-clear compressibility as a function of temperature). Another component of the program proposes to continue preparations for a test of the electroweak interaction (parity non-conservation in Fr atoms). A more suitable Francium laboratory will be prepared in order to perform atomic physics measurements with great accuracy (Stark-induced 7s --> 8s transition and hyperfine anomaly measurements). The Stony Brook Nuclear Structure Laboratory also serves as a focus of many educational activities. Students at the high school, undergraduate, graduate, and postdoctoral levels participate in the research program with various intensities, from beam line construction to running actual experiments.

연구과제명 : (9900793) A Renewal Proposal for the Galileo Program

기관명 : Stanford University
NSF 프로그램 및 연구분야 : SUPPORT OF LIGO RESEARCH / Other Applications NEC
연구기간 : 1999. 7. 1. - 2002. 9. 30.(추정)
전체연구비(추정) : $4,350,000
연구요약 :
A program of advanced detector research and development for LIGO is proposed by a multidisciplinary group at Stanford University. The group proposes research in the areas of interferometer configurations, high power lasers and optics, vibration isolation, alignment and interferometer control and advanced materials development for suspensions and core optics. All of these areas of research are important for the upgrade of LIGO that will provide sufficient sensitivity and bandwidth to fully exploit the potential of the LIGO detectors as a gravity wave astronomical observatory. The Stanford group comprises faculty and research scientists in the departments of Applied Physics, Aeronautics and Astronautics, Electrical Engineering and Physics. They include well known experts in laser development, electronics, materials science, optics, optoelectronics and semiconductors. This wideranging research program is viewed by the gravity wave community to be critically important for the success of LIGO.

연구과제명 : (9901133) Nuclear Structure Research
기관명 : University of Notre Dame
NSF 프로그램 및 연구분야 : HEAVY ION NUCLEAR SCIENCE / Other Applications NEC
연구기간 : 1999. 6. 1. - 2002. 5. 31.(추정)
전체연구비(추정) : $3,165,000
연구요약 :
The University of Notre Dame Nuclear Structure Laboratory (NSL) carries out a broad-range program in experimental nuclear physics. This work is centered around the NSL facilities, but also utilizes accelerators at other laboratories. The research program emphasizes extensive collaborations with experimental and theoretical physicists at other universities, often involving visits by these scientists and their students in order to use the NSL accelerator facilities. The active areas of research at the NSL include reaction studies with short-lived radioactive nuclear beams, nuclear astrophysics, the study of weak interactions and related fundamental processes, and nuclear structure physics. These four topics span a large fraction of the frontiers of nuclear-physics research, and have a particularly large overlap with other areas of many-body physics. Yet, they are all closely related. For example, radioactive-beam physics is an important issue both for modern nuclear-astrophysics research and for the study of nuclear properties far from the valley of stability, while the properties of the nucleus as a quantal many-body system can and have been exploited to learn more about the laws of physics at the most fundamental level. The NSL is the site of pioneering work in the development of low-energy radioactive nuclear beams, and is an important center for research in nuclear astrophysics. In addition, local research groups in Atomic Physics and Radiation Chemistry carry out interdisciplinary programs using the NSL facilities. Specific topics of current interest in nuclear astrophysics include the production of the elements in steady-state "nuclear burning" in main sequence stars, and in

violent events such as nova and supernova explosions. The radioactive nuclear beam research is directed at achieving a better understanding of nuclear reaction processes relevant for solar neutrino physics, as well as the structure and reactions of weakly-bound "halo" nuclei which appear at the limits of nuclear stability and are believed to have very diffuse surfaces that are rich in either neutron or proton matter. The fundamental-interactions program emphasizes several issues relevant to the search for physics beyond the standard electroweak model of elementary particle physics, including the search for "scalar currents" in weak decays and the limits to time-reversal violation in the decay of the neutron. In addition, the weak decays of nuclei relevant for various aspects of solar neutrino physics are being explored. The nuclear structure program involves the study of static and dynamic nuclear phenomena, such as the harmonic and anharmonic vibrations of nuclei, the recently discovered "magnetic" and "anti-magnetic" rotation phenomena, and the attempt to obtain a more complete description of the structure of "super-deformed" nuclei.

연구과제명 : (9970991) Studies of Nuclear Reactions and Structure
기관명 : Florida State University
NSF 프로그램 및 연구분야 : HEAVY ION NUCLEAR SCIENCE / Other Applications NEC
연구기간 : 1999. 5. 15 - 2002. 4. 30(추정)
전체연구비(추정) : $3,844,501
연구요약 :
This is a proposal for support of the experimental nuclear physics group at Florida State University. The proposed research is to be carried out at the FSU Tandem/LINAC accelerator facility and at other laboratories around the U.S. Improvements at the FSU facility, including new high-efficiency 'clover' detectors, a radioactive 14C beam and an intenxe, highly polarized 7Li beam will be valuable for investigations of the high-spin structure of s-d shell nuclei far from stability to test microscopic and macroscopic nuclear models, for exploring octupole collectivity in actinide nuclei, and for studying the structure of neutron-rich mid-mass nuclei. The polarized 7Li beam provides an excellent way to explore how the shape and internal structure of a loosely bound nucleus affect scattering and transfer processes, especially the couplings to the continuum which are so important in halo nuclei. Our developments in resonant particle decay spectroscopy instrumentation will permit high resolution studies of the alpha decay properties of light nuclei to explore mirror states, cluster structure, and widths of astrophysical interest. The FSU Tandem/LINAC and associated instrumentation are well suited to precision fast-beam laser spectroscopy of few electron ions to test relativistic and higher order QED effects in atomic structure calculations. We propose to take advantage of the new capabilities at the National Superconducting Cyclotron Laboratory after the upgrade, including the compact beam sweeper magnet which FSU is helping build, to examine proton and neutron multipole matrix elements in exotic nuclei and to probe the momentum distributions of 'halo' nuclei. Experiments are planned using Gammasphere and Euroball to investigate the quenching of pairing correlations and possible other dramatic phase changes at ultra-high spins. Our group has the primary responsibility for constructing the two Ring-imaging Cherenkov detectors for

the PHENIX experiment, which is optimized to study the interior of hot dense nuclear matter formed in relativistic heavy-ion collisions, and plans to be involved in 'mining' the data for signatures of quark-gluon plasma. Members of our group plan to exploit the new generation of electron accelerators and detectors for precision studies of the nucleon and light nuclei using the (e,e'p) reaction at Jefferson Lab, MIT-Bates, and the Mainz Microtron. Our group has been directly involved in the construction and commissioning of the CEBAF Large Acceptance Spectrometer at Jefferson Lab and is now involved in the e1 experimental program to study the electroproduction and decay of systems containing strange quarks to add to the understanding of fundamental two-particle interactions.

연구과제명 : (9974537) Proposal to Operate and Analyze Data from the High Resolution Fly's Eye Detector
기관명 : University of Utah
NSF 프로그램 및 연구분야 : ELE PARTICLE COSMIC RAYS & OTH / Other Applications NEC
연구기간 : 1999. 7. 1. - 2001. 12. 31.(추정)
전체연구비(추정) : $3,996,151
연구요약 :
This is a proposal to operate the High Resolution Fly's Eye (HiRes) observatory. This detector, located at the US Army's Dugway Proving Ground in Utah, is composed of two stations 12.7 km apart. It detects ultra high energy cosmic rays via nitrogen fluorescence in the atmosphere. The observatory is scheduled to be completed in the summer of 1999. This proposal is for the first 2 1/2 years of full operation. The goals of the experiment are the study of the spectrum, composition, and anisotropy of cosmic rays of energies from 10^18 eV to beyond 10^20 eV. Previous experiments, including the original Fly's Eye experiment, have shown evidence that the spectrum continues past the Greisen-Zatsepin-Kuzmin cutoff. The nature of the events above the cutoff is a puzzle which has stimulated much theoretical speculation. The HiRes detector will have an order of magnitude greater sensitivity than the previous Fly's Eye experiment. The project is a collaboration between the University of Utah, Columbia University, the University of Adelaide, the University of New Mexico, UCLA, and Montana State University. The educational outreach program, called "ASPIRE", provides direct access, via the internet, by Utah students and teachers to current research in astrophysics and produces interactive on-line physics lessons for use in K-12 classrooms and distance learning. The ASPIRE activity is supported jointly by the MPS Division of Physics and the MPS Office of Multidisciplinary Activities (OMA).

연구과제명 : (9979239) Pierre Auger Project
기관명 : Universities Res Assn Inc
NSF 프로그램 및 연구분야 : ELEMENTARY PARTICLE ACCEL USER / Other Applications NEC
연구기간 : 1999. 8. 15. - 2003. 7. 31.(추정)
전체연구비(추정) : $3,750,000
연구요약 :
Scientists love a mystery, because solving a mystery in nature means the opportunity to learn something new about the universe. High-energy cosmic rays are just such a mystery. Where

they come from, how they get their energy, and how they get here is not known. The highest-energy cosmic rays have a hundred million times more energy than the particles produced in the world's most powerful particle accelerator. Something out there -- no one knows what -- is hurling incredibly energetic particles around the universe. Do these particles come from some unknown super-powerful cosmic explosion? From a huge black hole sucking stars to their violent deaths? From colliding galaxies? From the collapse of massive invisible relics from the origin of the universe? Each second, about 200 cosmic ray particles with energies of a few million electron volts strike every square meter of the earth. While these low-energy cosmic rays are plentiful, cosmic rays at higher energies are far rarer. Above the energy of 10^18 eV, only one particle each week falls on an area of one square kilometer. Above the energy of 10^20 eV, only one particle falls on a square kilometer in a century! To find and measure these rare events, a high-energy cosmic ray study needs a truly giant detector. This is the instrument proposed by the Pierre Auger collaboration. The Pierre Auger Project will construct two 3000 square kilometer grids of detectors spaced at 1.5 kilometer intervals. An array in the Southern Hemisphere will attempt to track high-energy cosmic rays to their unknown sources. This project is supported jointly by the Division of Physics and the Office of Multidisciplinary Activities of the Mathematical and Physical Sciences Directorate.

(6) International Programs

연구과제명 : (9734873) Support for International Institute for Applied Systems Analysis (IIASA)
기관명 : Internat Inst Appl Sys An
NSF 프로그램 및 연구분야 : INTER INST FOR APP SYS & ANALY / Other Applications NEC
연구기간 : 1998. 4. 15. - 2001. 3. 31.(추정)
전체연구비(추정) : $6,733,000
연구요약 :
This three year grant to the International Institute for Applied Systems Analysis (IIASA), a multilateral research institute located near Vienna, Austria, will provide partial, continuing support for a policy-relevant research program related to environmentally sustainable economic development. Within this context, research will focus on three themes : (1) global environmental change, (2) global economic and technological transitions, and (3) systems methods for the analysis of global issues. Particular emphasis will be placed on the topics of transboundary air pollution, land-use change and land-cover change, links between greenhouse gas emission and other environmental factors, population-environment interactions, the dynamics of technological change, and impediments to growth in the transition economies of Central and Eastern Europe. Research will result in publications in peer-reviewed journals, international conferences and workshops and, where appropriate, will provide a scientific basis for international policy making on the issues associated with global change, economic transitions, and sustainable development. The United States is one of 17 countries that provide support for IIASA through their national member organizations. Other national members include organizations in Japan, Russia, and several other European countries.

[부록 2] ATP 프로젝트 개요

(1) 1996년 (6개 과제)

① General Competition (6개 과제)

연구과제명 : (96-01-0124) Enabling Large-Scale Recovery of Plastics from Durable Goods
회사명 : MBA Polymers
연구분야 : Abrasives, Adhesives, Ceramics, Coatings, and Composites
연구기간 : 1.91년 (1996년 3월)
전체연구비(추정) : $1,330,322.00
ATP 지원금 : $687,283.00
연구요약 :

Americans have become accustomed to the idea of recycling plastic packaging - soda bottles and food containers, for example - but recycling has hardly touched a larger, and potentially more profitable, segment of the plastics industry : engineering plastics. These are the high-performance - and high-value -- plastics used in durable goods : machinery, appliances, automobiles, computers, and the like. The United States produces almost 20 billion pounds of engineering plastic each year, and though the material has a high value, very little of it is recycled. On a cost-per-pound basis, the plastic is often the most valuable part of a junked appliance, a scrap computer, or a wrecked car. The problem is extracting the plastic economically, because to get the best use of the recycled plastic, the recycler must segregate it by type. The plastics used in durable goods are highly specialized. Five grades of basic plastic resin account for the majority of all plastic packages; 10 times that number would be required to categorize a similar percentage of engineering plastics in the durables market. The ABS co-polymer used in a computer housing is quite different from the version used in a refrigerator, and both are different from the type used in an automobile. The primary technique used by recyclers for sorting waste streams is to separate components by density, but this technique is inadequate with durable goods, where the many component plastics, often mixed with fillers or incorporating bits of metal, have similar densities. The complexity of the required process technology is daunting. MBA Polymers proposes to develop and evaluate several possible new approaches to sorting the engineering plastics waste stream based on thermal, mechanical, and chemical properties. MBA is a leading company in the development of plastic recycling technology. A commercially successful technology for recycling engineering plastics would lower raw material costs, save energy, and reduce the dependence of the U.S. plastics industry on foreign oil. Recapturing only 12 percent of the current U.S. production of engineering plastics would create a $1 billion annual business.

연구과제명 : (96-01-0141) Programmable Nanoscale Engines for Molecular Separation
회사명 : CuraGen Corporation
연구분야 : Separation Technology / Animal and Plant Biotechnology
연구기간 : 2년 (1996년 3월)
전체연구비(추정) : $3,430,820.00
ATP 지원금 : $2,000,000.00
연구요약 :

CuraGen proposes to develop a practical nanoscale molecular pump capable not only of transporting molecules from one point to the next, but also of actually separating them by mass. As such, it would be an ideal device for performing DNA fragment separations as part of a miniaturized, automated DNA analysis device. The research project has three main components : development of a general purpose physical device for molecular separations, development of a software suite to enhance the detection of molecules exiting the device, and using the results of the first two tasks for development of a prototype system for fast and convenient separation of DNA molecules for rapid genotyping. The proposed device is based on an array of etched microchannels that guide the sample molecules over a linear array of electrodes. Modulating the electrodes causes the molecules to migrate gradually from one end of the channel to the other, with the lighter molecules moving faster. The modulation will be programmable, allowing the device's action to be tailored to different samples for maximum efficiency. The proposed image enhancement software will borrow from concepts in information theory to reduce blurring and improve the resolution (the ability to distinguish one molecular species from another). The prototype device effects the separation in a homogeneous liquid, avoiding the use of gels or other special media necessary for electrophoresis and with the potential of replacing electrophoresis devices in many important applications. It should work much faster, be less expensive, and be more easily incorporated in miniaturized "lab-on-a-chip" devices, thereby contributing to significantly lower costs for DNA analysis.

연구과제명 : (96-01-0172) A Portable Genetic Analysis System
회사명 : Nanogen, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology / Animal and Plant Biotechnology
연구기간 : 2.416년
전체연구비(추정) : $3,935,255.00
ATP 지원금 : $2,000,000.00
연구요약 :

Nanogen's project is to overcome technical barriers standing in the way of a portable genetic analysis system that can rapidly and accurately profile a genetic sequence. Typical target applications would include forensic analysis, battlefield casualty identification, and trauma victim identification. The system also would have broad applicability in detecting pathogens for medical diagnostics, epidemiology, and environmental and health monitoring. It will be able to extract the DNA relevant to the identification process from a sample of blood or tissue with minimal preparation, fragment and separate the appropriate nucleic acids, and assay the fragments to identify the genetic polymorphisms unique to the individual's genetic code. The proposed system incorporates a disposable fluidics module to handle initial sample preparation; a sample purification module to separate and purify the sample DNA; an integrated assay chip; and a multichip detection and control module to analyze the assay results. Nanogen is developing the generic technology for sample handling under a separate ATP project awarded in 1995, and the assay chip is a core Nanogen technology. The current project builds on these capabilities by significantly increasing the size and complexity of the Nanogen assay chip to handle large numbers of genetic polymorphisms; developing the complex microfluidics system needed to accept the raw sample, extract the DNA and transport the DNA fragments to the assay module; and doing the systems integration necessary to make a practical prototype to illustrate the feasibility of this approach.

연구과제명 : (96-01-0257) High Performance Sensor Arrays for Digital X-Ray and Visible Light Imaging
회사명 : Xerox Palo Alto Research Center
연구분야 : Electronic Instrumentation/Sensors and Control Systems / Optics and Photonics / Semiconductors
연구기간 : 4년
전체연구비(추정) : $13,186,012.00
ATP 지원금 : $5,958,748.00
연구요약 :
Xerox's Palo Alto Research Center, working with Thermotrex Corporation (San Diego, CA) and TPL, Inc. (Albuquerque, NM), proposes a project to develop the next generation of large-area digital image sensors, based on thin-film silicon technology. Xerox itself has been a leading research center for imaging technology, but the proposed system would go well beyond the current state of the art. The target is a breakthrough system with higher resolution, higher sensitivity and lower electronic noise than anything now available, enabling new applications in mammography, radiography, fluoroscopy, non-destructive evaluation, and several other x-ray imaging applications. Specific research goals include imaging arrays capable of direct detection of x-rays without an intervening phosphor layer, which should increase x-ray sensitivity up to ten-fold; a hybrid fabrication process that integrates both amorphous and polysilicon thin-film devices in the same array, which should reduce external contacts, simplify packaging and lower cost (as well as improve resolution); and a fabrication process to build images with pixel amplifiers, reducing electronic noise up to ten-fold and enabling very high signal-to-noise performance. Xerox PARC contributes more than 10 years' experience with amorphous silicon imagers. Thermotrex, an industry leader in mammography, will evaluate the new technology for that and similar medical applications. TPL will be responsible for evaluating the new technology for non-destructive evaluation applications. RMD, Inc. (Watertown, MA), a small business with

extensive experience in radiation detection materials, will work as a subcontractor providing materials for the planned direct-detection imagers. One of the key benefits of the project, if successful, will be to enable new digital x-ray mammography instruments that would greatly improve detectability and accurate diagnosis of breast cancer. The basic imager technology also will have important applications in high-resolution document scanning.

연구과제명 : (96-01-0263) Color Sequential Imaging
회사명 : ColorLink, Inc.
연구분야 : Optics and Photonics / Computer Hardware / Metals and Alloys
연구기간 : 3년
전체연구비(추정) : $2,386,020.00
ATP 지원금 : $1,800,000.00
연구요약 :
Almost all digital color cameras and color displays capture or create the appearance of a color image by spatially separating the individual colors. In a typical color display, for example, each color pixel is actually a combination of three monochrome pixels, each assigned a different primary color by a color mask. This technique has become a liability as display devices simultaneously become ever smaller and strive for higher resolutions -- putting a premium on pixel real estate while requiring even more pixels in the shrinking space. Tiny "personal digital assistant" devices and small, head-mounted displays for virtual reality systems are prime examples of applications facing these colliding trends. ColorLink is exploring a wholly different approach to the problem : color sequential imaging. In color sequential imaging, the complete color image is displayed as a rapidly changing sequence of primary monochrome images. A switchable color filter selects which color is displayed in each image. Since every pixel in the display contributes to every primary image, a color sequential imaging display can have at least three times the resolution of an equivalent display using spatial separation. The concept of color sequential imaging is not new -- early attempts at color TV receivers tried a crude version using a rotating color filter wheel to switch colors. More recently, attempts have been made using solid-state tunable color filters based on liquid crystals, but to date these filters have had poor light transmission and poor color saturation. ColorLink has invented a new kind of rapidly tunable color polarizer filter that the company believes has the potential to overcome these problems. The ATP project will attempt several challenging extensions of the current technology to improve filter efficiency, develop faster switching liquid crystals, and develop the ability to fabricate the new filters on plastic (to enable the small, lightweight displays needed for portable or wearable devices). If successful, color sequential imagers would have a significant impact on the global electronic display and digital imaging markets, which are expected to exceed $20 billion annually by the next decade.

연구과제명 : (96-01-0315) Development of Novel DNA Binding Proteins as Antiviral Therapeutics

회사명 : Sangamo BioSciences, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3년
전체연구비(추정) : $2,680,000.00
ATP 지원금 : $2,000,000.00
연구요약 :
Viral diseases have long been among the toughest challenges for medical research. When compounds to cure or prevent viral diseases are discovered, these drugs are often highly disease-specific. There are no broad-spectrum anti-viral medications like antibiotics which are effective against bacterial infections. Researchers at Sangamo BioSciences suggest that recent developments in the understanding of proteins that bind to specific sites in DNA molecules offer the possibility of a novel strategy for designing antiviral drugs that function at the genetic level, using nature's own approach to gene regulation. Sangamo's approach is based on a class of DNA binding proteins called "zinc-fingers", which appear to bind DNA according to certain "recognition rules". In principle, zinc-finger proteins can be designed to recognize and bind to any gene or DNA sequence. Research has demonstrated that these binding proteins can repress or "turn off" the activity of a specific gene; the key to the Sangamo project. Sangamo proposes to develop the techniques necessary to design and build specific zinc-finger DNA binding proteins that suppress the activity of any clinically relevant gene required by target viruses. For example, the Human Immunodeficiency Virus (HIV) is believed to require the presence of a specific protein on the surface of immune cells in order to infect those cells. People who lack this protein because of a natural genetic mutation apparently are either immune or highly resistant to HIV. An engineered DNA binding protein that inhibits the production of this surface protein might convey similar resistance to HIV. In a direct anti-viral approach, the Hepatitis B Virus (HBV) is believed to be vulnerable to a DNA binding protein attack that would inhibit transcription of the virus's own DNA. Major challenges facing this project include increasing the specificity of the binding protein, from sequences of up to nine DNA base pairs to sequences of up to 15 to 18 base pairs. Sangamo proposes to pursue the development of highly specific DNA binding proteins for these viral diseases as part of their ATP project as well as to establish the basic methodologies for designing and building engineered zinc-finger proteins for any antiviral applications.

(2) 1997년 (63개 과제)

① General Competition (18개 과제)

연구과제명 : (97-01-0021) Using Biotechnology to Control Fruit Ripening
회사명 : Agritope, Inc.
연구분야 : Animal and Plant Biotechnology

연구기간 : 3년 (1997년 10월)
전체연구비(추정) : $2,800,871.00
ATP 지원금 : $990,222.00
연구요약 :
The commercial value of fruit depends heavily on the ripening process, which ideally should proceed to a point that is attractive to the consumer--but not too far, or else the fruit becomes overripe and eventually rots. Overripe produce is a significant economic problem, with an average of 20 percent or more of perishable fruits and vegetables being lost postharvest and total U.S. losses estimated at several billion dollars annually. Conventional remedies, such as storage in a controlled atmosphere or chemical treatment, can be costly. Agritope previously developed novel ripening control technology for tomatoes and melons by using genetic engineering techniques to manipulate the biochemical pathway leading to the synthesis of ethylene, the plant hormone that controls the ripening process. The company now proposes to adapt this approach to control the ripening of tree fruit (peaches, pears, and apples) and bananas. Agritope has identified a single gene that, after insertion into a plant using the tools of genetic engineering, reduces ethylene production. The enzyme produced by this gene converts a chemical precursor of ethylene into biochemicals normally present in plants, thereby reducing resources available for ethylene synthesis without causing undesirable side effects. The successful adaptation of this approach to tree fruit and bananas will be difficult because it will probably be necessary to isolate, test, and select fruit-specific promoters--segments of genetic material that control the time and extent of gene expression and are expected to be critical in achieving adequate reductions in ethylene synthesis. In addition, the company will design, produce, and test synthetic genes that produce the key enzyme that acts on ethylene precursors. If successful, the project is expected to improve the efficiency of U.S. agricultural production by increasing marketable yield and reducing postharvest losses of the targeted fruits. In addition, the resulting fruit will be of higher quality and tolerant of longer shipping distances than are current varieties.

연구과제명 : (97-01-0023) Development of TERFENOL-D High-Powered Ultrasonic Transducer Technology for Sonochemistry
회사명 : ETREMA Products, Inc.
연구분야 : Manufacturing (Discrete)
연구기간 : 2.33년
전체연구비(추정) : $1,485,149.00
ATP 지원금 : $698,783.00
연구요약 :
Ultrasonic technology, which harnesses inaudible acoustic energy, has been applied to industrial cleaning and medical tools. However, a transducer has yet to be developed with sufficient power to enable ultrasonic processes developed in the laboratory to be scaled up into viable commercial processes. ETREMA proposes to overcome the barriers to the development of ultrasonic

transducers capable of 25 kW--more than three times the power of current state-of-the-art transducers--at a frequency of 20 kHz. Such transducers would be made of crystalline TERFENOL-D(Reg.), a "smart" material which changes shape slightly when exposed to a magnetic field. This material features a combination of power, energy density, and reliability that make it superior to nickel and piezoceramics. ETREMA plans to develop software models that can predict the performance capability of the transducer in different operating conditions, and then to build and demonstrate a laboratory prototype high-power transducer. Technical challenges include affordable dissipation of the heat generated in a small transducer package and the prediction of TERFENOL-D's unique characteristics (acoustic, thermal, strain, and magnetic) and their interactions. Applications for this high-power ultrasonic transducer include devulcanization (recycling) of rubber with National Feedscrew and Machinery in Massillon, Ohio, which has technology to recycle ground rubber from scrap tires into reusable rubber compounds. This would allow the potential recycling of the 250 million tires discarded annually in the United States. Another application of the high power ultrasonic transducer is the treatment of plant seeds, which could improve yield and germination and increase U.S. food exports by $600 million annually. Additional applications range from polymerization to high-quality crystallization initiation in pharmaceutical processing.

연구과제명 : (97-01-0025) Critical Components for Process Control in Microelectronics Manufacturing
회사명 : On-Line Technologies, Inc.
연구분야 : Microelectronic Fabrication Technology
연구기간 : 4.1년
전체연구비(추정) : $2,884,573.00
ATP 지원금 : $1,297,677.00
연구요약 :
Led by On-Line Technologies, a small Connecticut maker of measurement instruments, this joint venture will develop integrated tools and methods for closed-loop control of a key semiconductor-manufacturing process. The semiconductor industry has identified closed-loop control as an essential capability, necessary to efficiently produce chips with more and ever smaller devices and to improve the overall effectiveness of manufacturing equipment. Initially, On-Line and its partners--the ADE Corp. (Westwood, MA), Advanced Fuel Research (East Hartford, CT), Applied Materials (Santa Clara, CA), and the Massachusetts Institute of Technology (Cambridge, MA)--will focus on the process for fabricating epitaxial silicon. This exacting process yields the precisely oriented, sandwich-like arrangement of different materials that forms the substrate for integrated circuits. The partners plan to develop and integrate non-contact sensors, algorithms, and other critical components necessary for in-line, wafer-by-wafer control. This would be a major improvement over the industry's current practice of set-point control and off-line sampling, which incurs a 2 to 4 percent reduction in process capacity and delays in detecting problems, sometimes requiring large batches of wafers to be scrapped. The joint venture will seek to apply and evaluate a promising optical method for

measuring resistivity, a critical processing variable that has proven difficult to measure with non-destructive methods. Technical challenges include integrating the prototype non-contact sensor for measuring resistivity with others for measuring the thickness and uniformity of epitaxial layers and incorporating the sensors into an on-line measurement tool, which could operate as a stand-alone instrument or as part of a cluster of fabrication equipment. Researchers also will develop algorithms for evaluating measurements of multiple process variables and controller software for modifying process recipes. Risks include the possibility that the accuracy of the modeling may not be adequate, given the process complexity, achieving an integrated thickness and resistivity system with the ruggedness, speed, and accuracy needed for industrial applications will be difficult. The new technologies will be tested on a semiconductor manufacturing line at Texas Instruments. Augmented with other sensors, the underlying closed-loop technologies could be adapted to many other semiconductor manufacturing processes and to materials other than silicon. The increase in tool productivity as a result of On-Line Technologies' close-loop control technology could be worth $800 million per year in capital cost and probably an equal amount in operating cost.

연구과제명 : (97-01-0034) New Zeolite Synthesis Technology
회사명 : Chevron Research and Technology Company
연구분야 : Catalysis/Biocatalysis
연구기간 : 3.0년
전체연구비(추정) : $2,690,416.00
ATP 지원금 : $1,722,200.00
연구요약 :
Zeolites are materials that feature three-dimensional crystalline structures, uniform pore dimensions, and internal cavities of regular size and shape. These materials are often used as catalysts in petroleum refining and petrochemical processes because their structure permits only certain types of molecules to enter and constrains the chemical reactions that can take place. Zeolites offer advantages over conventional catalysts, which are often hazardous and can have lower activity levels and shorter lives. While the use of zeolite catalysts has definite advantages, their current production has a number of disadvantages, including environmental, that could limit the ability of catalyst manufacturers to deliver the low-cost catalysts needed for refining and petrochemical processes. Chevron has discovered a potentially new manufacturing process for zeolites. If successful, it will substantially lower the cost and cycle time for zeolites and zeolite-containing catalysts and will have significantly less environmental impact than current manufacturing methods. Commercialization of this new technology would lead to the availability of advanced zeolites of improved performance which would otherwise be too expensive to produce by existing methods. The new manufacturing process also has the potential of enabling the discovery of new zeolite materials with unusual and important properties and new applications. The estimated, total potential value to the U.S. economy of this new technology is $2.5 billion per year, counting new refining and petrochemical sales as well as the potential

applications for zeolites in other areas.

연구과제명 : (97-01-0038) Advanced Transgenic Model Systems for Biomedical Research and Development
회사명 : Genencor International, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology / Animal and Plant Biotechnology / Bioprocessing/Biomedical Engineering
연구기간 : 2.5년
전체연구비(추정) : $4,776,382.00
ATP 지원금 : $2,000,000.00
연구요약 :

The lack of a cure for many human diseases is due in large part to the absence of an appropriate model system for preclinical studies and the testing of novel drugs and therapies. Animals are often inappropriate model systems because many human disorders are specific to human pathogens or tissues. For example, allergies are rooted in the genetics and immune response of the host, and infectious diseases such as AIDS have species-specific virulence factors. There is an urgent need to develop useful small animal models of human disease. Genencor proposes to establish a model system by engineering a transgenic mouse that supports the normal function of human stem cells, self-renewing cells in the bone marrow that mature into the cellular components of blood. The currently available animal models are made by transferring human stem cells or mature lymphocytes into naturally occurring strains of mice with weakened immune systems, but these fail to support normal human cell function. Instead, Genencor proposes to use transgenic mice with functional properties of a human immune system. The technical challenges of the project involve transferring the proper mix of genes for human factors into a single strain of mice, establishing the functional development of human immune cells, and demonstrating utility of the model in testing industrial and pharmaceutical products. If successful, the advanced transgenic mouse model could accelerate the development of safer household and personal-care products, highly effective drugs, and new gene and transplant therapies. The potential impact (direct and indirect) on the U.S. economy is estimated at almost $7 billion annually. Genencor is especially interested in the design of novel industrial enzymes with reduced allergenic potential.

연구과제명 : (97-01-0067) Fundamental New Strategies to Discover Drugs
회사명 : Isis Pharmaceuticals
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $6,378,000.00
ATP 지원금 : $2,000,000.00

연구요약 :
The current strategies for drug discovery are fundamentally limited by the rate that chemicals can be designed, synthesized and screened for biological activity. A radical new technology is needed to circumvent the major bottlenecks in drug discovery. The technical challenges to be overcome in creating this radical new approach include the development of powerful new methods that will not only assemble compounds but also select the best ones to synthesize. Other challenges include the development of synthesis methods and instruments to make the targeted compounds 100 times faster than is currently possible and the development of an assay system that uses highly sensitive, high-resolution mass spectrometry for high-throughput drug screening. Isis will work with the University of California at San Diego and Irvine, Protogene (Palo Alto, CA) and IonSpec (Irvine, CA) to integrate computational methods, synthetic chemistry, automation, and rapid screening to permit the evaluation of up to 15 million compounds per year and dramatically accelerate drug discovery. The initial application of Isis' new technology will be to discover new classes of antibacterial compounds to combat the growing problem of drug-resistant bacteria. Isis proposes to develop potent antibacterial drugs through systematic exploration and disruption of critical microbial cellular functions that are essential to the life cycle of drug-resistant bacteria and that represent novel targets for drug discovery. Isis' goal is to produce promising drug candidates for clinical trials in two years. The worldwide market for antimicrobial agents is $20 billion. It is estimated that a significant portion of these costs is associated with the use of multiple drug regimens and long hospital stays. The company estimates that its novel compounds that promise simpler treatment could have the potential to reduce U.S. healthcare costs by over $2 billion annually. The technology developed in this project can also be used to design new drugs for treating other conditions.

연구과제명 : (97-01-0087) Building a Future Database
회사명 : Continuum Software, Inc.
연구분야 : Computer Systems and Software Applications
연구기간 : 3.0년
전체연구비(추정) : $1,663,525.00
ATP 지원금 : $1,163,525.00
연구요약 :
Businesses keep records and databases because it's vitally important to know what has happened in the past. However, it's equally important to know what's going to happen in the future. That is why Continuum Software proposes to build databases of future events. Continuum's project meshes elements of "data mining"--the sifting of huge amounts of existing data such as sales records to pick up subtle patterns--and modern machine learning tools for predictive analysis. Several techniques exist to predict future trends based on data mining, but they generally require experts in artificial intelligence and machine learning. Continuum is developing software tools that use a new and unique application of machine learning called

"Projective Visualization" to analyze huge amounts of warehoused data, even when the records in that warehouse are often incomplete, and predict the future behavior of not just individual variables but groups of variables : essentially predicting future database records. Business managers then can use their existing database tools--tools they are familiar with and that already have been tailored to their needs--to analyze these future records. The project involves several risky unknowns : for example, the amount of data needed for reasonable predictions may be too huge to process practically, and the kinds of data stored in typical business databases (e.g., transaction records) may be too limited for useful predictions. The project also will develop a graphical interface to simplify the development of the basic knowledge models used by the Projective Visualization technology. The value to U.S. industry of data mining has been demonstrated in the marketplace--one application in the credit-card industry saved 12 times the development costs in a single year. If successful, the Continuum technology will enable an entire class of powerful new data mining tools for market analysis and business simulations.

연구과제명 : (97-01-0092) A Non-intrusive Method for Intelligent Process Control of the Densification of Powder Preforms During Electroconsolidation
회사명 : Superior Graphite Company, Inc.
연구분야 : Intelligent Control
연구기간 : 3.0년
전체연구비(추정) : $2,309,895.00
ATP 지원금 : $1,997,150.00
연구요약 :
Composites, intermetallics, and other advanced engineered materials offer performance advantages over conventional materials used in everyday products, but high manufacturing costs largely limited them to specialized applications in aerospace, defense, and sports-equipment markets. The Superior Graphite Company proposes to refine a promising--but still experimental--near-net-shape manufacturing process that has the potential to make advanced materials cost competitive for large-volume applications. Anticipated advantages include shorter cycle times and lower capital and production costs--due in part to the ability to densify complex-shaped parts directly without the costly process of "canning," which is associated with current net-shape processing techniques such as hot isostatic pressing. In addition, the process will be able to make parts from a wider variety of materials because it achieves substantially higher temperatures, without the auxiliary heating furnaces that other hot consolidation processes require. The research challenge is to meet ever more demanding dimensional and material-property specifications of industry. This requires automated process control, based on a scientific understanding of how varying conditions influence changes in a part's shape and density during consolidation, particularly with regard to temperature and pressure. Conventional temperature sensors and pressure transducers within the die would affect the conditions being measured and are impractical with internal temperatures of 2000-3000 C. Instead, Superior

Graphite will develop a mathematical model to predict the distribution of temperature and compacting pressure within a die chamber, eliminating the trial-and-error testing for each production run. Modeling work will be integrated with an evaluation of experimental approaches to measuring the interrelated characteristics of a densified component. With Bio-Imaging Research Inc., Argonne National Laboratory, and Northwestern University, the company will evaluate X-ray imaging and non-intrusive sensing techniques for measuring variations in conditions and for monitoring dimensions of a part throughout the process. The process will be tested by several manufacturers. Success could translate into as much as $2.5 billion in abrasion-resistant wear parts, cutting tools, high-temperature fasteners, and other structural components currently made by a more expensive means or with a less costly but inferior material.

연구과제명 : (97-01-0135) Simple, Generic, and Low-Cost Genetic-Based Tools for Disease Detection, Monitoring, and Intervention
회사명 : Third Wave Technologies, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 2.0년
전체연구비(추정) : $4,093,399.42
ATP 지원금 : $2,000,000.00
연구요약 :
Efforts to prevent disease rather than simply treat it after onset are limited in part by a shortage of low-cost diagnostic tools. Third Wave proposes to fill this gap by developing new generic technologies based on its proprietary family of natural and engineered Cleavase enzymes, which perform unusual functions on genetic material. These enzymes target genetic material based on its physical structure, whereas the standard but still-costly methods of genetic analysis focus on chemical sequence. Based on its finding that the physical structure accurately reflects the chemical sequence, Third Wave has used Cleavase enzymes to develop simple, low-cost assay platforms to detect mutations and quantify specific genetic sequences for research purposes. The company now proposes to develop generic Cleavase-based tools appropriate for healthcare applications, such as large-scale treatment monitoring, with an aim toward eventual point-of-care testing. Key challenges include developing methods for detecting and quantitating large numbers of target genes that exist in very low numbers without expensive instruments and facilities. To overcome these challenges, the company plans to expand the recognition capabilities of existing enzymes, discover new enzymes, explore the potential of Cleavase enzymes for disease management, and simplify the process of analyzing assay results. The proposed technologies would be used to measure viral loads and high or low numbers of micro-organisms, detect mutations, identify links between genomes of different organisms, and monitor gene expression. The company believes Cleavase technologies will capture substantial shares of the markets for research and clinical reagents and that the ripple effects to the economy could create up to 25,000 new jobs over the next decade. By helping to shift the

paradigm for medical care from post-symptomatic treatment to cost-effective preventive screening and intervention, the technologies could substantially reduce U.S. healthcare costs. Other applications include cost-effective diagnosis of disease in plants and animals.

연구과제명 : (97-01-0193) A National Knowledge Infrastructure
회사명 : Cycorp, Inc.
연구분야 : Computer Systems and Software Applications
연구기간 : 3.0년
전체연구비(추정) : $3,069,367.00
ATP 지원금 : $1,640,000.00
연구요약 :
One of the steepest barriers to realizing the full potential of computers to enrich and simplify our lives is that they don't know the millions of things that we assume "everyone" knows, such as that most people sleep at night, or that infants can't drive cars, or that you can't be in Dallas and Chicago at the same time, or that you can't be as old as your mother. However, it is possible to represent such knowledge in ways that computers can use it. Cycorp will work on this task and will develop software tools that conduct clarifying dialogues to zero in on what the user intends. Together, this tool and the underlying knowledge base should enable the average person to express their requests in plain English and to better have those requests served. For instance, online text searching programs often return a huge number of irrelevant matches with an unknown, unseen, but equally large number of missed opportunities that are never located. Even a small degree of understanding of the query and the material being searched through can eliminate the vast bulk of those false positives and false negatives. Within the nation's evolving information infrastructure, Cycorp proposes to build the foundation elements of a "widely held information layer," or WHI : a large reference ontology along with interface and inference tools that allow people to interact with this repository of knowledge, comment on and extend it, and have it deduce new conclusions for them from it. The company will use Cyc--the large and growing common sense knowledge base begun in 1984--and its CycL representation language as the starting points. Cyc is already the largest knowledge base in the world, but it must be expanded even more to attract and justify the efforts of other organizations and individual software developers. In part, this will entail integrating other ontologies, most of which are highly specialized, into the WHI. Cycorp's goal is to provide a catalyst and "jump start" an assortment of bottom-up, third-party efforts to bring knowledge-based applications to market. The technical challenges include developing multiple means of expressing the same idea without sacrificing efficiency, accommodating divergent viewpoints without getting tangled in contradictions, as well as defining the hundreds of thousands of basic terms and millions of basic rules that make up an adequate core on top of which others can build. In the near term, tools developed by Cycorp with ATP support can be of use to almost any firm struggling to integrate multiple databases, a market that is forecast to grow to $21 billion by the year 1999.

연구과제명 : (97-01-0222) High Performance ASIC Technology for Digital Signal Processing
회사명 : Athena Group, Inc.
연구분야 : Other Information/Computers/Entertainment
연구기간 : 3.0년
전체연구비(추정) : $2,274,149.00
ATP 지원금 : $1,859,669.00
연구요약 :

Digital signal processing (DSP) increasingly underlies such technologies as communications, multimedia computing, consumer electronics, biomedical instrumentation, and industrial and military electronic systems--it has become a $3.4 billion industry. The demand for higher performance DSP devices in smaller packages and at lower cost exceeds the capabilities of current technology. The algorithms employed in the widely used DSP microprocessors rely heavily on multiply-accumulate operations. Mathematicians have suggested that algorithms that use the mathematics of the residue number system (RNS) can handle these operations better than those used in existing DSP microprocessors. The Athena Group Inc. (Gainesville, FL) plans to use circuit designs based on RNS mathematics to address the need for advanced DSP. Working with VLSI Technology Inc. (San Jose, CA), a manufacturer of application-specific integrated circuits (ASICs), the Athena Group will address the technical challenges to develop standardized components (cells) that take advantage of RNS and that can be combined with other standardized components to produce application-specific DSP devices. A key challenge in this project is to create RNS-based algorithms (which at present are complex and difficult to use) that are user friendly. Athena also plans to develop an appropriate computer-aided design environment for using the standard components. The company expects that the technology will offer an up to tenfold increase in speed over conventional DSP technology in one-third of the chip area and at approximately half the cost. Potential applications include ultrahigh-speed communications over bandwidth-limited phone lines and radio channels, and high-resolution, full-motion medical imaging devices.

연구과제명 : (97-01-0226) Measurement Technology for Quantitation of the Complete Human Proteome
회사명 : Large Scale Biology Corporation
연구분야 : Bioinformatics
연구기간 : 2.5년
전체연구비(추정) : $3,012,856.00
ATP 지원금 : $1,995,256.00
연구요약 :

Swiftly improving methods of genetic analysis are producing abundant data describing the estimated 100,000 human genes. However, drug development and other commercial applications of these data are limited by a shortage of information about gene function, specifically the expression (production) of proteins. Human proteins exist in the body in widely varying amounts and have highly diverse functions and properties--and new technology is needed for their comprehensive detection and quantitation. Large Scale Biology Corporation proposes to develop the technology needed to build a database of all human proteins--one that encompasses as many as 300,000 proteins and represents all cell types, tissues, and protein forms and classes of abundance. The company proposes to develop novel methods of increasing sensitivity and dynamic range for protein detection by 2-DE to span the estimated eight orders of magnitude separating the most and least abundant proteins in human tissues. These advances will build on LSB's recent work in automating 2-DE (funded by a previous ATP award) that, combined with increased detection, will enable the creation of comprehensive, quantitative databases of protein expression in normal, diseased, and therapeutically treated samples. Prototype databases--one containing the 20,000 most abundant proteins detected in 50 human tissues and two containing tissue-specific proteins--are planned as part of the project. These databases would provide medical researchers with a means to detect quantitative changes in proteins associated with disease and drug effects. The pharmaceutical and biotechnology industries are rapidly moving toward drug development based on genetic code. The impacts of this project could include substantial improvements in the rate of discovery of new therapeutics and greater probability that those drugs survive safety testing and reach the market. These developments will ultimately result in decreased medical costs, improved health, and increased productivity resulting from decreased illness.

연구과제명 : (97-01-0240) Evolution of a Murine Model for AIDS : Applications to Discovery of Small Molecule and Vaccine Therapeutics
회사명 : Maxygen, Inc.
연구분야 : Animal and Plant Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $2,155,853.00
ATP 지원금 : $1,999,943.00
연구요약 :
The effort to combat AIDS is running into a host of obstacles, one of which is the cost and difficulty of testing promising therapies and vaccines. Medical science has long tested new medicines in animals before using them in humans, and the primates now used as the animal model for AIDS are expensive to obtain and maintain. A small animal model would be less expensive and would accelerate AIDS research and testing. Mice offer a possible model but until recently could not be infected with the HIV-1 virus, which causes AIDS in humans. The recent discovery of molecules that act as co-receptors for HIV-1 has enabled the infection of mouse cells that are genetically engineered to produce those molecules. However, the virus still will not replicate in mouse cells in a manner that causes disease. Maxygen proposes to develop a variant of HIV-1 that will replicate and cause disease in transgenic mice bred to produce key co-receptors. The company will pursue various methods of evolving the virus. The challenge is

to achieve sufficient genetic mutations to enable HIV-1 replication in mouse cells but not so many that the value of the model is compromised. In addition to testing existing HIV-1 isolates, Maxygen will use a proprietary technique called DNA shuffling, or molecular breeding, which is effective in changing genetic traits that require many mutations. Libraries of novel recombinant HIV-1 strains will be constructed and their activity examined in tissue culture cells and transgenic mice. A weakly replicating virus will be mutated further to enhance its virulence. The market for an effective mouse model for AIDS would be large : More than 120 medicines and vaccines for AIDS and related diseases are now in clinical development. If successful, the project will reduce the human suffering and economic cost (currently approximately $2 billion per year) wrought by AIDS by accelerating the discovery, reducing the costs, and improving the quality of new therapies and vaccines. In addition, if DNA shuffling proves to be a feasible approach in the AIDS arena, the generic technology then could be applied to other medical needs, such as the development of a small animal model for hepatitis C and design of gene therapies.

연구과제명 : (97-01-0244) Optical Maximum Entropy Verification (OMEV) Technology for Anti-Counterfeiting

회사명 : Physical Optics Corporation

연구분야 : Electronic Instrumentation/Sensors and Control Systems

연구기간 : 3.0년

전체연구비(추정) : $2,323,620.00

ATP 지원금 : $1,109,957.00

연구요약 :

Pushing beyond the practical limits of optical technology, the Physical Optics Corp. aims to develop a potentially foolproof antidote to forgery and product counterfeiting, now estimated to cost the U.S. economy more than $80 billion annually. To accomplish this objective, POC first must extend industrial state-of-the-art capabilities in the critical areas of statistical optics, pattern recognition, optoelectronic packaging, signal processing, manufacturing, and software. POC's approach is based on a novel technology system that it calls Optical Maximum Entropy Verification (OMEV). As envisioned, the laser-based system will randomly generate patterns with micrometer-sized features, a feat difficult to achieve outside the laboratory. These patterns will be embedded in one-of-a-kind random-phase masks, which serve as templates for product labels. The authenticity of product labels is verified by comparing product label with a reference (master mask) in the OMEV optical correlator. Through complex statistical means, correlator and label work in lock-and-key fashion. Because the intricate patterns of masks are randomly generated, odds that labels can be forged are exceedingly slight--less than one chance in 1,000,000,000,000,000,000,000,000,000,000,000, according to POC's calculations. OMEV labels will not contain redundant information, a wedge that opens the door to counterfeiting of holograms; nor will they be reprogrammable, a vulnerability of electronic "smart cards." The complexity of OMEV masks, labels, and keys may foil would-be counterfeiters, but it also presents a variety of process- and market-related challenges. While the system will not accept false labels, for example, it could reject true labels damaged during production. Reliability will be a key issue addressed during the development of a prototype OMEV system. Beyond surmounting significant technical hurdles, POC faces the additional challenge of devising low-cost methods for making key system components so that the technology is affordable for prospective customers, adding only a few cents to the price of their products.

연구과제명 : (97-01-0255) Advanced Magnesium Alloys Production Process (AMAPP) Project Brief
회사명 : Ovonic Battery Company (ECD)
연구분야 : Advanced Materials/Chemicals
연구기간 : 3.0년
전체연구비(추정) : $18,904,388.00
ATP 지원금 : $8,206,088.00
연구요약 :
Nickel-metal-hydride (NiMH) batteries are used in many portable electric and electronic devices and have captured more than 30 percent of the market for rechargeable batteries. Among their advantages, current NiMH batteries store two times more energy and are environmentally superior to lead-acid and nickel-cadmium batteries. Using proprietary approaches, Ovonic Battery, original developer of NiMH technology and a subsidiary of Energy Conversion Devices (Troy, MI), and Manufacturing Sciences Corporation (Denver, CO) propose to develop advanced materials technology for future low-cost, high-energy-density improved NiMH batteries using magnesium-based hydrogen storage materials for the negative electrode. The materials used in current NiMH battery production are rare-earth metals and zirconium alloys, which are more expensive than magnesium. Magnesium is lightweight, low cost, and has superior hydrogen storage capacity, but until now its use in batteries has been prevented by slow hydrogen absorption and desorption at ambient temperatures and the ready oxidation of magnesium alloys. The companies propose to overcome these challenges by developing new thin-film magnesium alloys using a novel rapid solidification process, which will yield materials with special microstructures, and tailored alloy surface properties. In addition to their own capabilities, the companies will use processing facilities at Oak Ridge National Laboratory, the Colorado School of Mines, and Iowa State University. Improved NiMH batteries will help build a U.S. industry base in the rapidly growing rechargeable battery market. Such batteries also will enable the widespread use of sustainable energy systems, such as practical electric vehicles and stand-alone photovoltaic power systems. In addition, a new U.S. industry could be built around the magnesium alloy materials, which also could be used to store hydrogen for use in fuel cells and solid-state heat pumps.

연구과제명 : (97-01-0257) Ultrathin Silicon Ribbon for High-Efficiency Solar Cells Project Brief
회사명 : Evergreen Solar, Inc.

연구분야 : Environmental Technologies
연구기간 : 3.0년
전체연구비(추정) : $3,058,186.00
ATP 지원금 : $1,367,714.00
연구요약 :

Photovoltaic (PV) technology for harnessing the sun's energy has improved steadily over the past three decades and now serves a $1 billion market. However, solar energy systems are still not cost-effective solutions for meeting mainstream power or rural electrification needs in the United States and the developing world because today's PV material, crystalline silicon, is too expensive. Evergreen proposes to develop a manufacturing process that will dramatically reduce the costs of the silicon photoelectronic material and overall PV manufacturing costs. The company proposes to explore an innovative new approach to manufacturing the silicon materials, which involves growing an ultrathin silicon sheet called "String Ribbon" on which the solar cells are made. If this process is to become economical for maintstream power, it is necessary to achieve very thin ribbons with greater widths and higher process speeds than can be done today, while simultaneously achieving high efficiencies. The technical challenges are great and involve such things as achieving extremely precise control of thermal gradients in the silicon as it is formed and cools. In addition, the company plans to develop novel methods for fabricating solar cells with 16 percent efficiency at high yields. The new material technology is expected to cost much less than thick crystalline silicon PV products while retaining the reliability and market acceptance of the traditional PV material. If successful, the project will be an important step toward enabling the U.S. solar industry's goal of $1-per-watt PV module manufacturing costs. The technology would provide, if successful, environmentally friendly, affordable electricity for rural regions and developing nations while helping to reduce global warming emissions. Low-cost, ultrathin silicon also could potentially be used in flat-panel displays in electronic applications.

연구과제명 : (97-01-0259) A Long-Term Pressure-Sensing System for Use in the Human Body and Harsh Environments
회사명 : APEX Medical, Inc.
연구분야 : Electronic Instrumentation/Sensors and Control Systems
연구기간 : 3.0년
전체연구비(추정) : $3,044,983.00
ATP 지원금 : $1,492,041.00
연구요약 :

Heart disease is the primary cause of death in the United States. Half of all Americans diagnosed with heart failure die within five years, partly because heart transplants, the usual treatment for the end-stage of this degenerative disease, are constrained by factors that include high transplant costs and a shortage of donor organs. The availability of a durable, miniature, fully implantable blood-pressure-sensing and monitoring system in association with an implantable artificial pump that would effectively regulate heart function would improve long-term management of heart failure and save lives. APEX and EAST DEVELOPMENT propose to design such a monitoring system that is biocompatible, durable (lasting at least five years), and highly accurate. The system will be used as a component--and could enable the further development--of APEX's concept for a novel left ventricular assist device (LVAD), a wholly implantable heart pump that would offer advantages over commercially available pumps, which tend to be large, heavy, prone to mechanical failure, and conducive to infection. The proposed pressure-sensing system would permit the new LVAD to be physiologically integrated with the human body's blood flow requirements, which vary depending on factors that include physical activity, emotional stress, and the strength of the heart. The implantable system also would remove a potential entryway for infection created by current blood-pressure monitoring technologies, which require catheter-based probes or other invasive entry into the body. Technical challenges include design of a biocompatible system through careful selection of sensing elements, materials, and geometry as well as miniaturization that will be achieved through design of a customized integrated circuit for implantable devices. The worldwide market potential for LVADs is $6 billion to $8 billion annually. The company estimates that 80,000 individuals in the United States could benefit from the proposed LVAD technology. In addition, the new sensing system would have other applications in medicine (e.g., in sensors for kidney-dialysis machines) and industry (e.g., in ultrapure fluid processing techniques used in the semiconductor and dairy industries).

연구과제명 : (97-01-0260) Enhanced Manufacturing Technologies for Bioactive Proteins and Peptides in Transgenic Tobacco
회사명 : CropTech Development Corporation
연구분야 : Animal and Plant Biotechnology
연구기간 : 4.0년
전체연구비(추정):$8,803,664.00
ATP 지원금 : $4,313,796.00
연구요약 :
Traditional pharmaceutical production methods, such as cell cultures and microbial fermentation, continue to be limited by high costs and the difficulty of processing complex, recombinant DNA derived protein products for therapeutic needs. Recently, transgenic plants have begun to demonstrate great potential as cost-effective systems for producing commercially valuable proteins. Plants offer several advantages, including the capacity to process active human proteins and accept foreign genetic material rapidly and efficiently. The joint venture partners propose to refine the technologies needed to use transgenic tobacco as a biofactory for making high-volume proteins, high-value glycoproteins, and bioactive peptides for medical applications. Tobacco was chosen because it has long been a prime laboratory model for plant genetic engineering and

because it has a prodigious capacity for biomass growth, reproduction, and protein production. The project will involve integration of the unique post-harvest transgenic plant expression technology developed by CropTech with Dyax's protein purification system, which utilizes a powerful phage display combinational method for selecting optimal binders for affinity chromatography and purification of proteins. Technical challenges include customizing these systems to suit the demands of a variety of different products, developing a system for appropriate glycosylation of proteins produced by the plant, and developing separation methods for distinguishing proteins with specific structures for use in isolating and purifying the desired therapeutic glycoform. The new transgenic plant-based production systems are intended to be adaptable for many medically important proteins, such as insulin, and are expected to cost much less than traditional methods. This effort will not only reduce the costs of many drug therapies but also enable the development of orphan drugs that currently are too expensive to commercialize. Additionally, the proposed system for isolating and purifying peptides could enable the cost-effective production of a wide variety of bioactive peptides, which constitute a growing share of new drug candidates but are currently difficult or costly to produce. Overall, this project could reduce the costs of producing some drugs by more than 90 percent and provide the basis for a new agricultural industry based on healthful applications of tobacco, a $2.8 billion U.S. crop that underpins the economies of six states.

② Information Infrastructure for Healthcare (6개 과제)

연구과제명 : (97-03-0003) Computer Aided Medical Planning : A New Paradigm in Vascular Intervention
회사명 : ANSYS, Inc. (formerly Centric Engineering Systems, Inc.)
연구분야 : Bioinformatics / Computer Systems and Software Applications / Imaging and Image Processing
연구기간 : 3.0년 (1997년 10월)
전체연구비(추정) : $4,483,050.00
ATP 지원금 : $1,979,437.00
연구요약 :
Vascular disease is the leading cause of death in the Western world, in part because of the difficulty of selecting effective treatments. The complexity of blood flow in the human body makes it difficult for physicians to devise treatments based on past experiences with other patients. Furthermore, there are no tools incorporating models of physiology for use in evaluating the efficacy of procedures for restoring vascular function. Centric Engineering proposes to develop medical planning software that would enable physicians to evaluate vascular patients, identify potential hazards a patient might face, and predict the feasibility and compare outcomes of various treatments--all before beginning treatment. The proposed Computer Aided Medical Planning (CAMP) system combines imaging, bioengineering simulation, and high-performance computing technology. Visual images of the patient's anatomy and physiology will be modeled based on data obtained using ultrasound, computerized tomography, and magnetic resonance

techniques, and the physician will be able to interrogate the model. The CAMP system will require unprecedented simulation capabilities--not merely new functions but rather a redefinition of the simulation environment in terms of presentation of results, user interface, turnaround time, and other features. Specific technical challenges include defining the geometry of blood vessels mathematically, defining boundary conditions for blood flow, modeling the complex material behavior of blood vessels, and extracting relevant physiologic data from computational analyses. If successful, the project will introduce predictive tools into a field largely dominated by diagnostic techniques. The CAMP system will improve vascular treatment, enable consultations with physicians at remote locations, and provide case databases for physician training. The annual market for computational resources for vascular treatments could be as high as $25 billion. The project also would create jobs in medical simulation and potentially lead to the evolution of a new industry comparable in size to the medical imaging industry.

연구과제명 : (97-03-0032) A Master Patient Index (MPI) for Massively Distributed Records Across a U.S. National Backbone
회사명 : Sequoia Software Corporation
연구분야 : Information Technology
연구기간 : 2.0년
전체연구비(추정) : $2,261,608.00
ATP 지원금 : $1,861,450.00
연구요약 :
Computerized patient records promise many healthcare benefits, such as the ready availability of a patient's entire life history, but the advantages are currently isolated within institutions. Existing computerized record systems are usually internal to an organization and cannot be scaled up for use across a broader community. Yet the frequent consolidations and collaborations among healthcare providers are increasing the need to combine and correlate computerized records from different institutions. Sequoia proposes to develop a master patient index (MPI) that correlates and cross-references patient identifiers (e.g., name, birthday, Social Security number) and automatically matches records accurately. Some experimental MPIs have been deployed but experiences with these systems indicate that conventional relational techniques are unable to perform the requisite functions such as modeling, replication and synchronization. Furthermore, there are no standards for linking MPIs among enterprises. Sequoia proposes an alternative architecture for a navigational MPI technology. There are three technical challenges. First, interchange and transport software is needed to move a minimal data set from host healthcare systems to the MPI. The proposed solution involves the use of plain-text files easily generated from any host platform. Second, software is needed to automatically link and retrieve medical records that use different demographic data or criteria to identify patients. Sequoia proposes to adapt matching techniques from the chemical and signal analysis fields. Third, a distributed search and navigation server is needed. Prototype software will be designed and deployed across

a testbed within the Johns Hopkins institutions in Baltimore. If successful, the project could save lives by providing immediate access to summary medical records in emergencies, increase detection of fraud in Medicare and Medicaid programs, reduce the costly duplication of medical tests, and increase provider productivity. The proposed MPI also could reduce paperwork, which accounts for a substantial portion of U.S. healthcare costs. ATP support will accelerate diffusion of the proposed MPI and potentially save billions of additional dollars.

연구과제명 : (97-03-0056) Physician's Assistant for Continuous Transcription and Structure
회사명 : Kurzweil Applied Intelligence, Inc., Division of Lernout & Hauspie
연구분야 : Computer Systems and Software Applications
연구기간 : 2.0년
전체연구비(추정) : $2,504,471.00
ATP 지원금 : $1,885,000.00
연구요약 :
Medical institutions need structured electronic data for a variety of purposes, and the growing interest in computerized patient records has heightened the necessity of capturing clinical information in a consistent and useful way. One barrier to the acquisition of detailed, highly structured clinical data is clinicians' preference for rapid, unstructured approaches to case documentation. To meet the needs of both institutions and physicians, L&H proposes to design and demonstrate the Physician's Assistant for Continuous Transcription and Structure (PhACTS), which will enable clinicians to dictate, in continuous speech, records of their encounters with patients. The automated system will produce not only transcripts but also clinical data for use in computerized patient records. The clinician will navigate through a familiar set of report sections, or topics, and then dictate each section using natural prose. The speech-recognition component of the system will capture and display the words for verification or correction; the use of topic-specific language modeling is expected to enable accurate, rapid function. A medical language extraction and encoding (MedLEE) system from the Center for Advanced Technology at Columbia University will translate the text into a standard and structured format, SGML, which can then be used in clinical databases. The technical challenges are to label unstructured text according to topics, construct language models from the labeled text, design a continuous-speech recognition system that uses many different language models, integrate MedLEE into the on-line system, structure the output in SGML, display the structured output in a comprehensible format, and implement an error-correction process that is acceptable to the user. The project will contribute to the development of speech-recognition systems through user independence, lower error rates, and real-time performance. If widely adopted, the PhACTS is expected to reduce the $6.6 billion spent on medical transcription annually, potentially reduce the costs of malpractice insurance, and support the implementation of computerized patient records. In addition, the technology could be used for structured data entry in other fields where structured data are required, such as law enforcement and aircraft maintenance.

연구과제명 : (97-03-0061) RxInfo : Data Mining Tools for Assessing the Impact of Pharmaceutical Therapies on Population Based Healthcare Outcomes
회사명 : CHIME-Inc.
연구분야 : Information Technology
연구기간 : 3.0년
전체연구비(추정) : $3,041,908.00
ATP 지원금 : $2,000,000.00
연구요약 :

As the U.S. healthcare industry strives to provide improved care at lower costs to an aging population, new methods are being sought to control costs. One technique for containing costs is the continued evaluation of new drug therapies that might reduce the onset and degree of costly medical problems. The Connecticut Healthcare Information Management and Exchange (CHIME) proposes to develop cost-effective "intelligent" systems for the direct evaluation of drug therapies by clinicians and researchers. The system would be based on the 1.4 million patient years of clinical experience accumulated annually in databases at hospitals and healthcare facilities. The technical challenge is to link raw clinical data to patient histories that are categorized by clinical episode, flagged for errors and missing data, loaded into a fast and low-cost computing resource, and evaluated using professional expertise. Development of such a system is especially difficult in the healthcare arena for many reasons : The data are not currently collected and coded consistently or linked to patient histories or clinical episodes, outcome measures are not coded in the data, and huge amounts of data will need to be processed to produce near-real-time response. The project will take advantage of the clinical patient data warehouse located at CHIME and rely on computer scientists and data-mining experts from Yale University and major pharmaceutical companies. Tools will be developed for large-scale, low-cost, real-time access of data; integration of data into patient histories and disease episodes; identification of data patterns and creation of disease templates; interpretation of data patterns; and automated analysis of drug therapies. The system will be inexpensive because it will use otherwise-idle computing resources during the night. A testbed will be created to evaluate the system using large volumes of clinical data. If successful, the project will improve clinical decision making and reduce administrative costs and healthcare expenses.

연구과제명 : (97-03-0081) MEDassist : A Generalized Component-Based Technology to Serve as a Foundation for Decision Support Systems
회사명 : Datamedic
연구분야 : Information Technology
연구기간 : 3.0년
전체연구비(추정) : $2,756,557.00
ATP 지원금 : $1,748,242.00

연구요약 :

Little is known about how individual clinical decisions are made and how one medical practice compares to another. Yet the need for clinical data and its interpretation at the point of care is now greater than ever before as healthcare organizations seek improved ways to manage care and costs as demands grow for measures of provider performance. Education of practitioners, coupled with process change supported by computer systems, has been shown to help achieve compliance with clinical protocols. But most current decision-support systems focus on a single type of clinical event and have not been used for ongoing collection of high-quality data sets. Datamedic proposes to develop a computing infrastructure for real-time decision-support systems that will reduce healthcare providers' deviations from prescribed clinical guidelines and protocols. The company already has technology for the automatic collection of clinical data and will now move beyond raw data to the dissemination of knowledge. The MEDassist project will be based on five components : an "inference engine" that will interpret codified guidelines to identify departures from these guidelines; an alert manager for presenting alerts and analyses to the user; a real-time data integrator; a data-integrity module to support the collection of consistent, complete, and validated core data; and language for describing disease-specific or operational guidelines. There are many technical challenges, including representation of codified guidelines in a way that will enable real-time monitoring of them and the design of an alert manager that does not interfere with or delay clinical decision making. MEDassist will be tested in field trials at a number of American Oncology Resources clinical centers and compared to standard educational interventions. The technology will improve the compilation and analysis of extensive clinical data sets and enable clinical studies that have not been possible to date because of the high cost of collecting the necessary data. The project also will provide tools for monitoring and controlling practice variations and collecting error-free data. The combined annual savings resulting from improved compliance with guidelines, improved data collection, and increased provider knowledge is estimated in the hundreds of millions of dollars.

연구과제명 : (97-03-0083) Pre Op The Pre-Operative Decision Support System
회사명 : HT Medical Systems, Inc.
연구분야 : Information Technology
연구기간 : 2.0년
전체연구비(추정) : $3,632,446.00
ATP 지원금 : $1,999,595.00
연구요약 :

Healthcare providers are under continuing pressure to contain costs while also maintaining or improving the quality of care. One way to accomplish both objectives is to reduce the invasiveness of surgical procedures, an approach that provides clear economic benefits through shortened hospital stays and also reduces trauma to the patient. However, the transition to minimally invasive surgery requires the development of methods for evaluating candidates for these procedures, selecting appropriate medical devices, training physicians, and supporting remote consultations and access to on-line reference material. To help meet these needs, HT Medical Systems proposes to design a virtual reality system that will enable physicians to use patient-specific data for diagnosis, selection of medical devices, rehearsals for operations, and remote consultations. The Pre-Operative Decision Support System (PreOp(TM)) will integrate three-dimensional data from medical imaging hardware with physics-based computer models of medical devices to create a patient-specific virtual environment for planning, rehearsals, and training. The system will encompass a tactile feedback device that can replicate the "feel" of medical instruments and also record motion, so that a procedure can be practiced before being performed in actual surgery. The technical challenges include the modeling of medical device dynamics, development of methods for integrating patient data into a real-time simulation system, design of the tracking and feedback robotics technology, and construction of a tool for creating digital patient records. Because minimally invasive medical devices (e.g., catheters) are typically made of wires, the computer modeling technology will need to accurately represent the physics of wire dynamics. PreOp(TM) is expected to improve the quality of medical decisions and physician training; reduce the incidence of surgical complications; and permit continued reductions in the invasiveness of surgical procedures, thereby reducing surgical costs and risks. The project also could expand significantly the market for medical simulation systems.

③ Component-Based Software (6개 과제)

연구과제명 : (97-06-0005) Certifying Security in Electronic Commerce Components
회사명 : Reliable Software Technologies Corporation
연구분야 : Information Technology
연구기간 : 3.0년 (19997년 10월)
전체연구비(추정) : $2,358,378.00
ATP 지원금 : $1,978,178.00
연구요약 :
Many mainstream businesses are using the Internet to distribute information and to pursue electronic commerce, but concerns about the security of private information have hindered the growth of electronic commerce. Electronic commerce over the open Internet has the potential to radically expand the market for software components and to eliminate barriers to software distribution, expanding the market in available components and reducing barriers to entry for new component vendors; however, the Internet also involves security risks. Current encryption approaches secure the data transmission medium while leaving the server and client software communicating over that medium potentially vulnerable. Hackers can attack the relatively unprotected software at either end of a transaction rather than the relatively secure link between them. Security is not typically addressed during software development. Reliable Software Technologies proposes to move security analysis from ad-hoc penetrate-and-patch methods to a rigorous, mathematically sound methodology. RST will implement this methodology in testing

technology for assuring the security of software components used to build Internet-based commerce applications. While the proposed methodology and testing technology will be generally applicable, this project will focus initially on components for the Java framework which has received broad acceptance from the distributed and network software development communities. The proposed security certification pipeline would integrate various component-testing tools and processes (e.g., fault injection to determine the effect of program corruptions on security) and analysis of system-level interfaces to determine whether a failure in one component will corrupt other components. The key technical challenges are to develop broadly applicable rigorous analysis methods, implement these in tools, and integrate these tools into a mathematically sound comprehensive security testing process. The company will build a prototype environment for testing complete systems. Once a component is tested and found to meet minimum thresholds, a "stamp of approval" would be issued in the form of a digital signature, which would assure a user that no alterations had been made since the security certification. If successful, the project will pave the way for growth in electronic commerce. Even if electronic commerce fails to attain the projected annual market of $100 billion or more, the direct and indirect benefits of software security are estimated at $10 billion annually.

연구과제명 : (97-06-0008) Business Object Component Specification, Generation and Assembly
회사명 : Data Access Technologies, Inc.
연구분야 : Information Technology / Computer Systems and Software Applications
연구기간 : 2.25년
전체연구비(추정) : $2,649,450.00
ATP 지원금 : $2,000,000.00
연구요약 :
Businesses need to constantly transform themselves to remain competitive in a rapidly evolving global marketplace. Current information technology, which is needed to support the modern enterprise, can impede such transformations because software technologies have not improved to keep up with the required rate of change and enterprise integration. Rapid assembly of business software components is a potential solution, but no technology currently addresses the full range of component-based business application requirements. Data Access Technologies proposes to develop and validate technologies for "business objects" as components of information systems based on Distributed Object Computing (e.g., CORBA-IIOP Internet, Active-X). The proposed architecture, tools, and infrastructure could enable interoperable, reusable, portable software objects to be distributed across the enterprise in an environment that reduces the cost and complexity of information technology solutions. Data Access Technologies' advanced "Business Object Architecture" will include semantic information about the business element implemented in the object, provide an open-standards-based infrastructure that hides complexity, and produce business solutions composed from finer-grain reusable components. The technical challenges of the project include the development of an integrated semantic model (i.e., the set of descriptions

that quantifies an abstract concept) and specification mechanism for business components; a method for automating the generation of components from semantic specifications; a method for automating the assembly of large-scale business components (i.e., applications) from smaller units; and a standards-based infrastructure for enterprise-wider component integration and deployment over broad-based distributed networks (i.e., the Internet). The combination of a semantic specification for business objects, automated generation and an open, flexible distributed application architecture will dramatically improve productivity in provisioning business solutions. To achieve broad industry acceptance, Data Access Technologies has joined with other industry leaders to submit the projects technology baseline to the Object Management Group (OMG) as part of its business object standardization efforts. The use of business object components could deliver a 10 to 1 productivity improvement over current business software practices, potentially providing over $100 billion in direct and indirect benefits to U.S. industry.

연구과제명 : (97-06-0023) A Programmable Framework Based on Semantic Modeling Components
회사명 : Synquiry Technologies, Ltd.
연구분야 : Information Technology
연구기간 : 3.0년
전체연구비(추정) : $4,062,001.00
ATP 지원금 : $2,000,000.00
연구요약 :
Synquiry proposes an innovative approach to the far-reaching challenge of developing a basic technology framework to support a commerce in software components. While pieces of the puzzle have emerged in recent years--the Java virtual machine, for example, provides a model for basic mechanical interconnection of components--the overall goal remains elusive. A fundamental obstacle, Synquiry argues, is that while technologies may exist to build modular software constructs, traditional programming paradigms result in components in which the semantics of the application are intimately threaded throughout the code. The tight coupling of semantics with component gets in the way of attempts to build generic components that can be automatically combined to build many quite different applications. The key technical challenge is to create a radically different structure in which semantics are largely uncoupled from the processing code. The approach is to split the problem into three constructs : independently defined models that capture the semantics of a particular application, model-independent applets that contain the processing code, and generic links providing access to the content to process. The processing applets and especially the semantic models, which are inherently customizable, will offer rich opportunities for vendors to develop specialized constructs for a component software market. The proposed system will allow application users to handle for themselves many tasks now requiring trained programmers - development, customization, and maintenance - tailoring applications to their specific business needs with dramatic improvements in productivity and quality.

연구과제명 : (97-06-0032) Component-Based Commerce : The Interoperable Future
회사명 : Commerce One, Inc. (formerly VeoSystems)
연구분야 : Information Technology
연구기간 : 2.25년
전체연구비(추정) : $10,155,543.11
ATP 지원금 : $4,800,000.00
연구요약 :
The Internet is an ongoing explosion of resources--documents, databases, services, even software applications. Internet commerce is forecast to be a major driver of the U.S. economy within five years, but today's digital anarchy threatens that growth. While the Net has rich resources, they are, like diamonds, hard to find and arduous to extract. Web pages, designed by and for people, are individualistic - each with its own format and interface to the resources it offers. The companies in this joint venture propose to apply the concepts of component-based software to the developing infrastructure of Internet commerce, creating tools to enable non-programmers to assemble innovative business applications and services by linking together Net resources as components in a seamless whole. The Net as a whole is becoming increasingly unwieldy for people to use, but too unpredictable for machines to understand. The technical challenges include creating a means of transforming existing Internet services and resources into "components" that can be integrated without the custom programming now required; building an extensible, semantic-based framework for integrating components in new applications; creating a scalable, distributed system for registering and indexing available components, so they can be found; and building an execution environment that provides software agents with basic services such as authentication, directories, billing, payments, and translation. If the ATP project is successful, the consortium members propose to create a joint venture to further develop and market the resulting technology. Based on industry studies, CommerceNet estimates that the market for successful products based on this project could reach $1 billion by the turn of the century, enabling a $50 billion to $100 billion market for Internet commerce. The joint venture also includes BusinessBots (San Francisco, CA), CommerceNet (Palo Alto, CA), and Tesserae Information Systems, Inc. (Palo Alto, CA).

연구과제명 : (97-06-0037) MirrorBall : A Component Infrastructure Initiative
회사명 : Sterling Software, Inc.
연구분야 : Information Technology
연구기간 : 3.0년
전체연구비(추정) : $2,467,200.00
ATP 지원금 : $1,591,100.00
연구요약 :
Component-based software is gradually gaining acceptance in the marketplace. Recent years

have seen the development of a number of tools or programming languages for building reusable components, as well as an increasing number of available components. Even within this environment, however, much of the work of application development - deciding on the basic structure of an application program, selecting components, integrating them into the whole - is done "by hand and at high cost." Sterling Software will develop the high-level tools needed to realize the full potential of component-based software development. Specifically, they will develop tools to create a high-level "pattern language" that facilitates the description and reuse of basic program structures and the relationships between components; tools to support formal specifications for components to facilitate the selection and evaluation of compatible components for specific tasks; and techniques to specify program architectures that facilitate the integration of components. The project also includes the development of prototypes to demonstrate the feasibility of these techniques in practical program design. Success in this project will result in tools to help ensure U.S. dominance in the component software market, which is projected to grow to $7 billion worldwide within five years.

연구과제명 : (97-06-0038) Debugging Component-Based Software for Enterprise Systems
회사명 : Averstar, Inc. (formerly Intermetrics, Inc.)
연구분야 : Computer Systems and Software Applications
연구기간 : 2.025년
전체연구비(추정) : $2,670,166.00
ATP 지원금 : $1,665,419.00
연구요약 :
Software and systems are increasingly built of components that are assembled and integrated to serve a specific function in the enterprise. The assembled components both now and in the future will be heterogeneous; written in different languages including Java, C and C++, using different object models including Java Beans, COM+ and Corba, and will continue to embrace valuable legacy systems. Complexity increases as multiple processes execute locally and remotely using diverse hardware, operating systems, and different network protocols. No tools are available for debugging software and systems that are assembled from heterogeneous components. The dynamic nature of the application development market makes it difficult for competing vendors to invest in debugging tools when product functionality is still driving the evolution of their products and, frequently, the viability of their companies. However, Intermetrics estimates it is worth $1 billion to the U.S. economy over a five-year period to deliver debugging tools that can dramatically increase developer productivity, improve the reliability of the resulting systems, and shorten the delivery time of component-based software and systems. Intermetrics proposes to develop a tool for quickly detecting and debugging incompatibilities in distributed, software components. The tool will take advantage of information captured during component development, so that programmers will be able to focus on anomalies in component behavior and interaction instead of details of each component supplier's

framework. This message-based debugging aspect of the tool will display message traffic among software components in a variety of useful ways, including application-specific viewers. Messages will be captured by software "probes" placed at key points to intercept, interpret, display, and play back messages sent by the components. The most technically challenging aspect of the Intermetrics tool is automating the placement of the probes and enabling creation of the application-specific viewers by interpreting semantic knowledge of components captured during their development.

④ Motor Vehicle Manufacturing Technology (10개 과제)

연구과제명 : (97-02-0004) Technology for Gear Performance Prediction Utilizing High-Speed Precision Measurement
회사명 : M&M Precision Systems Corporation
연구분야 : Manufacturing(Discrete)
연구기간 : 2.5년 (1997년 10월)
전체연구비(추정) : $2,053,490.00
ATP 지원금 : $1,378,890.00
연구요약 :
Gears are essential to controlled power transmission in moving mechanisms such as motor vehicles, aircraft, and household appliances. Described in technical terms as toothed wheels that transmit uniform angular velocities between rotating shafts, gears are known more generally as expensive components that power a huge business : Gear products for one car cost about $1,000 and the U.S. market for gears is nearly $21 billion. Gear making has improved over the years but with continuing manufacturing problems. In particular, geometric anomalies and elastic deformations of gear teeth continue to lead to vibration and noise problems in automobile transmissions, the interior of helicopters, and other applications. M&M Precision Systems proposes to develop a capability to measure gear teeth accurately and relate any gear manufacturing errors to the resulting vibration and noise. Software would be developed to enable the automatic prediction of transmission errors that would result from generic manufacturing error patterns. The proposed system would be more precise than current gear-testing methods, which are somewhat uncertain in that gears can conform to existing metrology standards but still exhibit transmission errors when assembled. No systematic method is currently available for identifying the cause of the problem in these cases. M&M proposes to design a high-speed sensor system for rapid measurement of gear teeth and prototype software for predicting vibration and noise-generating properties. The technical challenge is to create a measurement system that is at once accurate, rapid, and precise. If successful, the project will improve gear performance in the U.S. automobile industry, increase the speed of quality-assurance measurements, and eliminate the need for expensive processing. Gear costs could be cut by as much as 50 percent. These advances could increase sales of American cars. Other potential markets for the technology include the heavy equipment, mining, appliance, shipbuilding,

aerospace, robotics, and defense industries.

연구과제명 : (97-02-0014) Manufacturing Agility Server
회사명 : Flavors Technology
연구분야 : Manufacturing(Discrete)
연구기간 : 3.0년
전체연구비(추정) : $2,521,968.00
ATP 지원금 : $1,987,614.00
연구요약 :
The failure of a single robot in an automated manufacturing cell can force an entire production line to stop, even though other robots on the line could fill in for the failed device. A software system that could dynamically reassign operations along a production line would lower the cost of automotive body assembly and have an impact on other types of manufacturing as well. Flavors Technology, Inc. (Manchester, NH) and its subcontractors propose to develop a systems architecture, based on a manufacturing agility server (MAS) and autonomous software agents, that would permit manufacturing operations to be reassigned dynamically to similar manufacturing equipment. MAS would receive status information from the network of device controllers within a manufacturing cell or along a production line. If a device fails or is unavailable because of maintenance, MAS would reassign the task. Conventional approaches to reconfiguring manufacturing processes, such as classic optimization schemes, are not used in practice due to their extensive calculation requirements and extreme sensitivity to process dynamics. In contrast, MAS would rely on the interaction of independent software agents--software objects that are a spinoff of artificial intelligence research--that can respond to events independently. Such a system could also support dynamically reconfigurable production lines. Once the core MAS technology is developed, it will be tested in a simulated production environment and ultimately will be integrated with the control systems of an automotive assembly line. Within the U.S. automotive industry, MAS technology could significantly increase welding-line productivity, reduce vehicle time-to-market, and improve vehicle quality.

연구과제명 : (97-02-0015) Next Generation Agile Fixturing System
회사명 : Lamb Technicon Machining Systems
연구분야 : Manufacturing(Discrete)
연구기간 : 3.0년
전체연구비(추정) : $2,239,530.00
ATP 지원금 : $1,970,930.00
연구요약 :
Car buyers today are demanding a variety of powertrain options. To meet these demands, manufacturing systems need to produce up to 100,000 distinct parts, a complexity of function

that requires time-consuming and costly changeover of the fixtures used to hold parts for the critical machining process. The fixtures used in all high-volume machining systems today are dedicated, meaning they are unique to each part. This is the primary barrier to the implementation of fully flexible machining systems, which are needed to enable manufacturers to reduce the cost of product variation, vary supply to meet changing demands, and move new products to market quickly. Lamb Technicon proposes to develop an agile and "intelligent" fixturing system for high-volume machining operations. In the proposed system concept, a fixture will be reconfigured automatically to service any part presented. After a part is secured in the flexible clamping system, a locating system will identify the position of the part rapidly and accurately. Any misalignments will be corrected before the part is machined. Modeling software will be developed to verify that a fixturing system is capable before it is used. The key challenge is to integrate complex equipment into a high-volume manufacturing system that must produce accurate parts reliably for up to 24 hours a day. The "Big Three" automakers (Chrysler, Ford, and General Motors) will specify system needs and requirements and evaluate the results of the project. If successful, the project will reduce capital investment costs for auto part machining systems by millions of dollars annually. Savings of up to $18 million per machining system are possible. In addition, machining costs would be reduced by $30 to $50 per vehicle, new products could be marketed more rapidly than before, and new products could be produced for niche markets. The technology also could reduce machining costs in other industries, such as aerospace, image processing, and defense.

연구과제명 : (97-02-0018) Flexible Robotic Assembly for Powertrain Applications (FRAPA)
회사명 : Automated Powertrain Assembly Consortium (c/o NCMS)
연구분야 : Manufacturing(Discrete)
연구기간 : 4.0년
전체연구비(추정) : $7,520,659.00
ATP 지원금 : $3,726,610.00
연구요약 :
Manual assembly of automotive powertrain components is a repetitive process that presents the risk of injury to workers and the risk of misassembly. Automation of this process, in the form of a flexible assembly workcell designed for such applications as gear meshing of heavy transmission components, would eliminate these risks. Previous efforts to perform automated assembly using conventional serial robotic manipulators that were instrumented for force compliance were not adequate to these tasks. To achieve this level of automation successfully, the Automated Powertrain Assembly Consortium, consisting of the Ford Motor Company (Dearborn, MI), Perceptron Inc. (Plymouth, MI), Progressive Tool and Industries Company (Southfield, MI), MicroDexterity Systems (Memphis, TN), and the National Center for Manufacturing Sciences (Ann Arbor, MI), plans to develop new approaches to manipulator design, three dimensional spatial location of objects, and manipulator control that allow the cell

to emulate human manual dexterity, touch, and vision. The consortium will adapt a parallel-controlled, low-inertia robotic manipulator with high stiffness and accuracy of position for use with a three dimensional vision system. After developing the manipulator, its controller, and force-and vision-perception systems, the consortium will construct a prototype cell for evaluation. The consortium predicts that such technology could save the automotive industry more than $120 million a year and could be readily applied to the farm machinery, railroad transportation, and defense industries. The enabling technologies alone would increase U.S. market share in both the world machine vision and robot mark.

연구과제명 : (97-02-0027) Low Cycle Time Liquid Molding Process for Automotive Structural Components
회사명 : Stewart Automotive Research, LLC
연구분야 : Automobile Manufacturing
연구기간 : 3.0년
전체연구비(추정) : $2,310,882.00
ATP 지원금 : $1,998,782.00
연구요약 :
Despite their light weight and high strength, composite materials (hybrids of two or more materials) are rarely used in structural parts for automobiles because of quality control problems and the difficulty of achieving high performance at affordable costs. Stewart Automotive Research (SAR) proposes to develop a manufacturing process and associated software package to produce composites that are cost competitive with steel and will help pave the way toward a new class of ultra-lightweight vehicles. SAR plans to make the parts by infusing a fibrous preform with a highly reactive resin using a proprietary process called Zoned Pressure Molding (ZPM), which provides active control over resin flow and thereby improves quality control. The preform is placed in a hard tool and resin is distributed across its surface before infusing down through the part. The distribution is rapid because, unlike conventional liquid molding processes, the resin does not need to flow through the preform to reach the perimeter of the part. As a result, highly reactive resins can be used, shortening the curing cycle to as little as 90 seconds and enabling the formation of very large parts with inexpensive tooling. Technical challenges include the development of tough, heat-resistant materials (e.g., fiber-reinforced plastics or elastomers) for use in the upper mold surface. Computational Mechanics Co. and Rice University will provide flow modeling and materials testing expertise. Other challenges include programming the flow control equipment to achieve the desired flow over and through the preform. A cost-effective simulation tool will be designed to model this process. ZPM promises order-of-magnitude reductions in equipment, tooling, and design costs. If successful, the project could transform the design of automobiles by maximizing the performance of inexpensive reinforcing materials. The new materials and processes would reduce vehicle weight and the number of parts needed.

연구과제명 : (97-02-0028) Sub-Micron Precision Grinding of Advanced Engineering Materials
회사명 : Cummins Engine Company
연구분야 : Manufacturing(Discrete)
연구기간 : 3.0년
전체연구비(추정) : $5,587,200.00
ATP 지원금 : $2,786,800.00
연구요약 :
Manufacturing diesel engines that emit reduced levels of pollutants requires the use of advanced materials such as ceramics and metal-matrix composites at tighter dimensional and surface-finish specifications. But manufacturing processes can account for 70 percent of the cost of ceramic engine components. For these materials to become commercially viable, industry needs to reduce the contribution to the cost of manufacturing engine components made by machining these materials to sub-micron tolerances. Cummins Engine Co., Goldcrown Machinery (Cincinnati, Ohio), and Cincinnati Milacron (Cincinnati, Ohio) have formed an alliance, the Sub-micron Precision Grinding Team, to develop innovative grinding processes and equipment to meet these needs. The team will test new methods of truing a grinding wheel (creating the precision form on the wheel) and of dressing the wheel (removing non-abrasive material to expose abrasive particles), and will investigate additional technologies to make the grinding of ceramics cost effective--such as grinding several components from a single ceramic bar. Among the technologies to be developed are innovative grinding wheels, a new coolant filtration system, a laser truing system, and sensors and algorithms for truing. The project will evaluate advanced materials for diesel applications, develop the technologies into prototype grinding machines, and integrate the technologies developed by the team to produce a grinding system for testing on the shop floor. Sub-micron precision grinding will allow improved engine reliability, domestic production of engine fuel systems, and domestic production of a new generation of machine tools and related products for the world market.

연구과제명 : (97-02-0041) Motor Vehicle Rapid Toolmaker
회사명 : Sanders Prototype, Inc.
연구분야 : Manufacturing(Discrete)
연구기간 : 2.0년
전체연구비(추정) : $2,496,077.00
ATP 지원금 : $1,989,565.00
연구요약 :
Over the past 10 years, rapid prototyping machines have strengthened the capability of U.S. automakers to shorten production cycles. However, existing processes lack the 0.1 percent accuracy and resolution needed to make the tooling for production of new vehicles. Sanders Prototype proposes to develop a low-cost tool-making machine and associated processes to rapidly produce plastic, ceramic, and metal tools for use in automobile manufacturing. The

proposed process, which would be accurate enough to make tools for injection molding of parts, would transform three-dimensional (3D) computer-aided-design (CAD) files into accurate master patterns for tools that could be built in days. The Motor Vehicle Rapid Tool Maker (MVRTM) would use a precision plotter to position a jet to deposit small drops of a "build" material consisting of a thermoplastic material or a slurry of ceramics or powdered metal. Another jet would deposit a wax that would serve as the "support" material for part bracing and fine definition. Then the model would be trimmed to the desired height and dipped into a solvent to melt the wax. The resulting pattern of "build" material would be converted to a metal tool through an investment casting or sintering process. The technical challenges include building rapid, accurate jetting systems for fine and bulk deposition of material; designing a ceramic slurry for making ceramic tool patterns; designing a powdered-metal slurry for making metal tool patterns; and development of a software system to process the 3D CAD models. Technical support will be provided by materials scientists at the University of Michigan and Penn State University. The MVRTM could produce a rocker arm for an automobile engine in 3 hours, one-tenth the time required using an existing rapid prototyping machine. Moreover, the new system would produce parts with a superior surface finish and cost far less than similar machines do today. Other potential markets for the MVRTM include the electronics, appliance, aerospace, and medical industries.

연구과제명 : (97-02-0047) Nanocomposites New Low-Cost, High-Strength Materials for Automotive Parts
회사명 : Dow Chemical Company
연구분야 : Advanced Materials/Chemicals
연구기간 : 5.0년
전체연구비(추정) : $15,849,983.00
ATP 지원금 : $7,756,992.00
연구요약 :
Requirements for increased fuel economy in motor vehicles demand the use of new, lightweight materials, typically plastics that can replace metal. The best of these plastics are expensive and have not been adopted widely by U.S. vehicle manufacturers. Nanocomposites, a new class of materials under study internationally, consist of traditional polymers reinforced by nanometer-scale particles dispersed throughout and may present an economical solution to these problems. In theory, these new materials should be easily extruded or molded to near-final shape, yet provide stiffness and strength approaching that of metals--but at reduced weight. Corrosion resistance, noise dampening, parts consolidation, and recyclability all would be improved. However, producing nanocomposites requires development of methods for dispersing the particles throughout the plastic as well as efficient parts manufacturing from such composites. Dow Chemical Company plans to develop the technologies necessary to make nanocomposite materials cost effective, and - together with joint venture partner Magna International (Southfield, MI) - show that these materials can be used economically for

production of automobile front and rear systems. The project will investigate various approaches to producing nanocomposites. The widespread use of nanocomposites by U.S. vehicle manufacturers could save 1.5 billion liters of gasoline over the life of one year's fleet of vehicles and reduce related carbon dioxide emissions by more than 5 billion kilograms. These materials are likely to find use in non-automotive applications such as pipes and fittings for the building and construction industry; refrigerator liners; business, medical, and consumer equipment housings; recreational vehicles; and appliances.

연구과제명 : (97-02-0053) Real-Time Active Balancing for High-Speed Machining
회사명 : BalaDyne Corporation
연구분야 : Manufacturing(Discrete)
연구기간 : 3.0년
전체연구비(추정) : $2,936,487.00
ATP 지원금 : $1,984,113.00
연구요약 :

High-speed machining processes--in which spindles rotate at 40,000 revolutions per minute or more--promise dramatic improvements in machining productivity and precision, leading to improved surface finishes and simplified designs that could greatly reduce the weight and cost of automobiles and other products. But many of these promises remain unfulfilled because of practical limits on machining speed. Even minor imbalance or misalignment of tools and tool holders at high rotational speeds can result in excessive vibration, which causes bearing damage, broken tools, and poor surface finish. Balance problems are currently handled off-line in an ad hoc manner. Balance Dynamics proposes to develop real-time vibration control technology for high-speed machine tools used in automobile manufacturing and for rotating machinery in other applications, such as high-speed turbomachinery and aircraft turbine engines. The proposed technology would enable real-time on-line precision mass balancing after automatic tool exchanges and during changes in operating conditions, so as to provide upstream vibration control quickly (within 1 second) in multiple locations as needed. There are several technical challenges. One is to devise a way to estimate, analyze, and control the structural dynamics in rotating high-speed machinery. The University of Michigan will provide support in this area. A machinery fault warning and diagnosis system will be designed. In addition, a mass balance actuator device needs to be designed that can tolerate high temperatures, high centrifugal forces, and rapid angular acceleration. Methods for attaching the balancing system to rotating machinery will be developed. New bearing technology also will be needed. The proposed real-time active balancing system would enable companies to reduce downtime and safety hazards, extend bearing and machinery life, and increase the quality and precision of parts for automobiles and other products. Benefits to the U.S. economy are estimated at hundreds of millions of dollars annually, including reductions of up to 90 percent in auto part machining time and $125 million in annual savings realized through reductions in in-flight shutdown of aircraft engines.

연구과제명 : (97-02-0055) Development of the 3D Printing Process for Direct Fabrication of Automotive Tooling for Lost Foam Castings
회사명 : Extrude Hone Corporation
연구분야 : Manufacturing(Discrete)
연구기간 : 3.0년
전체연구비(추정) : $6,362,180.00
ATP 지원금 : $3,170,536.00
연구요약 :
The automobile industry increasingly uses aluminum engine components to reduce weight and energy consumption in its vehicles while controlling manufacturing costs. But the mechanics of making and assembling cores and molds for conventional casting has limited the designs that could be cast. The process of lost foam casting, in which a Styrofoam pattern immersed in dry sand becomes a metal casting as hot metal vaporizes the plastic foam, allows automotive companies to cast cylinder heads with the complex geometries required for modern internal combustion engines. Although this technique produces cost reductions of 20 to 60 percent, the cost of producing the tools to create the foam patterns is high and changes in tooling take substantial amounts of time. Extrude Hone and the General Motors Powertrain Group plan to develop three-dimensional printing process (3DP)(TM) techniques to produce the tooling that is used to make the Styrofoam patterns. The 3DP process will allow prototypes to be built up automatically, layer by layer, from a mathematical model. In addition to process development, the companies will develop the computer systems required to go directly from a parts design database to production of the tooling. Finally, a prototype machine for tooling production will be installed at a General Motors site to simulate its actual use. The partner companies expect savings from the earlier introduction of new products, the reuse of sand in the casting process, and increased accuracy of casting. The techniques developed for powertrain components also could be adapted for the manufacture of turbine components and in the creation of new materials such as metal "foams."

⑤ Digital Data Storage (5개 과제)

연구과제명 : (97-04-0003) Multiple Optical Recording Enhancements (MORE)
회사명 : National Storage Industry Consortium (NSIC)
연구분야 : Computer Hardware
연구기간 : 4.0년 (1997년 100월)
전체연구비(추정) : $21,189,142.00
ATP 지원금 : $10,383,135.00
연구요약 :
Imagine having a miniature personal library that could store thousands of professional-quality,

high-resolution digital photographs or a television set top box that can record and play back several hours of high definition television (HDTV) content. Such devices are not yet possible because of limitations in current technologies for data storage and data transfer. The joint venture partners, including Calimetrics, Inc. (Emeryville, CA), Energy Conversion Devices, Inc. (Troy, MI), and Polaroid Corporation (Cambridge, MA), propose to develop a synergistic combination of innovative technologies and processes that will enable such applications while also providing a market advantage for the U.S. data storage industry. The team will develop DVD-compatible write-once and rewritable phase-change optical disk media and drive systems with 10 times the capacity and up to five times the data transfer rate of writable DVD (digital versatile disks) systems that are coming to market soon. In addition, the partners propose to extend innovative manufacturing processes to reduce substantially the cost of media for optical disks. The project will combine four evolving technologies : Calimetrics' multilevel technology, which uses custom integrated circuits and specially written disks to increase data capacity and transfer rate; ECD's phase-change optical recording materials, which are used in rewritable DVD media; Polaroid's optics technology, which increases storage density per unit area and signal-to-noise (SNR) ratio; and Polaroid's versatile low-cost media processing approach. The technical challenges include the development of new coding and signal processing techniques to maximize disk capacity and performance; engineering of the media microstructure to support adequate SNR; and the use of special materials and processes to keep manufacturing costs down and control disk properties such as rewritability. The University of Arizona and Georgia Institute of Technology will provide support in optics, materials science, information coding, and signal processing. If the project is fully or even only partially successful, the proposed systems will be useful in government, business, entertainment, and other applications. The nation would benefit from additional engineering and manufacturing jobs, increased exports of related technologies, and market advantages for U.S. software and multimedia companies.

연구과제명 : (97-04-0007) Integrated Vacuum Lubrication System for Hard Disks
회사명 : Intevac, Inc.
연구분야 : Computer Hardware
연구기간 : 2.5년
전체연구비(추정) : $1,461,970.00
ATP 지원금 : $738,788.00
연구요약 :

The data-storage density of hard disk drives is increasing 60 percent annually, the result, in part, of dramatically reduced flying height, or spacing, between the read/write head and the magnetic disk. For this progress to continue, flying heights will have to be reduced to the point of pseudo-contact, but this will require significant improvements in the lubrication of the magnetic media. The protective topcoat, typically carbon, must be made thinner to permit closer spacing between the head and the magnetic layer. The lubricant film that is applied over the carbon must effectively reduce starting friction and minimize wear under increasingly difficult operating conditions--and with only a microscopically thin layer, approximately 30,000 times smaller than the thickness of a human hair. Moreover, the production process must apply this film with great consistency from disk to disk over long manufacturing runs and an acceptable cost. Current production processes will not be able to meet these goals because of the deposition process, in which lubricant is applied by dipping or spraying the disks in atmosphere. The carbon layer begins to oxidize, and other contaminants bond to the disk surface before the lubricant can be applied. The degree of contamination affects the extent and quality of the lubricating film from disk to disk, decreasing disk yield, decreasing reliability, and increasing manufacturing cost. Intevac proposes to apply lubricants through vapor deposition while the disks are under vacuum. The vacuum keeps the disks free of oxidation and contamination while the lubricant is applied. The proposed novel technique will lubricate up to 600 disks per hour and has the potential for maintaining the current rate of production, while substantially improving the lubrication quality, uniformity, and disk to disk variation, reducing the manufacturing cost. The technical challenges include the deposition of lubricant rapidly but without contaminating the other materials in the disk, and the application of a thin film that will function for five years and exhibit a "self-healing" property in which the lubricant flows into and replenishes the area depleted by head-disk contact. The deposition rate needs to be consistent with the rate for the previous layers of material, so disks can be processed continuously. Process improvements like this are necessary to achieve the 10 gigabits of data per square inch that will be needed by the year 2000 to maintain the 60 percent growth rate. If successful, the project will help U.S. companies maintain dominance in a rapidly growing, highly competitive industry. The market for hard disk drives is expected to reach $60 billion by 1999.

연구과제명 : (97-04-0010) Trainable Digital Logic A New Approach to Increasing Data Storage Density on Magnetic Media
회사명 : Neural Systems Corporation
연구분야 : Information Technology
연구기간 : 2.0년
전체연구비(추정) : $1,269,979.00
ATP 지원금 : $999,979.00
연구요약 :

All digital storage systems need to process noisy, distorted signals to decode the retrieved messages. Currently, noise and distortion are adequately dealt with, but as technology advances and systems are pushed to their limits, noise and distortion will increasingly degrade performance. Increasing data densities create distortion that conventional electronics cannot handle without increasing bit error rates (BER), the probability that a bit is received in error. The sensitivity of the signal processor to variations in the time required to process data also is increased. Neural Systems proposes to demonstrate the feasibility of a signal processing technique that will significantly increase data storage density and transfer rate, while reducing costs. The technique is based on a neural network concept. The company's trainable digital logic (TDL) pattern-recognition technique is simpler and faster to implement than competing signal processors and, as a further advantage, does not make simplifying assumptions about the sources of signal distortion (intersymbol interference, or ISI, is only one source). TDL works by recognizing distortion patterns and rapidly correlating them with the appropriate bits. The company plans to "train" the TDL to overcome ISI and then apply critical-timing circuitry to address the channel timing issue. Direct comparison with the best current technology will be made, and it is expected that TDL will improve performance substantially. Ideally, a chip would be designed that could be programmed for use by every disk drive manufacturer. Neural Systems also plans to demonstrate that TDL can be implemented economically. The technology could increase the U.S. share of the magnetic and possibly optical disk storage markets. In addition, similar technology might be used to increase channel capacity in cable television networks and other communications applications. Other applications are possible in the healthcare industry as well as the military.

연구과제명 : (97-04-0019) Continuous Low-Cost Manufacturing System for DVD
회사명 : Energy Conversion Devices, Inc. (ECD)
연구분야 : Other Continuous Manufacturing(Pulb/Paper, Textiles)
연구기간 : 2.0년
전체연구비(추정) : $5,915,653.00
ATP 지원금 : $1,979,777.00
연구요약 :
Current manufacturing processes for optical memory disks limit the efficiency of production. Optical memory disks such as CD-ROMs are produced by batch injection molding, followed by vacuum coating of reflective and/or recording layers, and spin coating of protective layers. The introduction of high-storage-capacity digital versatile disk (DVD) technology, which can store seven times more data than a comparable CD-ROM, has the potential to broaden the market for optical memory disks, if they can be manufactured at faster rates and lower cost than existing disks. Such improvements in manufacturing may be achieved by producing DVD disks in a continuous roll instead of as individual molded disks. Energy Conversion Devices, Inc. (Troy, MI) proposes to apply its expertise in roll-to-roll vacuum manufacturing and phase change materials to develop a process technology that both formats and coats DVD disks as part of a continuous, low cost manufacturing system. The major technical challenges are the technology to emboss the substrate continuously and coat thin films in a series of high-rate vacuum deposition chambers, ending in deposition of a protective film. Other challenges that the company will address include the development of multi-layer media with two recording surfaces. Successful development of this technology would allow the United States to be a major competitor in the production of the new-format optical disks, in contrast to existing foreign company domination

of the field. The near-term market for DVD media is expected to grow to $2 billion. If this project is successful, the process technology will increase the throughput of a single production line by ten-fold while offering quick turn around and reducing the unit manufacturing costs of DVD-ROM by a factor of two to four. In addition to their use in consumer electronics and computer storage, inexpensive DVDs would have a major impact on the photographic industry and storage of X-ray data and other medical records. Low-cost DVD-ROM disks would allow for the economical distribution of multimedia magazines and periodicals.

연구과제명 : (97-04-0020) Enabling Technology for a Digital Video Optical Tape Recorder of High-Resolution Motion Imagery
회사명 : LOTS Technology, Inc.
연구분야 : Computer Hardware
연구기간 : 2.5년
전체연구비(추정) : $10,900,000.00
ATP 지원금 : $5,400,000.00
연구요약 :
Digital High-Definition Television (HDTV) will replace the current analog TV transmissions in the United States by early in the 21st century. To support this metamorphosis, affordable digital recorders will be needed that offer the recording quality, performance, and features required for professional video production. Annually, these videotape and video recorder products amount to a $2 billion market in the United States. This joint venture led by LOTS Technology, Inc. (Sunnyvale, CA) includes Avid Technology, Inc. (Tewksbury, MA), EMC Corporation (Hopkinton, MA), Lucent Technologies (Murray Hill, NJ), and Polaroid Corporation (Cambridge, MA). The project proposes to develop next-generation systems with the technology required to produce affordable, digital optical tape recorders and erasable (i.e. reusable) optical tape. Existing uncompressed HDTV recorders are too expensive--at $400,000 each--for most commercial video organizations to buy and maintain, and costs can be reduced only through novel technologies and approaches. Whereas competing technologies are based on digital enhancements of magnetic tape, this ATP project focuses on optical tape, which offers a number of potential advantages, including high-rate recording, increased capacity per cartridge, reduced media costs per recorded hour, longer storage capability, greater damage resistance, and faster data access. Technology development is required to overcome various challenges, including : achieving high data rates to record and play back uncompressed digital video; developing a compression algorithm that limits fidelity loss to enable the efficient transmission of "contribution quality" video between studios via standard telecommunication channels; incorporating "erase capability" into an optical tape recording head; designing a long-lasting tape cartridge; and electronically implementing the "trick modes" (e.g., slow, pause, etc.) available in current video recorders. A dual-reel tape cartridge for quick data access and a multichannel, laser-powered optical head will be designed. If successful, the project will improve the performance and lower the cost of HDTV video media

and recording equipment.

⑥ Technologies for the Integration of Manufacturing Applications (6개 과제)

연구과제명 : (97-05-0006) Virtual Reality Telecollaborative Integrated Manufacturing Environment (VRTIME)
회사명 : Searle
연구분야 : Information Technology
연구기간 : 3.0년 (1997년 10월)
전체연구비(추정) : $2,622,145.00
ATP 지원금 : $1,650,000.00
연구요약 :
Current research on integration for manufacturing industries focuses on the control of shop floor activities. Less effort is devoted to addressing integration of manufacturing operations with facility design, training, and startup. Searle, the pharmaceutical subsidiary of Monsanto Co., proposes to create and demonstrate the basic technologies needed to apply virtual reality (VR) techniques to the design and integration of new facilities, including training and startup or recommissioning of existing facilities. VR software is used widely in entertainment and for display of battlefield situations, medical procedures, aircraft cockpit environments, and vehicle design. Current industrial VR systems are limited to stand-alone applications without cross-platform networking capabilities. Searle's proposed open-architecture simulation system addresses the integration challenges of combining VR, telecollaboration (the combination of telecommunications with integrated collaboration), and simulation in a heterogeneous computing environment. The resulting advanced applications will include remote telecollaboration among factory designers, reviewers, and site master planners. The network design will enable the use of geographically dispersed computer systems with different operating systems and software, linked in such a way that all sites can be immersed in the same view. The technical challenges include the integration of simulation tools through a common interface; development of robust methods for characterizing manufacturing activities, data, processes, and communications; and demonstration of distributed, autonomous software. The company will create a VR object library, interfaces, and algorithms to facilitate object retrieval and data transfer. Support will be provided by the Industrial Virtual Reality Institute at the University of Illinois-Chicago. If successful, the project could change the way processes are designed and implemented in the pharmaceutical and other manufacturing industries. Annual savings in facility construction and startup costs are estimated conservatively at $735 million in the manufacturing industry alone. The technology developed in the Searle project also would be of strategic value to the United States, which lags European countries in the establishment of VR research centers.

연구과제명 : (97-05-0011) Process Integration Using Model-Driven Engines
회사명 : Vitria Technology, Inc.
연구분야 : Information Technology
연구기간 : 2.0년
전체연구비(추정) : $2,250,000.00
ATP 지원금 : $2,000,000.00
연구요약 :

Supply-chain integration, build-to-order manufacturing, electronic commerce--these and other evolving elements of tomorrow's advanced manufacturing capabilities require extraordinary degrees of integration, coordination, and organizational dexterity. Vitria Technology, a Silicon Valley start-up company, proposes to develop model-based methods that would enable rapid-response couplings of processes and business systems within and across companies. Building on recent progress in coordination science, model-based integration, and other areas, Vitria aims to establish the technical basis for process integration engines (PIE), a new class of software. There are four primary technical challenges addressed by this project : variations in the definition of common processes among businesses, preservation of autonomy across shared systems, resolution of conflicting policies among partners, and communication with multiple data formats and protocols. The project will entail developing a series of models for describing a subset of business and manufacturing processes, integrating and coordinating those processes, and, the highest technical risk, reconciling conflicts in processes and policies within and across organizations. Akin to templates that can be customized to accommodate company-specific procedures, the models will direct the PIE. For a multicompany enterprise, a super-organizational model would be generated to configure the necessary operational links among manufacturing and business systems at each partnering organization. This capability would enable companies to use commercially available software packages for these high-order systems. Firms would not have to contend with software incompatibilities that now confound efforts to link processes, systems, and organizations into the equivalents of plug-and-play corporations. Anticipated benefits include faster and cheaper integration of processes and organizations, greater use of supply-chain management methods, and lower process and software re-engineering costs. Vitria estimates that off-the-shelf process integration engines could reduce software maintenance costs by more than 50 percent. Today, maintenance accounts for up to 70 percent of the cost of owning and integrating software applications. Vitria anticipates that, in addition to manufacturing, the technologies it is developing also would appeal to other large markets, such as financial services, healthcare, and telecommunications. Vitria estimates the potential savings in the manufacturing sector to be as high as $7 billion per year after five years, based on a 15 percent market penetration. Applying the technology to other industries would lead to additional savings.

연구과제명 : (97-05-0018) Agent-Enhanced Manufacturing System Initiative
회사명 : Advanced Micro Devices

연구분야 : Information Technology
연구기간 : 2.33년
전체연구비(추정) : $4,886,368.00
ATP 지원금 : $2,394,319.00
연구요약 :

Semiconductor factories are costly and complex operations, typically making 40,000 wafers at a time in a 300-step process performed by 500 computer-controlled machines. Current generations of factory control systems, based on a centralized "passive" control model with little flexibility, are unable to optimize this manufacturing process. To maintain U.S. leadership in world markets for information technology, computing and telecommunications, the semiconductor industry must address a number of critical challenges in manufacturing technology. These include escalating factory capitalization costs, increasing factory startup time and investment recovery, growing demands on operational effectiveness, and increasing process/factory complexity. Advanced Micro Devices (AMD) and ObjectSpace Inc. (Austin, TX) will address these challenges by researching, developing, and validating an agent-enhanced distributed computing infrastructure for defining, configuring, and deploying autonomous and mobile "software agents" that mimic and improve the functioning of "real world" agents such as factory workers, material, equipment, processes, etc. A software agent can take independent action in response to local conditions, generating adaptable system behavior. This type of "bottom up" control provides better scalability, responsiveness to localized conditions, and handling of complexity than does centralized control. The technical challenges to be overcome include the application of agent software technology to complex manufacturing problems, the simulation of static and dynamic factory conditions, and the design of new software agents. Once developed, the agents will be validated in a simulator and then demonstrated in AMD's state-of-the-art microprocessor wafer fabrication facility in Austin, TX. This approach is expected to extend the capability and lifetime of legacy manufacturing systems, resulting in a much more "active" control system that supports the real needs of the factory in the face of changing market, process, and market requirements. If successful, the project could benefit all companies that make, deploy, or use manufacturing systems in the semiconductor and other industries. The joint venture partners predict a 5 to 10 percent improvement in key manufacturing metrics, including fabrication capacity, equipment effectiveness, and factory startup time, in addition to reduced inventory, costs, and time to market--an impact worth an estimated $300 million-$400 million per year for a typical advanced microprocessor factory. The new technology will also improve productivity and business conditions in the manufacturing software industry. Other potential markets include the electronics, defense and automotive industries.

연구과제명 : (97-05-0020) EECOMS : Extended Enterprise Coalition for Integrated Collaborative Manufacturing Systems
회사명 : IBM Corporation, EECOMS

연구분야 : Information Technology
연구기간 : 3.17년
전체연구비(추정) : $29,658,091.00
ATP 지원금 : $14,680,341.00
연구요약 :
Solving and mastering the complexities of supply-chain integration can pay handsomely. A recent study showed cost savings for top supply chain performance averaging between 3 percent and 7 percent of company revenues. Yet, the changing logistics and contingencies of operating an extended enterprise with its many interacting parts can create process and business snarls of nightmarish proportions. Yesterday's supply-chain solutions may be inadequate for tomorrow's customers or an awkward match for an emerging market opportunity. The greatest challenge in this project is the development of the technology to execute plans and schedules across multiple organizations or enterprise boundaries. Manufacturing execution systems are technically difficult even for the simple case of a single facility (shop floor). Extending this capability to many cooperating sites is very risky, requiring significant innovation. Proposed solutions will incorporate the latest developments in software agents and rule-based systems, among other leading edge technologies. Members of the IBM-led CIIMPLEX consortium--combining manufacturers with small, entrepreneurial software and integration companies--propose to develop and demonstrate intelligent, dynamic technologies for integrating supply-chain planning, scheduling, and execution and enabling the multicompany enterprise to evolve in step with changing circumstances. One practical goal is to create the building blocks of a distributed computing environment that accommodate diversity in the processes, practices, and software of supply-chain members. Another is to develop methods, embedded in executing software, for evaluating supply-chain designs and for facilitating collaboratively made changes in those designs. Business rules will be encapsulated in software objects, and logic programs will check for inconsistencies arising from potential adjustments in supply-chain operations. To support timely resolution of problems, the consortium also will develop "virtual situation rooms" that will enable remotely located partners to manage crises, plan, and attend to other collaborative tasks in a context representative of their roles as members of an extended enterprise. Technologies developed by the joint venture will be pilot tested at manufacturing plants operated by Ingersoll-Rand Co.

연구과제명 : (97-05-0023) Distributed Factory System Framework
회사명 : Consilium, Inc.
연구분야 : Information Technology
연구기간 : 1.49년
전체연구비(추정) : $3,353,000.00
ATP 지원금 : $2,000,000.00

연구요약 :
To meet the demands of customers today, manufacturers need to produce a rapidly evolving mix of high-quality products. Software applications are used to manage product complexity and diversity, short lead times, and automation. The available manufacturing execution systems (MES) have limited flexibility. They restrict the selection of other manufacturing software applications, are costly to integrate with other company systems, and are difficult to modify as products and processes change. Consilium proposes to develop an adaptable, reliable MES that integrates multiple manufacturing applications from different vendors and also can be integrated with other company systems. The proposed system, called the Distributed Factory System Framework, would enable a manufacturer to choose a set of applications and run them together without custom software interfaces. The broad technical challenge is to orchestrate multiple applications so they operate in a coordinated manner (e.g., to track equipment status and collect quality management data and later correlate the information to show the relationship between quality and equipment status). The Framework will consist of software and protocols that coordinate applications by defining a common factory model, planning and scheduling the factory, coordinating the execution of the plan, and providing access to correlated data from multiple applications. Specific challenges include the cost-effective development of a new class of distributed software and the avoidance of excessive complexity in the protocols that might make the applications incompatible. A realistic prototype system will be designed and evaluated. The proposed MES would increase factory output, improve process control and thereby add value to products, and reduce manufacturing costs. Economic benefits are estimated at $8.5 billion annually in productivity enhancements in the semiconductor industry, Consilium's largest market. Additional markets could include the pharmaceutical, aerospace, and defense industries.

연구과제명 : (97-05-0028) ANTS Scheduling and Execution System
회사명 : Deneb Robotics, Inc.
연구분야 : Information Technology
연구기간 : 2.8년
전체연구비(추정) : $2,324,580.80
ATP 지원금 : $1,946,580.80
연구요약 :
Most factory scheduling systems seek the optimum schedule for an assumed stable configuration and cannot react rapidly to changes in resources. Moreover, most are not integrated into a unified system for task monitoring, scheduling, simulation, and execution. Deneb Robotics proposes to improve on existing systems by validating a new task scheduling and execution system in which software agents represent factory resources, systems, and jobs. A software agent is autonomous software code that takes independent action in response to local conditions. Software agents generate flexible, responsive system behavior. The proposed Agent Network for Task Scheduling (ANTS) system would continuously adapt to new conditions rather than simply

finding an optimum schedule, which is meaningless in a dynamic environment. The ANTS system would adjust schedules in line with resources, assist in recovery from faults in the factory and management interruptions in the supply chain, and dispatch work against the schedule, thereby streamlining the flow of material and services from an integrated supply chain. The agents can be upgraded independently as new functions are needed or new algorithms are discovered. The technical challenge is to integrate four prototype technologies : an agent-based symmetrical scheduling architecture (in which all aspects of the factory are represented as agents), market-based mechanisms for agent coordination, algorithms for response to varying demand, and independent scheduling for different parts of the factory. Deneb will develop an infrastructure that can support large
agent communities, algorithms for scheduling and execution, mechanisms for agent-factory interactions, and user interfaces. The system will be validated at a large shipyard. The ANTS system is expected to improve factory throughput, lead time, and agility while also reducing production costs. Potential annual productivity savings for the strategically important shipbuilding industry could be very significant. Other markets for the ANTS system include the aerospace industry, testing laboratories, and medical clinics.

⑦ Tissue Engineering Competition Results (12개 과제)

연구과제명 : (97-07-0001) Combinatorial Cell Culture : Tool Development and Application to Human Stem Cell Growth
회사명 : Automated Cell Technologies, Inc.
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년 (1997년 10월)
전체연구비(추정) : $2,642,260.00
ATP 지원금 : $2,000,000.00
연구요약 :
Bone marrow transplants are becoming more common, creating a need for ex vivo production of human hematopoietic stem cells, the precursors to mature blood cells. Automated Cell Technologies proposes to develop miniaturized, automated cell culturing tools to enable a "combinatorial" approach to cell culturing. The system will include an environmentally controlled containment chamber, a microscope with a digital camera and vision-imaging software, and an automated microfluidics liquid handling system. Key equipment challenges include developing a vision system capable of following the growth and differentiation of individual cells within the multiple-cell plates, an information-intensive data acquisition and management capability that can analyze the imaging data and make media formulation decisions based upon the data, and a robotics system capable of manipulating extensive banks of individual cells on an as-needed basis. The system will automate cell culturing and provide a platform on which to develop a combinatorial approach to the discovery of culture media and cellular pathway information. The system also will provide metabolic and pharmacological data at the individual-cell level (versus

the existing culture technologies that study large cell populations). It will offer the potential to automate the screening of emerging pharmaceutical leads or the testing for drug toxicity against individual cells. The core biological challenge of this project is to use these combinatorial cell culture tools to optimize a growth media for hematopoietic stem cells. The company will work with researchers at the University of Pittsburgh Medical School and Carnegie-Mellon University to develop these tools. The initial tissue engineering target is to apply these mechanical-biochemical-information technologies to develop a method to culture human hematopoietic stem cells that can be used for bone marrow transplantation--a procedure currently costing $150,000 per patient. If successful, Automated Cell Technologies will have created an alternative approach for discovering methods to selectively expand or differentiate cells which can be applied to many areas of tissue and organ replacement. This new technology will be useful for drug discovery, gene therapy, and toxicology testing (perhaps replacing animal testing). If the expansion and development of human hematopoietic stem cells prove successful, this will reduce transplant costs and improve patient quality-of-life for adult bone marrow transplants--a market projected to reach more than $4 billion in the United States by 2000.

연구과제명 : (97-07-0012) Ex Vivo Production of Universal Red Blood Cells and Platelets in a Biocompatible 3-D Tissue Scaffold
회사명 : Cytomatrix
연구분야 : Bioprocessing/Biomedical Engineering / Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $1,818,500.00
ATP 지원금 : $1,318,500.00
연구요약 :
The health of many Americans is threatened continually by the insufficient quantities of safe red blood cells (which perform oxygen transfer in the body) and platelets (which perform blood clotting functions) for transfusions. This multifaceted problem is due in part to the reliance on donated blood and to the need to match the blood types of donor and patient. Moreover, the infrastructure required to collect, screen, store, and distribute blood drawn from volunteers is very costly. Cytomatrix proposes to demonstrate a process for the cost-effective mass production of red blood cells and platelets that are universally compatible. The company's highly porous tissue scaffold, Cellfoam(TM), will be used as a chamber for culturing human stem cells. The project will need to overcome several technical barriers, including the current inability to expand and sustain stem cells and their potency over long periods of time or to support continuous production of cultured cells. Cellfoam(TM) is a three-dimensional lattice structure made of a composite material coated with biocompatible substrates. Early studies have shown that, within the channels of this structure, stem cells can mature while retaining their capacity to form blood cells. The production reactor will have separate compartments for different stages of the blood-forming process. If successful, the project will reduce the costs and increase the

safety of blood transfusions and provide ample amounts of blood components for universal use. The global market for these blood products is estimated at $10 billion in revenues annually.

연구과제명 : (97-07-0014) Three Dimensional Fibrous Scaffolds for Tissue Engineering
회사명 : Ethicon, Inc. (Johnson & Johnson)
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $5,013,000.00
ATP 지원금 : $2,000,000.00
연구요약 :
The use of biomaterials in temporary scaffolds for regenerating human tissues has assumed increasing importance in tissue engineering. However, the products currently used for this purpose do not exhibit the same multi-axial physical and mechanical properties as native tissues, which are hierarchical, three-dimensional structures. Available biomaterials, for example, tend to exhibit inadequate physico-mechanical properties for bone and cartilage. Therefore, Johnson & Johnson proposes : 1) to develop unique families of synthetic, bioabsorbable polymers with controlled resorption times ranging from weeks to years; 2) to develop underlying three-dimensional fibrous scaffolding structures that will provide independent control of the composite's multi-axial physical and mechanical properties (such as stiffness or strength) and allow different regions of such an implant to have different properties, like real tissue; and 3) to develop application-specific materials to optimize cell-fiber interactions. These technologies will allow independent control of the biological and mechanical properties of the implant. Critical to success as a regenerative implant is the ability for cellular growth and differentiation to match the resorption rate of the scaffold. The company will be assisted by Allegheny University Hospital (Philadelphia, PA), Drexel University (Philadelphia, PA), and Applied Product Development, Inc. (Bristol, PA) in areas of three-dimensional fibrous structure, design, and processing; orthopedic and pre-clinical studies; and prototype development and manufacture. For bone applications, the technical challenge is to design scaffolds with adequate stiffness and strength; for cartilage, the challenge is to accommodate the absence of blood vessels and the complex nature of bone-cartilage attachment. The dynamics of cell-fiber interactions and polymer resorption rates will be studied as a means of assessing and optimizing the environment for the maturation of bone and cartilage cells. An integrated engineering design framework will be established, enabling design, analysis, characterization, and manufacturing to be performed concurrently. If successful, the project will provid a reliable source of synthetic scaffolds for use in treating musculoskeletal injuries. More than 32 million such injuries occur annually in the United States.

연구과제명 : (97-07-0017) Development of Tissue-Engineered Vascular Grafts Based on Quantitative Cell and Tissue Biomechanics

회사명 : Advanced Tissue Sciences, Inc.
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $4,562,645.00
ATP 지원금 : $2,000,000.00
연구요약 :
Approximately 70 million Americans have some form of cardiovascular disease, and 900,000 die annually from related complications. Current treatments are often costly, intrusive, and inadequate. To provide a source of living replacement tissue for damaged blood vessels, Advanced Tissue Sciences proposes to design, construct, and evaluate prototype vascular grafts consisting of vascular cells seeded and grown on a biocompatible scaffold. The project will integrate recent advances in biomaterials, quantitative cell mechanics, bioreactor technology, and blood vessel mechanics. The technical challenges involve the selection of appropriate vascular cells and scaffold materials and the design of novel technology for controlling cell growth. Scaffolds need to be designed that support vascular tissue formation, degrade at the appropriate rates, and possess appropriate mechanical properties. Both synthetic and naturally derived biocompatible materials will be tested. In addition, technology that relies on mechanical strain and fluid shear stress will be designed for the precise control of cell growth, differentiation, and matrix synthesis in selected scaffolds. Next, a novel bioreactor will be constructed that provides the mechanical and chemical environment needed to grow three-dimensional vascular grafts by controlling various physical, chemical, biological, and transport processes. Finally, to quantify and evaluate incompatibilities between the engineered graft and native blood vessels, the mechanical and biological function of the grafts will be evaluated in an animal model. The prototype grafts will have uniform cylindrical geometry, structural integrity assured by the alignment of smooth muscle cells and an integrated collagen-and-elastin matrix, and mechanical properties that match those of native arteries. If successfully developed, the vascular graft will have immediate applications in coronary artery bypass surgeries and lead to the development of other engineered vascular tissues, such as replacements for large-diameter blood vessels. The proposed vascular graft will significantly reduce costs in one of the most expensive areas of health care.

연구과제명 : (97-07-0028) Synthetic Nerve Fiber Guides Using Novel Biopolymers and Cellular Adhesion Molecules
회사명 : Acorda Therapeutics, Inc.
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $2,682,685.00
ATP 지원금 : $2,000,000.00
연구요약 :
Injuries to the central nervous system (CNS) have long been considered irreversible. However,

recent laboratory studies have shown that spinal nerve fibers can regenerate and that polymer fibers coated with certain molecules can bridge gaps between nerve cells across regions of scar formation and overcome growth-inhibiting factors in the spinal cord. Building on these discoveries, Acorda Therapeutics proposes to coat polymeric fibers with molecules that mediate nerve cell adhesion and growth as a means of guiding nerve development and promoting regeneration of the spinal cord. Acorda will work with leading laboratories in biological polymers, regeneration studies, and spinal cord injury to design, construct, and test the proposed nerve-fiber guidance system. Unlike competing technologies, the system will be based on detailed analyses of the mechanisms underlying CNS development and will be reproducible, easily handled, and designed to avert an immune response. The pliable fibers will mimic "pioneer axons," nerve cell components that provide critical guidance cues during CNS development. Each fiber will be coated with naturally occurring bioactive molecules that will provide interfaces to guide the growth of injured axons. Synthetic polymeric growth substrates have not been studied extensively to date in models of brain or spinal cord injury. The technical challenges include selection of a polymeric material with appropriate fiber-forming and other characteristics, fabrication of various substrates coated with bioactive molecules, and testing of axon growth activity in a three-dimensional tissue culture that simulates a regeneration environment. Clinical devices then will be constructed and evaluated in animal models of spinal cord injury. The proposed technology could provide a new platform for the development of products with vast medical, social, and economic benefits and potential markets of $90 billion in the United States alone. The initial application will be in treatments for spinal cord injuries.

연구과제명 : (97-07-0038) Development of Immortalized Human Hepatocytes for Therapeutic Purposes
회사명 : Multi-Cell Associates, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology / Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $2,780,265.00
ATP 지원금 : $1,408,140.00
연구요약 :
Liver transplantation, the common treatment for acute or chronic liver failure is limited by the availability of donor organs. During 1996, in the United States alone, over 80,000 patients were diagnosed with liver disease and nearly 1,000 died awaiting transplantation. Extracorporeal liver support, a treatment currently being tested to improve patient survival by "bridging" them to transplant, typically uses pig liver cells to detoxify the patient's blood through interactions across hollow fiber membranes. The use of pig cells for this purpose is costly and may cause several problems, including severe complications related to the human body's immune response. Patient care might be improved if human liver cells could be engineered to replicate and perform the liver's detoxification functions without stimulating an immune response. MultiCell Associates proposes to genetically engineer a line of "immortalized" human liver cells to meet this need. The project exploits recent discoveries that led to engineered immortalized pig liver cells that

combine the functional properties of mature cells (which do not replicate) with the self-replicating properties of immature precursor cells (which perform no functions). The technical challenges involve complex and novel genetic engineering procedures to obtain an adequate supply of adult liver cells, which exhibit appropriate metabolic activity, are not tumorigenic, sustain human liver functions, and which do not cause an immune response. If successful, the project is expected to expand the use of extracorporeal liver-assist devices, for which the worldwide market is estimated at more than $2 billion. The proposed cell line also may be used for liver cell transplant, which could improve the health and survival of patients suffering from chronic liver disease and reduce the need for whole-organ transplants. In another application, the engineered cells could provide alternatives to animal testing of new drugs, potential food additives, and industrial chemicals.

연구과제명 : (97-07-0039) Molecular Approaches to Ice Control for Engineered Tissue Storage
회사명 : Life Science Holdings, Inc.
연구분야 : Animal and Plant Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $2,385,842.00
ATP 지원금 : $1,894,443.00
연구요약 :
A major barrier to the widespread clinical application of tissue engineering is the inadequacy of current methods for long-term storage of living biological materials. Problems associated with cryopreservation (i.e., storage of live tissues at subfreezing temperatures) include ice formation within cells, in the extracellular matrix, and in the spaces within and around the tissues. Tissue viability employing current preservation methods is seldom greater than 70 percent, and chemicals used in cryopreservation may adversely affect cell functions. LRT proposes to develop methods to either control or avert ice formation in preserved tissues. To control ice formation, the company will experiment with combinations of various proprietary compounds, including custom-designed synthetic ice blockers that bond with forming ice crystals. To prevent ice formation, a vitrification process will be designed using high concentrations of chemicals that interact with the water within tissues, resulting in the formation of a glass (i.e., a liquid that is too cold to flow). The technical challenges are to screen the vast number of combinations and concentrations of potentially useful chemicals, develop methods for adding and removing these agents without causing toxicity, and design effective rapid-warming techniques (e.g, electromagnetic warming). The effects of low-temperature storage on the viability and function of cell components will be determined both in vitro and in vivo. The proposed technologies would enable the broad clinical application of tissue engineering, which is expected to help treat conditions that account for approximately half of total U.S. healthcare costs, which exceeded $1 trillion in 1995.

연구과제명 : (97-07-0042) High-Throughput Screening of Hardy Cells for Encapsulation and Implantation Therapies

회사명 : CytoTherapeutics, Inc.

연구분야 : Diagnostic and Therapeutic Biotechnology / Bioprocessing/Biomedical Engineering

연구기간 : 3.0년

전체연구비(추정) : $4,636,868.00

ATP 지원금 : $1,999,600.00

연구요약 :

Implantation of encapsulated cells could provide a mechanism for the sustained delivery of naturally occurring enzymes and/or drugs to localized sites in the body. This approach could avert the side effects associated with systemic drugs delivered through the bloodstream and could overcome difficulties related to delivery of therapeutic agents to the central nervous system. However, broad clinical applications of encapsulated cell therapy have been limited by the difficulty of selecting and engineering hardy cells that survive and perform consistently in an encapsulated environment. CytoTherapeutics proposes to design strategies for rapidly screening and engineering cell lines that can survive and produce therapeutic agents on a long-term basis when encapsulated and implanted in the central nervous system. The project will focus on treatments for neurodegenerative diseases and progressive blinding disorders, not only because the population of aging patients with these conditions is increasing but also because potential new therapies are being discovered rapidly. Potential target sites for encapsulated cell therapy include the cerebrospinal fluid, brain parenchyma, and posterior chamber of the eye. Cell survival in these environments is affected by conditions such as low oxygen levels and inflammation. The company will identify the parameters that determine the survival, stable output, and immunological behavior of encapsulated cells and then screen and engineer human cells derived for specific applications. The therapeutic factors will be genetically engineered into the cells. A computer-controlled "physiometer" apparatus will be built and used to simulate cell behavior in the targeted sites and test conditions and parameters that alter the function and viability of the cells. The capsules will be made of polyether sulfone membranes, which can be designed to permit the diffusion of various types of molecules that influence the function of the enclosed cells. The project could lead to the development of effective therapies for conditions such as Parkinson's disease and diabetic retinopathy, which are currently untreatable or inadequately treated.

연구과제명 : (97-07-0043) Generation of Neural Stem Cell Implants for Neurodegenerative Disease Therapies

회사명 : CytoTherapeutics, Inc.

연구분야 : Diagnostic and Therapeutic Biotechnology / Bioprocessing/Biomedical Engineering

연구기간 : 3.0년

전체연구비(추정) : $4,279,515.00

ATP 지원금 : $1,999,937.00
연구요약 :
The limited capacity of nerve cells (neurons) for self-repair has long been a barrier to treating diseased or injured central nervous system (CNS) tissue. However, the recent discovery of neural stem cells, or central nervous system precursor cells, may provide a basis for restoring function to a damaged nervous system. Stem cells exhibit great capacity for renewal and, under the appropriate conditions, can give rise to several neural cell types, including neurons. CytoTherapeutics proposes to generate banks of human stem cells and identify the environmental factors that stimulate cell growth and differentiation as a basis for repairing diseased or injured CNS tissue. The stem cells will be obtained from human tissue, tested for safety and tumor-forming characteristics, and handled and maintained in an optimal manner to be determined as part of the project. Methods for inducing cell maturation will be identified. The cell lines then will be implanted in animals used as model systems for human diseases. The cell therapy will be evaluated for its effectiveness in replacing the myelin sheath on neurons lost in diseases such as multiple sclerosis, and in replacing the neurons lost in Parkinson's and other neurodegenerative diseases. Many technical challenges will need to be overcome, including difficulties associated with obtaining and maintaining potent human stem cells, administering effective growth factors to cells with appropriate timing, and ensuring stem cell survival and function after implantation. If successful, the project could substantially reduce the costs of neurological disease, estimated at $100 billion annually in the United States alone. The stem cell therapy would provide a basis for restoring neurological function and improving quality of life for the thousands suffering from CNS diseases or injuries.

연구과제명 : (97-07-0047) Xenogeneic Cartilage Transplantation
회사명 : Alexion Pharmaceuticals, Inc.
연구분야:Animal and Plant Biotechnology / Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $4,357,284.00
ATP 지원금 : $2,000,000.00
연구요약 :
Cartilage defects resulting from injury, disease, and advancing age can have a severe impact on quality of life. Many individuals with cartilage defects develop osteoarthritis and eventually require whole knee replacements. Because cartilage has limited inherent capacity to regenerate, there is strong interest in devising ways to engineer its regrowth and repair. Alexion and United States Surgical Corporation (North Haven, CT) propose to provide a virtually unlimited source of cartilage-replacement tissue by genetically engineering pigs to produce cartilage cells and mesenchymal stem cells (precursor cells for connective tissue) for transplant into humans. The project would build upon a pig-based transgenic cell line developed by Alexion to suppress hyperacute rejection from the transplant of vascularized organs. These transgenic cell

transplants, however, must be administered in conjunction with a stringent immunosupression regime, which is not possible with the transplantation of non-vascularized tissue such as cartilage. Established transgenic pig-cell lines will serve as a platform for genetically engineering additional transgenic pig lines that will express high levels of human molecules to overcome the human immune system's tendency to reject the foreign pig tissue. The technical challenges are to understand the human cellular response to cartilage cells and stem cells derived from pigs, develop an appropriate genetic engineering approach for overcoming tissue rejection, and design a moldable and biodegradable polymeric scaffold that will provide a network of interconnecting pores to temporarily support the genetically modified cells upon implantation, during attachment, migration, and growth. The project is expected to enhance the overall performance of transgenic technology and enable the development of other pig tissues that can be transplanted into humans. The initial market potential for cartilage repair products is estimated at $300 million to $500 million annually in the United States.

연구과제명 : (97-07-0049) Cardiac Muscle Regeneration Using Mesenchymal Stem Cells
회사명 : Osiris Therapeutics, Inc
연구분야 : Diagnostic and Therapeutic Biotechnology / Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $4,505,492.00
ATP 지원금 : $2,000,000.00
연구요약 :
Heart disease is a leading cause of death and disability in the United States. More than 300,000 Americans die annually from congestive heart failure, usually within five years of diagnosis, because cardiac muscle has little or no capacity for self-repair and current treatments are often inadequate. A possible new therapy is suggested by studies of mesenchymal stem cells (MSCs), multipotent precursor cells that differentiate into various tissues, including bone, cartilage, tendon, bone marrow stroma, adipose, and skeletal muscle. Osiris Therapeutics and its colleagues at Johns Hopkins University propose to prove that mesenchymal stem cells also can differentiate in the body into cardiac muscle and restore function to damaged heart tissue. MSCs will be harvested from bone marrow, cultured with various media and agents, and implanted within normal and damaged heart tissue in animals. In contrast to typical tissue engineering projects, the entire muscle-formation process will take place within the body. It is believed that biological, electrical, or mechanical triggers in the host environment may be critical in establishing fully integrated and functional tissue. The fate of the MSCs will be determined in both normal and damaged cardiac muscle of animal models for human heart conditions. The technical challenges are to identify culture conditions, growth factors, or other agents that induce stem cell maturation into cardiac muscle; prove that this process occurs within the body; and demonstrate that function can be restored to damaged heart muscle. Protocols for cell therapy will be established. If successful, the project could help reduce medical costs, improve the well being of

patients with heart conditions, and provide a partial solution to the chronic shortage of donor hearts for transplants. The U.S. market for the proposed technology is estimated to be as much as $2 billion.

연구과제명 : (97-07-0051) Biocompatible Resorbable Polymers Designed for Tissue Engineering
회사명 : Integra LifeSciences Corporation
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $3,937,880.00
ATP 지원금 : $2,000,000.00
연구요약 :
The repair of cartilage--connective tissue that dissipates compression forces and provides a low-friction interface between bone surfaces--poses a unique tissue engineering challenge. Cartilage lacks blood vessels and a natural capacity to heal. When induced to heal in the laboratory or clinic, it regenerates very slowly and usually inadequately. The biomaterials currently available for use in medical devices have a variety of shortcomings, such as restricted mechanical properties. Integra LifeSciences proposes to synthesize and characterize biocompatible polymers with controllable physical, mechanical, biodegradation, and other properties for use in cartilage repair. The proposed polymer system has a modular design, allowing various components to be combined to achieve the requirements for cartilage growth. The biological properties of the material will be modified to foster the growth, survival, and function of cartilage-precursor cells and the expression of the extracellular matrix proteins found in mature cartilage. Once implanted, the polymer system is expected to stimulate cartilage repair by recruiting and differentiating precursor cells from surrounding tissues. Integra's approach does not require the introduction of cultured cells and, therefore, avoids the potential for adverse immune system response and makes these families of materials universally applicable. The technical challenges include determining the compatibility of the new materials with the human body, designing a system that exhibits enhanced mechanical properties and an appropriate rate of absorption into the body, ensuring that the implants remain in place during repair, and inhibition of the scarring process. If successfully developed, the technology would offer a significant advance in the cost-effective treatment of cartilage defects. The annual market potential for knee and shoulder defects alone is projected at more than $2 billion by the year 2000. In addition, the new materials could be used in medical devices for other applications, such as cell adhesion coatings, drug delivery systems, chronic wound healing, bone regeneration, and repair of nervous system components, which would have much broader impact on the potential commercial market.

(3) 1998년 (77개 과제)

① General Competition (23개 과제)

연구과제명 : (98-01-0009) Nanoencapsulated Powder Metallurgy
회사명 : Powdermet, Inc.
연구분야 : Abrasives, Adhesives, Ceramics, Coatings, and Composites
연구기간 : 3.0년
전체연구비(추정) : $2,492,442.00
ATP 지원금 : $1,203,990.00
연구요약 :

The ability to engineer materials with designer microstructures would allow for the development of improved materials to meet specific needs--such as for higher-strength, higher-speed metal-cutting and metal-forming tools for the tool and die industry, better metal-matrix composites, and improved electronic packaging materials. Powdermet, a commercial spin-off company of Ultramet (Pacoima, Calif.), proposes a technology based on a newly developed capability to coat extremely fine particles (less than 5 microns) with metals and ceramics using chemical vapor deposition techniques in a recirculating fast-fluidized bed reactor. Key technical barriers include developing on-line instrumentation and strategies for precise chemistry and deposit control, developing techniques to control nucleation and growth of nanoscale deposits, and developing control techniques to enable the creation of nanostructured metal and ceramic structures after consolidation. The advanced nanoengineered powder production techniques will be combined with state-of-the-art consolidation techniques enabling the design and control of final material structures on nano-, micro-, and macroscales simultaneously. Technical success will lead to the ability to custom-build material chemistries and microstructures into metals and ceramics at the atomic level in a scaleable, cost-effective manner. These techniques also could eliminate the use of environmentally hazardous volatile organic compounds and energy-intensive milling and blending technologies in the manufacturing process. The materials that are developed during the project will be characterized for their strength, toughness, hardness, and wear resistance. Key subcontractors and program partners include Amer-TEM (Sunnyvale, Calif.), Metals Technology (Northridge, Calif.), the University of California at Los Angeles, Ceracon (Fair Oaks, Calif.), Bodycote IMT (London, Ohio), Sulzer-Metco (Westbury, N.Y.), Applied Analytical Sciences (Costa Mesa, Calif.), Oak Ridge (Tenn.) National Laboratory, and Energy Materials Testing Laboratory (Biddeford, Maine). Powdermet's project will improve our understanding of the influence of grain boundaries and interfaces on the properties of materials. If successful, Powdermet and its partners expect their nanoengineered materials to gain a significant market share in the $10 billion to $12 billion world market for metal-cutting and forming tools and dies, abrasives, hardfacing and wear-resistant materials. ATP participation in the project will accelerate the development of nanoengineered products for the marketplace by 5 to 10 years, giving engineers a new class of high-performance materials and enabling a revolutionary 10 to 1 increase in tool and die performance.

연구과제명 : (98-01-0013) Superfingerlings : Development of Advanced Biotechnology, Genetic Manipulation, and Animal Husbandry Techniques for Use in Aquaculture

회사명 : Kent SeaTech Corporation

연구분야 : Animal and Plant Biotechnology / Marine Biology

연구기간 : 3.0년

전체연구비(추정) : $2,698,636.00

ATP 지원금 : $1,852,375.00

연구요약 :

Ocean capture of fish, an important source of protein for the world's growing population, is reaching the limits of sustainability. For some species, overfishing has led to declines in numbers available for human consumption. Fish raised through aquaculture, under controlled conditions, now equal one-fourth of the world seafood supplies of 80 million metric tons. In the United States, aquaculture has focused on valuable fish such as catfish, trout, salmon, tilapia, and striped bass. Rapidly developing competition from foreign countries with warmer weather and lower production costs (Taiwan and Israel for striped bass, Chile for salmon) is a serious threat to the domestic aquaculture industries for several fish species. Aquatic Systems plans during its three-year project to develop genetic engineering techniques for striped bass and hybrid striped bass to increase the growth rate and disease resistance of the animals. The key innovation--and most difficult challenge--will be the use of retroviral vectors to transfer the desired genes to the germline, so that future generations will carry the desired traits. The company also expects to develop advanced methods for producing fertile tetraploid broodstock, fish with four rather than the normal two copies of each chromosome, so that environmentally safe, sterile fish can be raised for market. (The offspring of tetraploid and normal diploid fish are triploid and usually all sterile.) The project also will include development of techniques to manipulate the spawning cycle to obtain larvae year-round, to preserve bass sperm at low temperatures for future use, and to culture larvae and fingerlings indoors under controlled conditions. The project will be undertaken in collaboration with researchers from the University of California at San Diego (La Jolla, Calif.), the University of Connecticut (Storrs, Conn.), North Carolina State University (Raleigh, N.C.), and the Institut de Biologie Moleculaire et Cellulaire (Strasbourg, France). Without ATP cost-sharing, it is unlikely that this team would have come together. Once developed, these techniques are expected to be applicable to other fish produced via aquaculture, raising the current crop value for the five most important farmed species from $600 million to an estimated $1.6 billion, reducing the amount of labor involved in producing a pound of fish but potentially increasing aquaculture employment by 15,000 to 30,000 full-time jobs.

연구과제명 : (98-01-0014) Low-Cost Investment Cast Technology for Microturbines Project Brief
회사명 : Howmet Research Corporation
연구분야 : Metals and Alloys
연구기간 : 2.0년
전체연구비(추정) : $2,849,841.00
ATP 지원금 : $1,769,428.00
연구요약 :
The market for microturbines--a turbine with an integrated electrical generator with an output of 10 to 100 kilowatts--currently is in the hundreds of units but is projected to grow to the hundreds of thousands of units by the year 2003. These units, characterized by their ability to burn many kinds of fuel quietly and with low exhaust emissions, will serve as standby power systems for industry and as part of a hybrid electric vehicle's power system. Hybrid electric vehicles, which have much lower emissions of nitrogen oxides than do conventional internal combustion engines, have been proposed as a solution by which the automotive industry can meet strict clean air standards in California and the Northeastern United States. To make such turbines practical with parts at aerospace quality and tolerances, but at automotive volumes and costs, Howmet Research Corp. (the research and development arm of the Howmet Corp.) proposes to develop a highly automated, high-volume system for investment casting that reduces the casting process cycle-time by as much as 90 percent while maintaining high quality. To meet this goal, Howmet must develop new mold materials, mold firing/curing and pattern-removal processes, furnace designs, and related technologies to allow high throughput. In particular, the company expects to develop a fast-cycle vacuum induction melting furnace that incorporates process control technology and will be operated in a semi-continuous fashion. All of the manufacturing steps will be integrated, and a prototype lean manufacturing cell for producing microturbine components will be developed and tested. Recent estimates have predicted that foreign markets may require 20 MW of additional power by 2003. If U.S.-made microturbines--offering a low-cost solution requiring only marginal infrastructure--capture only 25 percent of that market, it would create a new export market worth nearly $2 billion. ATP funding will help to ensure that the United States will be the first to market with a high-quality, low-cost product.

연구과제명 : (98-01-0026) Development of Hen Oviducts as Bioreactors via Promoter-less MiniGene Insertion
회사명 : AviGenics, Inc.
연구분야 : Animal and Plant Biotechnology / Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $1,969,867.00
ATP 지원금 : $1,515,867.00

연구요약 :

Genetically engineered animals have the potential to produce medically important proteins and drugs at lower cost than from cell culture systems or serum-derived sources. Earlier research has been aimed at introducing into mammals foreign genes whose products would be extracted from the animal's milk. However, introducing these genes into poultry so that their products would become part of the whites of the birds' eggs may prove faster and more effective. AviGenics is investigating three proprietary genetic techniques to introduce specific genes into chickens for subsequent expression in the hen oviduct during egg development. The most promising, promoter-less minigene insertion (PMGI) via targeted gene disruption, is the most risky but likely to be the most efficient. PMGI allows targeted insertion of a DNA molecule encoding a particular gene into the desired spot on a chromosome. All approaches involve significant risks, such as the possibility that the engineered changes will interfere with the normal egg and chick development. PMGI, if successfully implemented, will minimize these risks. As an initial application, AviGenics plans to develop chickens whose eggs contain large quantities of human serum albumin (HSA). The potential impact on the global market for this important human protein is enormous. Annual demand for HSA, which is currently isolated from human blood plasma at a cost of $750 to $1,500 per kilogram is 440 metric tons (440,000 kilograms). The company estimates that a single large hen house, containing perhaps 100,000 laying hens, could produce 5 percent of world demand for HSA at a cost of $80 per kilogram of HSA, plus the cost of purification. The benefits to society are obvious, hence there is a strong justification for the ATP to accelerate this research. The company also expects the technology to prove useful in the production of other pharmaceutical proteins, such as blood factors (VIII, IX, X), antibodies, and most other biopharmaceuticals. However, modification of the avian genome is difficult, and the project requires the development of novel genetic engineering techniques.

연구과제명 : (98-01-0039) The BioBatteryTM Technology : An Innovative Medical Treatment for Arrhythmia

회사명 : Engineering & Research Associates, Inc.

연구분야 : Bioprocessing/Biomedical Engineering

연구기간 : 2.0년

전체연구비(추정) : $1,980,437.00

ATP 지원금 : $1,535,818.00

연구요약 :

Abnormal heart rhythms--arrhythmias--resulting from malfunctioning electrical behavior of cardiac tissue, affect more than 3.7 million Americans. One form of arrhythmia, atrial fibrillation, results in over 70,000 strokes in the United States annually at a treatment cost of more than $3.6 billion annually. An additional 400,000 Americans suffer from or are at risk for ventricular tachycardia, a life-threatening arrhythmia. Patients with arrhythmia are treated with drugs (which can have undesirable side effects), implanted pacemakers or defibrillators (which are expensive to implant and can malfunction), open-heart surgery (which is expensive and has a 10 percent mortality rate), or procedures--tissue ablation--that destroy the abnormal heart tissue that causes the arrhythmia. Relatively new techniques have been developed to perform tissue ablation using a catheter to apply radiofrequency (RF) energy to destroy the defective heart tissue. While this avoids expensive, highly invasive, open-heart surgery, it has proven difficult to control the amount of damage to the heart muscle and to prevent dangerous coagulation. SEBRA plans to develop a system that uses the flow of electrical current between two dissimilar metals that are in contact with heart tissue to monitor the temperature of tissue that is exposed to radiofrequency energy to produce tissue ablation. The company expects to establish an affiliation with a major catheter manufacturer to develop a catheter system containing different metal electrodes and test it in clinical trials to bring it to market. With ATP funding, SEBRA will investigate the use of a specially designed catheter, in which the dissimilar metals used to detect the biological current flow are on separate electrodes within the catheter. Working with cardiology researchers at the University of Arizona (also in Tucson), the specially designed catheter/RF ablation technology will be tested in live animals before a prototype design is finalized for use in clinical trials. In addition to potentially enabling a much improved therapy for the heart conditions of a significant portion of the population, the basic SEBRA technology might be applicable to a variety of other conditions, including Parkinson's disease, brain tumors, urological and gynecological disorders, breast and prostate cancer, and wound healing (in conjunction with heat-activated human plasma.)

연구과제명 : (98-01-0056) Bone Regeneration Using Allogenic Mesenchymal Stem Cells Project Brief
회사명 : Osiris Therapeutics, Inc.
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $3,958,126.00
ATP 지원금 : $2,000,000.00
연구요약 :
Clinical repair of bone defects--predominantly spinal fusions or grafts to repair long bones damaged by wounds, breaks, or removal of bone tumors--currently uses bone graft materials from the patient's own bone (autograft bone) or bone marrow. The availability of bone grafts and the recruitment of bone progenitor cells from each patient is limited. Osiris Therapeutics proposes that culture-expanded human bone progenitor cells (human mesenchymal stem cells or hMSCs) that are not genetically identical to the patient's own cells could be used effectively to regenerate bone in these clinical applications. To confirm this hypothesis, Osiris will undertake a three-year animal study to demonstrate that allogeneic (different donor, same species) mesenchymal stem cells can form bone in animal models, to determine the interaction of these cells with the animals' immune systems, to establish conditions for culture-expanding allogeneic hMSCs for clinical use, and to demonstrate the overall safety of this approach. Osiris anticipates that graft protection will occur naturally, bypassing the need for systemic immunosuppression.

Subcontractors for parts of the experiments with non-human primates will be Dr. Ronald Hoffman of the University of Illinois at Chicago School of Medicine and BioMedical Enterprises, Inc. (San Antonio, Texas). Successful demonstration in animals using allogeneic hMSCs not genetically identical to the patient's hMSCs may allow for more effective clinical bone repair, because hMSC allografts could contain higher concentrations of regenerative cells than are available from current clinical approaches and be available "off the shelf." By increasing graft effectiveness, the cost of repeat procedures could be eliminated, healing time could be reduced, and the patient could return sooner to a normal life. For the 300,000 spinal fusions performed in the United States annually, potential savings could be $2.4 billion. For the 400,000 U.S. long bone repairs, the savings could be another $1.8 billion. Cost-sharing by the ATP can accelerate greatly this work so that the potential benefits to the nation would occur much sooner.

연구과제명 : (98-01-0059) Nanostructured Chemical Feedstocks : The Next Generation of High-Performance Polymeric Materials
회사명 : Hybrid Plastics, LLC
연구분야 : Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 3.0년
전체연구비(추정) : $2,183,047.00
ATP 지원금 : $1,987,602.00
연구요약 :
The U.S. Air Force has developed a new family of high-performance hybrid plastics with advanced properties that potentially could be applied to a wide variety of consumer and industrial products--products as diverse as contact lenses, carpets, automobile windshields, and golf clubs. These plastics incorporate nanostructured polyhedral oligomeric silsesquioxanes, or POSS. POSS hybrid plastics are organic-inorganic materials that combine the features of organic polymers with those of ceramics. The Air Force has produced polymeric materials with POSS technology that are lighter, more durable, and able to withstand higher temperatures than conventional polymer formulations, but many other substantially improved properties also are possible. POSS technology might launch the first new wave of high-performance plastics and polymer applications since the 1950s. Technical and economic limitations prevent this, however. Depending on the feedstocks used for their production, a pound of POSS material costs between $1,000 and $5,000, and production can take as long as three years. Hybrid Plastics, the only producer of POSS technology, proposes finding new feedstocks to make POSS materials and developing processes that will overcome production limitations. The project's major challenge is to accomplish these ambitious goals in a way that reduces the cost by a dramatic two orders of magnitude, to between $10 and $50 per pound. ATP support will allow the company to pursue this aggressive program rather than focusing on much less ambitious projects. Hybrid Plastics will look for new raw materials among the silanes (similar to hydrocarbons, but with silicon replacing some carbon, and produced in high volume for the silicones industry),

silsesquioxane/silicone resin wastes (byproducts of the silicones industry), and--least expensive of all--common sand. Major subcontractors will be the U.S. Air Force Research Laboratory (Edwards Air Force Base, Calif.) and the Department of Chemistry of the University of California at Irvine. A totally successful project would, within a few years, generate annual sales within the plastics industry alone of an estimated $66,250,000. Even if costs are reduced by only one order of magnitude, the polymer/plastics industry is so large and diverse that this project would spawn substantial economic and technological benefits for the nation.

연구과제명 : (98-01-0064) Creation of a National Digital Tissue Repository
회사명 : Advanced Pathology Systems, Inc.
연구분야 : Bioinformatics
연구기간 : 3.0년
전체연구비(추정) : $3,644,308.00
ATP 지원금 : $1,642,000.00
연구요약 :

Advanced Pathology Systems (APS) plans to establish a National Digital Tissue Repository (NDTR) containing computerized three-dimensional microscopic images of biological tissues in unprecedented detail. This will require modernizing the century-old, labor-intensive science of microscopy. The company will create new technologies to produce three-dimensional images of the cellular structures of tissues in all their variety. Fluorescent dyes will reveal important chemical features of tissue components. The repository--a virtual library--will contain more than 2,000 images of healthy and diseased tissues for research and teaching. The repository also will produce images of samples submitted by investigators studying how tissue structure and chemistry respond to various physical and biological influences. For most purposes, people could access the images over the Internet. The company proposes to develop fully automated microscopy based largely on major advances in the current technologies of fluorochrome staining and block face microscopy. This form of microscopy, little-known and unperfected, examines bulk tissues directly and eliminates traditional microscope slides. By viewing the cut surface of a tissue sample and then repeatedly sectioning deeper to reveal and image the adjacent underlying layers, the new approach will gather the information to reconstruct the tissue digitally in three dimensions. Using tissues supplied by California Pacific Medical Center (San Francisco), APS will attempt to make giant strides in preparing samples, imaging, and handling huge digital data sets (a single tissue specimen might require one gigabyte of storage or more.) One of the most important--and high-risk--challenges will be to develop a large suite of tissue-specific dyes that will bring out intricate details of structure and chemistry in comparatively bulky samples. Ultimately, the country's nearly 7,000 anatomical pathology laboratories and their patients will enjoy the benefits of enhanced capabilities and vast cost reductions from the many improvements to microscopy. Moreover, creation of the NDTR will provide a powerful enabling technology that will significantly increase the capacity of the multibillion-dollar biotechnology industry to enter new areas and improve the quality of existing products. The fact that a much larger share of the benefits go to the users of the repository rather than APS provides a strong justification for ATP cost-sharing.

연구과제명 : (98-01-0065) A Xenogenic Solution to Spinal Cord Injury
회사명 : Alexion Pharmaceuticals, Inc.
연구분야 : Animal and Plant Biotechnology / Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $2,945,377.00
ATP 지원금 : $1,993,300.00
연구요약 :

Tragically, injuries to the spinal cord can lead to permanent paralysis. Currently, there is no effective treatment to restore nerve function after traumatic injury to the spinal cord. Approximately 200,000 Americans suffer from spinal cord injuries, and 7,500 to 10,000 additional people are injured every year. The clinical need for an effective treatment is recognized as an area that needs to be addressed with new innovative therapies. Restoring nerve function in spinal cord injury patients would also provide significant cost savings for the health care system in the treatment of these patients. It is estimated that a single patient in their mid-twenties diagnosed with tetraplegia would accumulate over $1 million in health care costs during their lifetime. Nerve fibers in the spinal cord are surrounded by myelin, an insulating sheath. Loss of this protective myelin sheath occurs after injury to the spinal cord and leads to the loss of normal nerve function. Alexion Pharmaceuticals proposes to develop a xenogeneic cell transplantation therapy, transplanting cells from a different species, to regenerate the myelin sheath and restore nerve function. A key challenge in this project is to develop cells that re-myelinate the damaged spinal cord and also evade the patient's immune system. This involves discovering the exact mechanisms of how the human body rejects xenogeneic neuronally derived cells. The company then will devise a cell engineering strategy to block the immune response, which will permit cell engraftment and spinal cord repair. Even partial success could generate knowledge that would benefit other areas of medicine, such as transplants involving other tissues and organs. The opportunity for ATP cost-sharing was an incentive for Alexion and its collaborators to undertake this high-risk and cutting-edge research.

연구과제명 : (98-01-0070) A Spoken-Language Forms Translator for Information Transactions
회사명 : Language Systems, Inc.
연구분야 : Other Information/Computers/Entertainment
연구기간 : 2.0년
전체연구비(추정) : $3,632,695.00
ATP 지원금 : $1,815,206.00

연구요약 :
Service providers in medicine, law enforcement, financial businesses, and similar professions spend a large part of their time filling out forms. Doctors and nurses devote an estimated one-third to one-half of their time to paperwork. The situation becomes much worse when forms require information from people who do not speak English; help must be found to interview them or translate forms for them. This is a significant problem--the 1990 census showed that 14 percent of people over age five speak a foreign language at home. Language Systems, Inc., proposes a PC-based system that will slash the time consumed in filling out forms while at the same time providing automated language translation for the service provider and a non-English speaking client. The service provider's questions and the client's answers will be converted to text by a speech recognizer and translated by an automated translation component, which passes the foreign language text to the speech synthesizer to produce spoken output. Due to the high-risk nature of combining advanced technologies into an innovative system for capturing the verbal data of service interviews, the project has been unable to secure venture capital funding. Both speech recognition and translation present major technical challenges because of the ambiguity of many spoken words and phrases. Additionally, translation must accommodate different ways that languages segment meaning into words. In many cases, a very literal translation of a sentence from one language into another will produce unintelligible results. To attack the technical difficulties, LSI will integrate knowledge of dialog "scripts" with grammar and word knowledge to apply some predictive power to solving translation and speech recognition problems. Several software translation engines will operate simultaneously. The output will be evaluated automatically and the best translation will be selected and then spoken by the speech synthesis component. LSI aims to achieve an accuracy rate of 95 percent in field trials. The company plans to accomplish this by exploiting the highly structured nature of forms, which serves to restrict both the grammatical form and the meaning that questions and answers in a dialog may take. Eloquent Technology, Inc. (Ithaca, N.Y.), will develop speech synthesis (software that turns text into speech) for the various languages to be included in the project, and the Linguistics Department of the University of Southern California (Los Angeles, Calif.) will assist with language analysis. A successful project potentially could free up staff time equivalent to a 25 percent staff increase in the service sector alone.

연구과제명 : (98-01-0074) Smart Piezoelectric-Based MEMS Accelerometers with Wireless Interface for Industrial Applications
회사명 : Wilcoxon Research, Inc.
연구분야 : Electronic Instrumentation/Sensors and Control Systems
연구기간 : 3.0년
전체연구비(추정) : $4,032,469.00
ATP 지원금 : $1,887,949.00
연구요약 :

Like pulse rates in humans that can indicate disorders, vibrations in a working machine tell much about the "health" of the apparatus. Vibration detection instruments called accelerometers can continuously monitor equipment vibrations to predict failures and decrease downtime, which in the example of the pulp and paper industry costs $1 million a day. However, existing devices are costly and limited in both functionality and application. They consist of bulky sensors connected by cables to power supplies and recorders and can only be added onto machines, not built into them. Wilcoxon Research proposes to develop a new class of piezoelectric-based accelerometers using microminiaturization techniques developed for computer chips. The advanced, battery-powered devices will be ultra-small, less costly, and better performing, and they will have microprocessor "brains" that communicate with recorders by radio. The goal is sensing devices only one three-hundredth the size and one six-hundredth the weight of conventional accelerometers. The sensors will be smart enough to take and interpret various kinds of readings, periodically respond by radio, calibrate themselves, and report if they are failing. The radio-based devices will cost only half as much as current accelerometer systems. They could be installed on or built into many types of machines, including rotating and moving apparatus and aircraft. Savings from installation worldwide of the new devices are projected at $500 million. The development belongs to the family of technologies called microelectromechanical systems, or MEMS. The heart of the MEMS sensor will be a razor-thin layer of a piezoelectric material that generates an electric current when stressed, as by vibrations. Microminiaturizing piezoelectric sensors and the associated amplifier, microprocessor, and radio circuitry for industrial use presents daunting challenges, however--for example, designing a structure that will mechanically integrate the piezoelectric material with its supporting structure and the signal conditioning electronics. Expert help in designing the radically new sensor and making experimental devices will come from the project's main subcontractor, the Electronic Materials and Processing Research Laboratory at Pennsylvania State University (University Park, Pa.). Without ATP cost-sharing, Wilcoxon would have used its R&D funds for less far-reaching projects.

연구과제명 : (98-01-0083) Composite Railroad Crossties
회사명 : Seaward International, Inc.
연구분야 : Abrasives, Adhesives, Ceramics, Coatings, and Composites
연구기간 : 3.0년
전체연구비(추정) : $3,042,962.00
ATP 지원금 : $1,904,981.00
연구요약 :
Over 14 million railroad crossties, nearly all wood soaked with creosote, are replaced annually in the United States. Seaward International proposes to develop composite ties of recycled plastic with superior strength, stiffness, and significantly longer life--and recyclable themselves. They could save the nation over $1 billion annually through reduced maintenance, improved productivity, lowered accident rate, and avoided disposal of plastics in landfills. Additionally, the

technology would remove from the environment a substantial amount of creosote, a cancer-causing chemical, and save over 1 million cubic meters of hardwood reserves that are depleted for conventional ties every year. One of the reasons for ATP support is that Seaward itself can capture only a small fraction of the potential benefits from this technology. For feed stock, Seaward plans to use plastic scraps usually rejected by recyclers, such as auto industry trim. For economy, only the inner part of the ties will be made with high-strength plastic, reinforced with advanced composite members. The outer part will be pure plastic of lower strength and lower cost. Several significant research challenges include : formulating a high-strength plastic blend; designing reliable composite structures; finding ways to overcome the resistance to bonding between the composite and the plastic and neutralize forces that tear them apart when they expand differently as temperatures change; enabling the plastic to hold spikes tightly; finding fillers and additives to improve many of the plastic's properties; and developing economical manufacturing methods. Seaward hopes to make plastic and composite at less than one-fourth the cost of present materials. For compatibility with existing ties, the company is aiming for replacements of similar size, shape, and weight as the traditional kind. So difficult is the engineering that the chance of completely meeting all objectives has been estimated at only one in 20. The direct payoffs would be great, however, even for partial success that produced commercially successful ties. The new technology, furthermore, could totally or partially replace treated lumber and timber, a $4 billion industry in the United States and triple that worldwide. Innovations in plastics could advance the entire composites and plastics industries, and a successful reinforcement effort could improve concrete and other reinforced materials. The School of Civil and Environmental Engineering at the Georgia Institute of Technology (Atlanta, Ga.) will design the composite reinforcement members, and Norfolk Southern Corp. (Roanoke, Va.) will test the ties and provide end-user consultation.

연구과제명 : (98-01-0086) Improved Materials Performance for Market Penetration of Crossed Beam Volumetric Displays
회사명 : 3D Technology Laboratories, Inc.
연구분야 : Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 3.0년
전체연구비(추정) : $2,222,230.00
ATP 지원금 : $1,922,230.00
연구요약 :
There is a growing need for realistic three-dimensional visualization of volumetric data sets in a spectrum of industries ranging from science and medicine, to manufacturing, and even entertainment. The development of display hardware that is capable of accurately presenting three-dimensional data to viewers has languished behind similar developments in microprocessors and visualization software. Commercially available display technologies fall far short of meeting the cost and performance needs of demanding applications. 3D Technology Labs (3DTL), a Silicon Valley start-up company, is developing a "crossed-beam" volumetric display

(CBD) technology that provides accurate and realistic three-dimensional visualization, of many types of electronic data sets, without the need for glasses or cumbersome headgear. 3DTL's simple, yet elegant, concept is based on an optical phenomenon in which two infrared laser beams of different wavelength intersect inside a volume of transparent optical material called an "image chamber," to address a tiny point of visible light--a voxel--in three-dimensional space. The sequential absorption by the image chamber material of the two different lasers, only at the point where they cross, is the essential feature of this display. Once activated, a voxel momentarily emits light in all directions and can be seen through all surfaces of the image chamber. Scanning the lasers under computer control moves the voxel and generates real three-dimensional, animated images, inside the display. This display, therefore, can draw three-dimensional images that can be seen by multiple viewers simultaneously, through different sides of the image chamber (front, back, sides, top) with no limited or obstructed viewing regions. Current materials used for the image chamber not only are expensive but have limited performance and brightness. This ATP program will support the development of a fundamentally new class of optical materials for the image chamber, enabling system scale up to 12 inches to 18 inches on a side, at a substantially lower cost. In addition, this program also will support the creation of a programming development environment, along with specific application software.

연구과제명 : (98-01-0097) 3-D Fiber Deposition Processing : The Development of Near-Isotropic Composite Bar Stock
회사명 : Ebert Composites Corporation
연구분야 : Abrasives, Adhesives, Ceramics, Coatings, and Composites
연구기간 : 3.0년
전체연구비(추정) : $2,639,633.11
ATP 지원금 : $1,941,511.42
연구요약 :

Composite materials (combinations of two or more materials, such as fiberglass) have become practical for structural applications thanks to advances in reinforcing and shaping parts, but they remain largely two-dimensional materials. Typically the reinforcing fibers that give the composite its strength are in a woven fabric, giving the composite enhanced strength in two dimensions. The third dimension is more problematic--techniques for interconnecting multiple layers of material remain imperfect. Ebert Composites Corp. plans to design, build, and demonstrate a prototype computer numerical control (CNC) machine that precisely and rapidly places reinforcing glass fibers or fiber bundles through up to 30 layers of woven, polymer matrix composite material. The planned machine will feature multiples of a proprietary insertion mechanism designed to deposit fibers at precise locations in the z-direction through layers of material. The technical challenge is to design a robust system that operates consistently and minimizes damage to the woven material. A control system will be designed to enable precise positioning of the fibers at various speeds using multiple axes of motion control. The system will be designed to achieve fiber density of 25 percent of the overall laminate density at a speed of about 180 insertions per minute (to mesh with the rate of pultrusion, a standard composites manufacturing process). Ebert would not develop this machine without ATP support because of the high technical risk associated with the project. If successfully developed and commercialized, then the technology would be used to manufacture thick, low-cost composite bar stock, which could be machined to make corrosion-resistant fasteners and other hardware that would compete favorably with traditional materials. Ebert already has developed a composite bolt that is very strong in two dimensions; the CNC machine would enable the production of bolts that are uniformly strong in three dimensions. The potential market for bolts (now made of stainless steel and mostly imported) is estimated at $1 billion annually. Many industries, from chemical processing to transportation, would benefit from the use of low-cost composite bolts. Subcontractors include W. Brandt Goldsworthy & Associates, Inc. (Torrance, Calif.); Cincinnati Milicron (Cincinnati, Ohio); Dr. Christopher Pastore (Maple Glen, Pa.); Dr. Vistasp Karbhari of the University of California at San Diego; and James Hook (Alpine, Calif.).

연구과제명 : (98-01-0108) The Next Generation Intelligent Monitoring System
회사명 : Montronix, Inc.
연구분야 : Intelligent Manufacturing
연구기간 : 2.0년
전체연구비(추정) : $1,944,261.00
ATP 지원금 : $1,378,908.00
연구요약 :
Industrial machining of metals typically is controlled by an inefficient assortment of independent hardware and software systems, which cannot be integrated because of the lack of affordable, open-architecture platforms for control systems. Montronix plans to design and demonstrate a personal computer-based "intelligent" system for in-process monitoring of machine tool condition, real-time detection of and response to process variations, and rapid machine and process setup. PCs now have become viable open-architecture controllers thanks to rapid advances in processing power and reliability. Even so, a number of technical challenges must be overcome to design a reliable control system. A hardware and software architecture must be designed that can easily incorporate a variety of components to perform all monitoring tasks simultaneously. The system must be portable, reconfigurable, and easily upgraded and expanded. It will be particularly difficult to ensure that the system responds immediately to very rapid changes, so process models will be developed that reliably detect and predict changes in parts and processing speed. Other technologies to be developed include a mechanism enabling the monitoring system to communicate with the controller, indices for predicting tool faults, algorithms to optimize cycle time and tool life, and sensors to collect data. Montronix also will design a human-machine interface that will enable personnel to use a standard PC operating system. The ATP project will accelerate the development of the overall system and enhance its

performance and benefits. If successful, the project will set the stage for plug-and-play hardware and software in machine tool monitoring and control. The new technology will have broad applications in the automobile industry and general machining, increasing productivity and product quality while reducing engineering and training costs. The Department of Mechanical and Industrial Engineering at the University of Illinois (Urbana/Champaign, Ill.) will develop computer models for machining processes.

연구과제명 : (98-01-0110) Living Heart Valve Replacements
회사명 : CryoLife, Inc.
연구분야 : Bioprocessing/Biomedical Engineering / Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $3,178,151.00
ATP 지원금 : $1,996,545.00
연구요약 :
Heart disease is the leading cause of death in the United States and accounts for more than $200 billion in annual health care costs. These costs could be reduced greatly if affordable replacement heart valves could be developed that are more durable than existing devices. CryoLife plans to develop the materials and processes needed to demonstrate a living heart valve prosthesis that will grow and repair itself for the lifetime of the recipient. The company will use cryopreserved (frozen) pig tissue, from which the original cells will be removed (to prevent immune response and implant rejection by the recipient), leaving a matrix of connective tissue. A controlled process will be developed to ensure that the matrix retains mechanical integrity. The patient's own cells then will be implanted into the matrix to initiate growth. Biochemical systems will be developed to stimulate this process, and conditions for handling the human donor cells will be standardized. The hydrodynamic function, durability, and biomechanical performance of the composite valves will be evaluated. In addition, cellular activity within the matrix will be measured. Finally, the function of the device will be evaluated in an animal model. If successfully developed, the new technology is expected to be superior to all alternatives, including mechanical valves, which are prone to malfunction, and transplanted pig heart valves, which tend to fail within five to seven years. The new device would reduce the need for post-surgical treatments and repeat surgeries, thereby substantially reducing U.S. health care costs. It also will offer a solution to the shortage of suitable organ donors. Children and the elderly are expected to be the initial beneficiaries. Even if not fully successful, the project is expected to expand the knowledge base on living, tissue-engineered implants.

연구과제명 : (98-01-0114) Efficient Low-Cost Manufacture of Oligonucleotides Using Non-Chromatographic Purification
회사명 : IBC Advanced Technologies, Inc.
연구분야 : Separation Technology

연구기간 : 3.0년
전체연구비(추정) : $2,845,552.00
ATP 지원금 : $2,000,000.00
연구요약 :
Antisense therapies, in which synthetic agents interfere with the body's genetically driven production of disease-related proteins, show great promise for combating many diseases, including AIDS, cancer, and rheumatoid arthritis. However, the synthesis and production of antisense agents are very expensive. IBC Advanced Technologies plans to reduce these costs by developing new chemistries for separating and purifying medically important oligonucleotides, which will bind to certain types of genetic material that make key proteins, acting as antisense agents. The company will apply modeling tools and rapid, highly selective molecular-recognition technology to design and synthesize molecules that recognize both short and long oligonucleotides based on the type, number, and arrangement of chemical units. A major technical challenge will be to extend the current ability to purify individual chemical units to make molecules that differentiate among complex oligonucleotides. The knowledge gained then will be applied to develop generic analytical and processing approaches that can be extended to design, model, and synthesize a wide range of new chemical purification systems as needed. Because separation and purification constitute a high proportion of manufacturing costs, the new technology, if successfully developed, will enable significant reductions in the costs of manufacturing oligonucleotides over conventional chromatographic systems. The new systems also will increase product purity from about 95 percent to 99 percent. These advances, if commercialized, will shorten time to market and increase production of oligonucleotides, making it possible to satisfy growing demand in therapeutic, diagnostic, agrichemical, and biotechnology research markets. The resulting increases in sales of low-cost therapeutics, gene-based diagnostic systems, and purification technology are expected to be worth $4 billion to the U.S. economy over the next 10 years.

연구과제명 : (98-01-0131) Integrated GMR Isolated Devices and Planar Transformers
회사명 : Nonvolatile Electronics, Inc.
연구분야 : Semiconductors
연구기간 : 2.0년
전체연구비(추정) : $2,939,200.00
ATP 지원금 : $1,813,992.00
연구요약 :
Rapid increases in the performance of integrated circuits (or chips) and the complexity of data transmission networks have heightened the need to protect fragile elements of these systems against power surges and other anomalies. Existing protection/galvanic isolation strategies are large and bulky and cannot be integrated with the electronics they protect. Nonvolatile Electronics plans to develop the technologies needed to demonstrate the integration of signal-

and power-isolation functions on silicon chips, a major step toward reducing the cost and size of power and signal interface systems. The company will monolithically integrate various components that are typically large in size and packaged separately (e.g., signal isolators and transformers), and combine them in novel single and multichip IC packages. These novel devices will be unique integrated single and multichannel components (digital signal isolators, integrated transceivers, solid-state switches, and current switches). Chips will be designed to optimize the integration of isolation devices and control/interface circuits. A variety of technical challenges must be overcome. Highly sensitive materials will be developed to detect magnetic fields created by small input currents. New materials and device designs will be optimized to achieve the switching speed and energy storage requirements for power converters. Wafer level dielectric materials will be developed to isolate devices with breakdown voltages as high as 3,000 volts. Low-cost packaging approaches and test equipment and procedures will be developed. In addition, a prototype device will be built and demonstrated. If successfully developed, the new technology will dramatically increase speed, bandwidth, and functionality while reducing communication and power device size. This will result in reduced circuit board space, cost, and power consumption. The ATP funding will accelerate this work by several years and enable the United States to establish a leadership position in monolithic isolation technology. The technologies will be broadly applicable, finding use in computing, telecommunications, automotive, aerospace, industrial, and medical applications. The materials and device advances have spillover benefits in the magnetic data storage industry.

연구과제명 : (98-01-0145) A Rational/Combinatorial Approach for Designing Non-Viral Vectors for Liver Gene Therapy
회사명 : Mirus Corporation
연구분야 : Diagnostic and Therapeutic Biotechnology / Bioprocessing/Biomedical Engineering
연구기간 : 3.0년
전체연구비(추정) : $3,848,450.00
ATP 지원금 : $2,000,000.00
연구요약 :
Gene therapy holds tremendous promise for the treatment of liver disease and many other disorders, but methods of gene transfer remain inefficient because of immune reactions and the aggregation of DNA containing particles after delivery into the patient. Mirus Corp. plans to develop a "gene in a bottle" technology in which non-viral gene containing particles are formed and injected into the patient. Combinatorial techniques will be explored to design the particle with characteristics that improve the probability of reaching the targeted area. The result would be an efficient delivery of a functioning gene into the cells responsible for liver disorders, including hemophilia and hypercholesterolemia. ATP funding is expected to accelerate the development of this enabling technology by three to six years. If successfully developed and later adopted for clinical use, the new technology would be more convenient and effective than the

drugs, blood products, and other conventional therapies currently in use. Gene therapy targeting the liver could be used to treat at least 100 genetic disorders, as well as multicausal disorders such as diabetes. The new technology could be used to achieve regulated, in vivo secretion of proteins, such as growth hormone and obesity treatments and deliver genes to other tissues, such as lungs and muscles. Although gene therapy is expensive, its costs are likely to become more predictable and easier to control with this technology. In addition, pharmaceutical and biotechnology companies will have a valuable new platform on which to base their future products.

연구과제명 : (98-01-0154) Non-invasive Glucose Measurement Using Chemical Amplification and Optical Sensing
회사명 : MiniMed, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $3,455,325.00
ATP 지원금 : $1,998,000.00
연구요약 :
Diabetes, a disorder in glucose metabolism, afflicts an estimated 16 million Americans and is a leading cause of death by disease. Careful control of blood glucose levels can reduce the risk of complications, but existing self-monitoring methods are painful, inconvenient, and prone to error. MiniMed Inc. plans to develop and test components for a simple, accurate, minimally invasive system for measuring glucose levels. The planned system consists of two basic components : a tiny sensor, placed just under the skin for periods of up to a year, containing fluorescent molecules that convert glucose concentrations into an optical signal; and an external instrument containing a light source to excite the sensor and detect the signals. A key technical challenge is to increase the signal-to-noise ratio at the sensor source, requiring modification of the sensor materials to increase the efficiency of light transmission through tissue. In addition, MiniMed will develop and test a reference compound for calibrating the transduced signal, design optical read-out instruments to detect the transduced glucose and reference signals, and optimize biocompatible polymers for packaging the implanted sensor. A prototype system will be built and demonstrated in an animal model. The ATP project will accelerate the development of these components and enable the completion of a prototype glucose-measurement system. If successfully developed and later commercialized, the new system will reduce the cost and increase the simplicity of glucose monitoring , thereby improving the diagnosis and treatment of diabetes as well as the well being and productivity of those afflicted. The new chemistries, materials, and devices also are expected to serve as a platform for the development of other sensing applications, for example for detecting infectious disease organisms and environmental contaminants. A portion of the materials synthesis and testing will be performed by Lawrence Livermore National Laboratory (Livermore, Calif.), and Dr. Darrell Wilson of Stanford University

School of Medicine (Stanford, Calif.) will serve as a consultant.

연구과제명 : (98-01-0163) Development of Next-Generation OCT Technology
회사명 : Coherent Diagnostic Technology, LLC
연구분야 : Diagnostic and Therapeutic Biotechnology / Imaging and Image Processing / Optics and Photonics
연구기간 : 3.0년
전체연구비(추정) : $2,652,000.00
ATP 지원금 : $1,797,000.00
연구요약 :
Optical coherency tomography (OCT) is a new imaging technology that may have a major impact on numerous market sectors similar to the impact of X-ray computer tomography, MRI, and ultrasound. OCT produces high-resolution, real-time, cross-sectional images of the internal microstructure of biological tissues, specimens, or materials. OCT is optically based, non-contact, and achieves resolution in the 2 to 10 micrometer range--one to two orders of magnitude superior to ultrasound or other tomographic imaging technologies such as CT or MRI. OCT is a powerful imaging technology that can provide in situ images of tissues at near histological resolution without the need for excision and processing of the specimen. The unique features of this technology can be applied to a wide range of medical (and non-medical) applications, including providing diagnostic information in situations where conventional biopsy is hazardous or impossible (such as in the coronary arteries or nervous tissue), reducing the high false negative rate and cost of conventional biopsy (such as in screening for early cancer), and guiding surgical intervention in situations where surgery is performed near sensitive structures (such as guiding stent placement or in microsurgery for nerve and vessel repair). Since OCT is a fiber-optic-based technology, it can be interfaced readily to standard medical imaging devices such as catheters, endoscopes, and laparascopes. Thus, OCT holds immense promise for a wide range of clinical applications and markets and could impact significantly on future clinical care--saving lives and reducing health care costs. CDT plans to develop and commercialize advanced technology that will dramatically improve performance over today's OCT systems. This includes new high-power high-resolution optical sources; low-cost video-rate scanning modules; advanced signal processing algorithms and hardware; and new probe modules including catheters, endoscopes, and handheld units. The ATP funding is expected to accelerate the development of these high-risk technologies by at least two years. The technology also has applications in non-destructive testing and "on-line" process control for manufacturing facilities. The components may have further application to optical communications, sensors, and data storage as well as non-OCT imaging systems.

연구과제명 : (98-01-0167) Intelligent Control of the Semiconductor Patterning Process
회사명 : National Semiconductor Corporation
연구분야 : Microelectronic Fabrication Technology / Intelligent Manufacturing / Semiconductors

연구기간 : 3.0년
전체연구비(추정) : $18,292,775.00
ATP 지원금 : $9,110,456.00
연구요약 :
The U.S. economy depends heavily on advances in semiconductor-based integrated circuits (or chips). Historically, semiconductor cost per function has fallen by 25 percent to 30 percent annually, but in recent years the rate of improvement has slowed. To restore this trend, a joint venture of four companies and four universities led by the National Semiconductor Corp. plans to improve the uniformity of the semiconductor wafer patterning process, the most critical and capital intensive part of the fabrication process. Patterning involves the use of photolithography and other techniques to make very fine lines, 250 nanometers (nm) wide, on wafers. The research team plans to reduce these dimensions to less than 150 nm, identify causes of dimensional variations, and reduce the variations. Parameters will be identified that reflect wafer condition at each step of the process, and in-line sensors will be developed to monitor these parameters in real time. Algorithms will be developed to adjust processing parameters in response to sensor data. The new technologies then will be integrated into a practical, closed-loop manufacturing control system. ATP support enabled a prestigious team of semiconductor vendors, users, and academic researchers to be assembled to accelerate both the research itself and its eventual application in industry. If successfully developed, the new process will lead to reductions in the size and cost of chips and improved electrical performance as well as increased efficiency and extended life of capital equipment. The impact on the U.S. economy will be far reaching because semiconductors are vital to so many sectors, from the $900 billion electronics industry to its many customers, including the automotive, telecommunications, and computing industries. In addition, the new components developed in the project could be used to monitor other manufacturing processes and even consumer products. Other participants include FSI International (Allen, Texas), KLA-Tencor (San Jose, Calif.), Lam Research Corp. (Fremont, Calif.), Stanford University (Stanford, Calif.), the University of California at Berkeley, the University of California at Irvine, and University of Michigan (Ann Arbor, Mich.). Key subcontractors include Jack Mott (Idaho Falls, Idaho), Spain, Inc. (Portola Valley, Calif.), Integrated Systems, Inc. (Sunnyvale, Calif.), and IBM Global Production Solutions (Boca Raton, Fla.).

연구과제명 : (98-01-0168) Hot Metal Gas Forming
회사명 : Auto Body Consortium, Inc.
연구분야 : Automobile Manufacturing
연구기간 : 3.0년
전체연구비(추정) : $6,900,000.00
ATP 지원금 : $3,000,000.00
연구요약 :
Tubular metal structures offer significant advantages in automobile design. Stronger, and more

efficient in the use of metal, they can reduce vehicle weight by 5 to 15 percent. They can cost from 5 to 10 percent less than conventional stamp-and-weld assemblies, have better crash performance, better vibration and noise characteristics, and are more dimensionally stable. The major drawback today is the processing technology, called hydroforming, which has high capital costs, is relatively slow, and imposes significant design restrictions. A research team of the Auto Body Consortium proposes to develop a new metal-forming technology--hot metal gas forming (HMGF)--that would overcome many of these limitations, reducing processing costs by half and the time to build new tooling (and its cost) by 40 percent. HMGF derives from superplastic forming and hot-blow forming, used in the aerospace industry to form aluminum and titanium structures; these technologies are not now used in the auto industry because they are too slow and expensive and are not well suited to the carbon structural steels used in cars. Key research tasks include developing materials and techniques to create special HMGF dies coated with a graded ceramic surface to withstand the stresses of the forming process, developing improved steel alloy formulations to work with the HMGF process, and developing an intelligent process control technology based on feedback from sensors in the dies. The development and integration of an entirely new process technology in the auto industry entails significant risks; ATP support will enable a broad, multidisciplinary effort bringing together both large and small companies, including several without the R&D resources to pursue such a project without the ATP. Members of the ABC project team include Atlas Technologies, Inc. (Fenton, Mich.), Autodesk, Inc. (Novi, Mich.), Chrysler Corp. (Auburn Hills, Mich.), Erie Press Systems (Erie, Pa.), Ford Motor Co. (Detroit, Mich.), Hydrodynamics (Madison Heights, Mich.), Lamb Technicon (Warren, Mich.), Progressive Tool & Industries (Southfield, Mich.), Robotron (Southfield, Mich.), Rockwell Automation (Milwaukee, Wis.), Sekely Industries, Inc. (Salem, Ohio), TOCCO (Madison Heights, Mich.), Tower Automotive (Rochester Hills, Mich.), and Wayne State University (Detroit, Mich.). HMGF could enable significant design and processing improvements and cost savings in the U.S. auto industry. Chassis weight, for example, could be reduced by 20 percent while increasing strength, resulting in better performing, safer vehicles with better fuel economy.

② Tools for DNA Diagnostics Competition Results (7개 과제)

연구과제명 : (98-08-0003) DNA Diagnostics for the Point of Care Using Electronic Nucleic Acid Detection
회사명 : Clinical Micro Sensors, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 2.0년 (1998년 10월)
전체연구비(추정) : $3,792,101.00
ATP 지원금 : $1,908,567.00
연구요약 :
More than 30 million cases of food-borne illnesses are reported every year in the United States, with outbreaks becoming more frequent and more severe. The development of rapid, low-cost

technology for on-site testing could save millions of dollars now spent shutting down food production lines and investigating sources of contamination. "DNA chips" hold promise for such testing, but the systems developed to date have various technical limitations and remain too expensive for widespread use. Clinical Micro Sensors was founded by California Institute of Technology researchers who developed an electronic DNA detection method that could reduce costs dramatically by eliminating several analytical steps. In this ATP project, the company will incorporate the new method into low-cost, rapid, flexible DNA chip technology that would be suitable for routine use in the field and in doctors' offices. The CMS microchips contain electronically active pads, each attached to a different DNA probe. The genetic material from a biological sample attaches to matching probes and to other probes that are electronically labeled. When a voltage is applied, the labels produce electronic signals that can be analyzed in minutes by a handheld unit to identify and quantitate genetic sequences. Among its advantages, the CMS technology can in principle analyze single- or double-stranded DNA of any length from whole blood, suggesting that little sample preparation is needed. It is also very sensitive because of the unique sensor structure employing molecular wires embedded in organized monolayers on electrodes. The key technical challenge is to make the method sensitive enough to eliminate the need for the costly process of amplification (i.e., making many copies of the sample DNA to produce enough for analysis.) Even if this is not possible, the methodology is still potentially cost effective. The company will determine the necessary sample preparation methods, optimize probe sequences, improve detection limits, and make several prototype chips. The new technology will be tested using clinical samples in collaboration with the UCLA School of Medicine (Los Angeles, Calif.). Applications for the new technology could include the detection of environmental hazards and quick identification of both medical conditions and the most effective treatments.

연구과제명 : (98-08-0006) Liquid Array Technology Development
회사명 : AxyS Pharmaceuticals, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $15,089,611.00
ATP 지원금 : $7,393,910.00
연구요약 :

New analytical tools will be required to interpret, and maximize the benefits of, the vast amount of data generated by ongoing international studies of the human genome. Axys Pharmaceuticals and Luminex Corporation (Austin, Texas) propose to develop such a tool in the form of "liquid arrays" that will offer 100-fold improvements in cost, performance, and ease of use over the best existing methods for identifying genetic mutations and studying gene function. Liquid arrays will consist of polystyrene microspheres (about 5 microns in diameter) mixed together in solution. The microspheres will be labeled with different combinations of fluorescent dyes and can be separated in a flow cytometer by size, color, and fluorescence level. Different DNA probes can be built onto sets of uniquely colored microspheres and these complex arrays of probes can be used to analyze DNA from a patient sample for a wide spectrum of mutations. To be economically practical, the challenge is to develop an inexpensive fabrication technology for turning out many different customized microspheres that can tolerate the organic solvents used in making DNA probes, and the accompanying set of dyes to distinguish them. With ATP assistance, the partners plan to develop a programmable method for customized synthesis of up to 1 million different types of microspheres, instruments to synthesize and process arrays in 1536-well microplates, and software to manage the process and interpret data. With each well containing an array that synthesizes and analyzes up to 1 million pieces of DNA, a single microplate could perform more than 1.5 billion assays. The ATP funding is expected to accelerate the basic technology development process by three years and enable the design of large-scale arrays. Liquid arrays will significantly improve disease diagnosis, accelerate gene discovery and drug development, and reduce health-care costs. The technology also could promote the discovery of useful new chemical compounds, improvements in animal breeds and plant crops, and development of new herbicides and pesticides. In the multibillion-dollar pharmaceuticals industry alone, the economic benefits from this project are expected to be significant.

연구과제명 : (98-08-0007) Reference Laboratory LabChip DNA Diagnostics System
회사명 : Caliper Technologies Corporation
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $4,146,743.00
ATP 지원금 : $1,999,998.00
연구요약 :
Some 85 percent of medical diagnostic tests are performed in high-volume clinical reference laboratories. The platforms currently used by these labs cannot perform most DNA diagnostic tests. Caliper Technologies Corp. plans to develop a fully automated genetic analysis system built around the company's proprietary, miniaturized "lab-on-a-chip" systems. The planned system could reduce by orders of magnitude the time required for key aspects of DNA analysis while using tiny volumes of biological samples and reagents, enabling rapid genetic testing at perhaps one-tenth of current costs or even less. The overall concept--which emulates a platform already assembled by Caliper for use in high throughput drug discovery applications--includes a sample and reagent handling system, microchips and processing equipment, and software to interpret data and report results. The company's microchips contain a network of micromachined channels without valves. Wells at the ends of the channels hold samples or reagents, which are moved through the channels by the application of electric fields. Caliper has developed electronics that enable precise, accurate control of fluid flow. In the ATP project, the company will develop purification and concentration schemes to enable the use of nanoliter sample volumes, explore the feasibility of making and storing solid reagents that can be reconstituted, and develop several

different DNA-based tests. Caliper also will develop two prototype microchip assays with up to 100 parallel processing channels. The initial systems will be able to process about 50,000 experiments per work day. Eventually, a single piece of equipment incorporating 10 microchips could perform more than 1 million multistep experiments per day. The proposed technology will have applications in many industries including health care, agriculture, food and water testing, national defense, and forensic and paternity testing.

연구과제명 : (98-08-0014) Polymerase Signaling Assay for DNA Variation Detection on Universal Processor Arrays
회사명 : Orchid Biocomputer, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $2,966,686.00
ATP 지원금 : $1,954,313.00
연구요약 :
Although they offer high processing power in a convenient format, the current generation of DNA chips remain costly for mass market applications. Orchid Biocomputer proposes to address this market by developing "universal processor" technology that will enable rapid, inexpensive detection products. The proposed technology will combine several novel concepts. To minimize complexity while providing for sensitivity of analysis and standardized manufacturing, a universal array will be designed representing all possible chemical combinations of a set of small DNA probes of four to six nucleotides. Such an array would be sufficiently "generic" to be used for many types of tests and significantly less expensive than standard arrays featuring customized sets of probes. Novel biochemical processes will be developed to capture DNA from a biological sample and apply it to the array, and digital images will be created indicating the presence or absence of fragments that complement each probe. Pattern-matching software will be developed for reliable, real-time analysis of many arrays at once. A major technical challenge is the miniaturization and integration of all elements of the system. If successful, the proposed technology will reduce the cost and complexity and increase the speed and accuracy of routine genetic and biochemical testing, leading to increases in the numbers and types of tests available. The primary applications will be in genomics research, for SNP discovery and genotyping followed by clinical diagnostics, especially in the diagnosis of infectious diseases and eventually the selection of the most appropriate drug treatments for each individual (pharmacogenomics). Overall, the capability to easily identify each person's unique genetic variants is expected to shift the focus of medicine from therapeutic to preventive strategies, saving millions of dollars now wasted because of misdiagnoses and ineffective therapies. Other industries, such as food manufacturing and agriculture, also will benefit from the new technology.

연구과제명 : (98-08-0020) Multiplex DNA Diagnostic Assay Based on Microtransponders
회사명 : PharmaSeq, Inc
연구분야:
연구기간 : 3.0년
전체연구비(추정) : $2,518,000.00 Diagnostic and Therapeutic Biotechnology
ATP 지원금 : $1,978,000.00
연구요약 :

Although knowledge of the genetic basis of human disease is growing rapidly, few low-cost tools are available for detecting the DNA sequences implicated in a disease in a given individual. PharmaSeq proposes to develop such a system, which will use miniature radio transponders and a scanner to accurately detect and differentiate up to 10,000 different DNA alleles at once. PharmaSeq's transponder contains an integrated circuit fabricated on a small silicon cube, only hundreds of micrometers on each side. The circuit stores information that identifies the sequence of an attached probe and transmits that sequence to the scanner by radio frequency. A single assay will contain anywhere from 10 to thousands of cube-shaped transponders, each attached to a different DNA probe. The presence of DNA sequences in a biological specimen is determined by reacting fluorescent dye-labeled specimen DNA with transponders, each derivatized with a different probe. A scanner then detects and measures the fluorescent signal generated by the labeled specimen DNA and identifies which transponder(s) were involved in the reaction by means of laser activation of the transponder's memory. The scanner is a flow fluorometer modified by addition of electronic circuitry to detect radio frequencies. In the ATP project, PharmaSeq will design and construct prototype transponders, assays, and instrumentation that analyzes up to 1,000 transponders per second. A major technical challenge will be miniaturization of a light-activated transponder and construction of the scanner. The proposed system will be more selective and sensitive than conventional assays, and more flexible because it can be upgraded easily with the addition of new probes. The new system will be applied initially to DNA diagnostic assays, a U.S. market projected to reach $1 billion by 2002. The technology also could be used for blood screening, identity testing, forensics, DNA sequencing, pharmaceutical drug discovery, and studies of gene function. It is expected that combinatorial synthesis of small chemical compounds on the transponders, followed by screening for binding to targets of pharmaceutical interest will become a basic tool for drug discovery of the future. The light-activated microtransponders also might be useful in communications, security, and other industries.

연구과제명 : (98-08-0029) Multiplexed Sample Preparation Microsystem for DNA Diagnostics
회사명 : ACLARA BioSciences, Inc.
연구분야 : Diagnostic and Therapeutic Biotechnology
연구기간 : 3.0년
전체연구비(추정) : $3,597,887.00

ATP 지원금 : $1,998,826.00

연구요약 :

With markets for DNA analysis tools already in the hundreds of millions of dollars and growing rapidly, many technologies that could enhance the analytical process are being investigated. However, only modest attention has been devoted to automated sample preparation, despite the need to efficiently extract purified DNA from complex biological material prior to analysis. ACLARA BioSciences proposes to develop a miniature, disposable plastic card that integrates all sample preparation steps and provides substantial savings in labor and reagent costs. The plastic card would contain a "microfluidics" system, in which liquid moves through integrated microchannels where samples are prepared and then analyzed. The proposed system would consist of two primary components : isolation of the DNA extracted from cells, and a microscale reactor to amplify the small amounts of purified genetic material. In addition, parallel processing of multiple reactions will be demonstrated. Various chip designs will be fabricated at the Microfabrication Facility at the University of California at Berkeley. Once developed, the new sample preparation technology will be integrated with ACLARA's microfluidics DNA analysis system, creating a universal diagnostic platform. The new sample-preparation process, envisioned for both research and diagnostics markets, could reduce reagent costs for DNA sequencing experiments by two orders of magnitude. The ATP support is expected to reduce time to market by at least two years, potentially saving the nation millions of dollars in DNA sequencing experiments alone. Furthermore, the components developed in the project could be applicable to other microfluidics-based bioanalytical devices, such as those used in immunoassays and drug screening and discovery.

연구과제명 : (98-08-0031) Integrated, Micro-Sample Preparation System for Genetic Analysis

회사명 : PE-Biosystems (formerly Perkin-Elmer)

연구분야 : Diagnostic and Therapeutic Biotechnology

연구기간 : 3.0년

전체연구비(추정) : $20,529,961.00

ATP 지원금 : $9,563,632.00

연구요약 :

Rapid improvements in genetic analysis techniques, offering ever increasing speed and sensitivity at decreasing costs, are driving major advances in medical diagnosis and treatment, identity testing, and other fields. But this trend is slowed by the tedious sample-preparation process, which often involves several manual steps and long waits as biological materials are readied for analysis. The four partners in this joint venture propose to overcome these barriers by designing a set of integrated, miniature devices that will automatically prepare at least 100 samples at once, thereby increasing output, reducing costs, and enhancing data quality. The partners will implement each process in single-purpose "chips," combine them into integrated devices that perform all steps from sample input to purification needed to ready samples for several different analytical techniques. The research challenge will be to develop a cost-effective, integrated system that accepts raw samples from a variety of sources, including bacteria, plant, and mammalian cells, and prepares them for a variety of procedures, including electrophoresis, hybridization, and direct amplification. Various technical approaches - including membranes, enzymes, and a method for depositing single cells into tiny reaction chambers - will be pursued for the selection, amplification, and purification of genetic material. The disposable devices will be useful for sequencing unknown DNA in studies of the genetic basis of disease, comparing sample DNA to known sequences for low-cost medical diagnosis, and studies leading to the discovery of new drugs. Led by Perkin-Elmer's Applied Biosystems Division, with experience in developing genetic analysis systems, the joint venture also incorporates the expertise of 3M BioSystems (St. Paul, Minn.) in chemistry, materials science, and processing. Monsanto (St. Louis, Mo.) and Millennium Pharmaceuticals, Inc. (Cambridge, Mass.), will perform application-specific testing of the devices in plant and human genetics. Compared to conventional methods, the proposed technology is expected to offer lower costs per test, greater reliability and less sample contamination (because each device is used only once), and lower reagent volumes and costs. The devices will be useful in academic and industrial research as well as clinical applications and will substantially accelerate progress in understanding the range and variation in human, plant, and microbial genetics.

③ Digital Video in Information Networks Competition Results (4개 과제)

연구과제명 : (98-04-0006) Integrated Layered Compression System Prototype
회사명 : DemoGraFX
연구분야 : Other Information/Computers/Entertainment / Computer Systems and Software Applications / Imaging and Image Processing
연구기간 : 2.0년 (1998년 10월)
전체연구비(추정) : $2,505,300.00
ATP 지원금 : $2,000,000.00
연구요약 :

For each theatrical film, several generations of copies totaling more than 1,000 prints are typically made of the master for release to theaters. Image quality is degraded with each generation, and prints can be damaged during use, or fade over time. DemoGraFX plans to develop a prototype compression and decompression system to enable the secure end-to-end deployment of digital films, which retain image quality during copying, use, and storage. Such a system is needed because a typical motion picture contains terabytes of digital data, which exceeds existing storage and quality-control capabilities. The prototype compression engine will contain digital signal processors to reduce noise and provide encryption and other signal conditioning. It will be based on the company's existing layered compression technology, which provides spatial scalability at high resolution. This technology, however, must meet industry's need for near-real-time compression speeds, through innovative optimization of the compression algorithm, and for security, through innovations in the integration of watermarking and encryption technology, without affecting video quality. Technology also will be developed to provide real-time decompression and decryption in theaters. In addition, methods will be devised for controlling image and color quality from capture to projection. The new technologies will extend MPEG-2 video compression to enable digital cinema, which demands the highest quality video and the best possible intellectual property protection. While the benefits of conversion to digital cinema are significant and will help the United States maintain leadership in this lucrative market, the high-risk nature of developing a system that meets industry's needs for quality and security has deterred investment. If successfully developed and later commercialized, the new delivery system is expected to cost about the same as existing film-based projection systems. Movies could be distributed electronically to theaters, saving $400 million now spent annually on release prints for the top-grossing 250 U.S. releases. New U.S. industries could be established to handle scanning, compression, and delivery of digital prints, creating domestic and export markets potentially worth hundreds of millions of dollars. Spin-off applications of the new technology could include digital film archiving and satellite delivery of digital films and televised live events. A subcontractor, Mercury Computer (Chelmsford, Mass.), will build the hardware modules for compression and decompression.

연구과제명 : (98-04-0007) Compressed Live Object Video Interactive Singular (CLOVIS) Technology
회사명 : Physical Optics Corporation
연구분야 : Imaging and Image Processing / Computer Systems and Software Applications
연구기간 : 3.0년
전체연구비(추정) : $3,482,223.00
ATP 지원금 : $1,569,999.00
연구요약 :
A better system for compressing digital image data--especially digital video data--is one of the holy grails of communications technology. Even the best existing methods generally must trade off quality of the reconstructed images, bandwidth of the transmission, and--in the case of "live" video--the delay or "latency" of the reception. The problem is exacerbated greatly by new high-definition video. Physical Optics Corp. believes it has the answer in CLOVIS--Compressed Live Object Video Interactive Singular. CLOVIS will be based on combining two key POC innovations : an entirely new approach to image compression using a branch of mathematics called catastrophe theory (Isomorphic Singular Manifold Projection) and Intelligent Frame Management, a new high-motion video compression technique based on fuzzy logic and a genetic algorithm that eliminates redundant frames (frames where the image doesn't change enough to be detectable.) A key feature of ISMP is that it captures all the essential information of three-dimensional edges and boundaries in the image in mathematical objects that can be

expressed completely in a finite number of terms. The best competing compression techniques are based on modeling the image in terms of mathematical waves or other expressions that have essentially an infinite number of terms. Since they can't all be used, these methods must throw more information away in the compression process than ISMP. As a bonus, ISMP automatically encodes different physical objects as different mathematical objects, which can be extracted and manipulated by other software to provide animation or other special effects. POC estimates that CLOVIS should achieve compression ratios up to 20 times better than the best existing technology using only a low-cost PCMCIA processing board--and that's only needed for encoding; decoding the video could be done entirely with software. It would make possible, for example, two-way, real-time, broadcast-quality digital video over low-bandwidth channels, such as a single phone line. CLOVIS has the potential to enable implementation of the industry's forward-looking MPEG-4 standard. If successful, the video compression capabilities of CLOVIS could lay the foundations for a new industry that combines TV, telephone, and computer communications in a single multifunctional device--or dramatically expand the capabilities of any of the three. Fully developing CLOVIS goes well beyond the resources of POC, a small company, and the risky nature of the work has discouraged outside investment.

연구과제명 : (98-04-0016) Integrated Speech, Language, and Image Processing for Real-Time Creation of a Videoconferencing Library System
회사명 : MediaSite (formerly ISLIP Media, Inc.)
연구분야 : Other Information/Computers/Entertainment / Imaging and Image Processing
연구기간 : 3.0년
전체연구비(추정) : $1,953,514.00
ATP 지원금 : $1,671,009.00
연구요약 :
Because video is such a powerful tool for information exchange, it is playing an ever growing role in corporate communications, particularly through videoconferencing. A great deal of corporate knowledge, potential training materials, and other valuable information could be captured in videoconference recordings. Ideally, it could be searched easily based on items such as topic, speaker, or images. Any ardent home-video fan can identify the resulting problem : with countless hours of video recordings, how do you find the exact scene or piece of information you want? MediaSite was established to address the basic task. Its core technology, the MediaKey Digital Library System, incorporates state-of-the-art techniques in speech recognition, language understanding, and image recognition in a package that largely automates the tasks of cataloging and indexing computer-based video collections for later search and retrieval. MediaKey, however, takes time and computing power. At present, it operates up to 10 to 12 times slower than "real time" and requires a high-performance computing workstation for advanced functionality. It does best with clean, highly structured video, such as studio-recorded narration or news broadcasts. MediaSite now proposes a quantum leap in this technology, so

that it could capture more detailed information--face recognition, more accurate speech recognition, handwritten white-board information--in near real time from videoconferences. This requires not only an order of magnitude increase in the speed of the system but also the ability to deal effectively with considerably poorer video and audio quality.MediaSite also hopes to lower the hardware requirements significantly to the level of a PC or plug-in board.MediaSite is a small company and requires ATP support to pursue this research, which will push the state of the art in several directions, including language analysis, algorithm optimization, and parallel processing of several different analysis functions. If successful, MediaSite will bring to video much of the same power of data storage, selection, and retrieval that text long has enjoyed. In addition to greatly enhancing the value of videoconferencing for corporations and government, the technology will have other applications in interactive TV, education and training, and consumer products for home-video collections.

연구과제명 : (98-04-0024) Improving Digital TV Broadcast Reception
회사명 : General Electric Corporate R & D
연구분야 : Other Information/Computers/Entertainment
연구기간 : 3.25년
전체연구비(추정) : $3,326,848.00
ATP 지원금 : $1,520,071.00
연구요약 :
Digital television (usually called high-definition television, or HDTV) presents issues for "free" over-the-air broadcasting because of poor indoor reception in urban areas. A team led by GE Corporate Research and Development plans to develop and demonstrate improved receivers, antennas, and transmitters that will both meet new HDTV standards and enhance indoor reception quality. Because the impairments are complex and not fully understood, the first task is to characterize the indoor reception environment. Then advanced receiver technology will be developed, including improved techniques for estimating channel conditions, new algorithms for adjusting equalizer filters, and low-cost adaptive antennas. This research can lead to a system-wide solution that benefits an entire industry but would be too risky and far-reaching for any single company to pursue. The vertically integrated project team spans all research, product, and service areas needed to implement this technology by early in the 21st century. If successfully developed and later commercialized, the new enabling technology could catalyze new businesses in the consumer electronics, broadcast equipment, and media industries and create many new jobs in the next decade. Spillover benefits would include expanded household access to information and new technology for satellite and other communications systems. Other team partners include the National Broadcasting Company (Washington, D.C.); Thomcast Communications, Inc. (Southwick, Mass.); and Thomson Consumer Electronics (Indianapolis, Ind.).

④ Catalysis & Biocatalysis Competition Results (4개 과제)

연구과제명 : (98-05-0007) Whole Genome Shuffling : Rapid Improvement of Industrial Micro-organisms
회사명 : Maxygen, Inc.
연구분야 : Bioprocessing/Biomedical Engineering
연구기간 : 3.0년 (1998년 10월)
전체연구비(추정) : $3,124,400.00
ATP 지원금 : $1,249,760.00
연구요약 :

Bioprocesses--such as fermentation--convert renewable feedstocks to high-value pharmaceuticals, chemicals, food additives, and other products having a combined market value of perhaps $38 billion. To achieve continual improvements in yield from these processes, researchers typically subject the associated micro-organisms to sequential random genetic mutations and then screen the mutant strains for increased productivity. This method, however, achieves a maximum improvement of about 10 percent annually. Maxygen proposes to double this rate to 20 percent by developing and demonstrating a new process based on its proprietary "DNA Shuffling" technology. DNA shuffling accelerates the natural process of evolution by allowing pools of DNA fragments to "mate" in the test tube. In the ATP project, the company will extend this technology from subgenomic fragments to whole microbial genomes, with the goal to rapidly accumulate multiple beneficial mutations in the target organisms. A highly sensitive screening system will be used to identify the few (10 to 20) improved organisms having subtle increases in product yield from a larger mutant population (greater than 10,000). These techniques will be integrated and demonstrated using three commercial micro-organisms that produce a popular antibiotic for animal, a commodity chemical, and an enzyme for the production of high-fructose corn syrup. The greatest risk is that the resulting "shuffled" organisms will fail to show increased productivity. If successfully commercialized, the new process will reduce fermentation costs, improve product quality, and accelerate the development of new products and processes for a number of industries that rely on biocatalysis, such as those producing pharmaceuticals, generic drugs, etc. Maxygen is a small, cash-limited, start-up company. Without the outside help of the ATP, Maxygen would focus its limited resources to commercialize its existing technology.

연구과제명 : (98-05-0008) Integrated Four-Way Converter for Diesel Emission Control Project Brief
회사명 : Thermatrix, Inc.
연구분야 : Catalysis/Biocatalysis / Advanced Materials/Chemicals
연구기간 : 1.92년
전체연구비(추정) : $2,421,742.00
ATP 지원금 : $1,648,864.00

연구요약 :
Air pollution reduces U.S. productivity, increases the incidence of disease and premature death, and damages crops and the environment. Vehicle-related air pollutants, in particular, cost the global economy $20 billion to $200 billion annually. In the United States, diesel engines in urban buses and many other vehicles emit 65 percent of particulate matter (diesel particulates are a suspected human carcinogen) and 35 percent of nitrogen oxides (a component of smog). To reduce the costs of air pollution and improve environmental quality, Thermatrix, Inc. (San Jose, Calif.), proposes to develop an innovative technology that simultaneously reduces the four primary types of emissions from diesel engines. The device will integrate flameless thermal oxidation (FTO) with an innovative catalyst to provide four-way emissions aftertreatment within a muffler. Thermatrix already has commercialized FTO products for stationary applications that dramatically reduce industrial emissions of particulates, hydrocarbons, and carbon monoxide. Doing the same for vehicle engines is much more difficult. The non-catalytic FTO technology will be integrated with catalysts developed by Southwest Research Institute (San Antonio, Texas) that reduce nitrogen oxides under simulated exhaust conditions. The primary challenge is to design a combined device that cost effectively reduces all four types of emissions in mobile applications while making the appropriate trade-offs among technical requirements (e.g., size, cost, performance) to meet minimum market standards. It is not certain that catalyst performance can be improved sufficiently or that adequate temperature control can be achieved during engine cycling while still meeting cost targets. If the project is successful, the new technology will virtually eliminate particulates and hydrocarbons and reduce the other two types of emissions by more than 50 percent, meeting the expected future standards for diesel emissions in both the United States and Europe. Once commercialized, the device, which is expected to cost $1,000 to $5,000, could save the U.S. economy $10 billion to $100 billion annually. The initial market will be urban buses. Southwest Research and Ceryx, Inc. (Camarillo, Calif.), will act as subcontractors under the project, which includes testing of the integrated prototype. Without ATP cost-sharing, this teaming arrangement likely would not have occurred.

연구과제명 : (98-05-0013) Biosynthesis of Chemical Intermediates
회사명 : Henkel Corporation, Chemicals Group
연구분야 : Catalysis/Biocatalysis
연구기간 : 3.0년
전체연구비(추정) : $5,967,978.00
ATP 지원금 : $2,978,021.00
연구요약 :
This project focuses on a versatile family of chemicals that, because of limited availability and high prices, have not achieved their potential for enhancing the quality and reducing the costs of many products, from impact-resistant plastics to moisture-resistant adhesives. The Henkel Corp. Chemicals Group and GE Corporate Research & Development (Schenectady, N.Y.) plan to

develop a bioprocess for the production of low-cost, chemical intermediates that then can be used to make plastics and other value-added products from renewable (agricultural) feedstocks. Prototype biocatalysts and a microbe-mediated fermentation process already have been developed, but major challenges must be overcome to engineer an entire metabolic pathway for use as a practical tool. The partners will attempt to genetically engineer catalysts to achieve a significant increase in conversion rate, prevent the production of metabolic intermediates detrimental to the process, optimize fermentation to enhance yield, and develop methods of recovering and purifying products that will reduce the investment capital required for downstream processing. The new technology will increase productivity in the U.S. plastics, chemical, fragrance, and farming industries and provide a total of $470 million in benefits per year to producers and consumers of products made from the chemical intermediates. In addition, the "green" process will replace more polluting processes for producing similar chemical intermediates, save energy, and reduce reliance on non-renewable resources. A successful project should lead to a microbial platform technology for biochemical conversions with many, potential spill-over applications and economic returns that neither Henkel nor GE could capture fully. Further, the technical risks inherent in engineering an entire metabolic pathway within a micro-organism pose an unreasonable challenge for Henkel and GE to undertake alone. Ultimately, success in this biocatalysis platform technology could help expand the emerging industries associated with chemicals and plastics from renewable resources. Henkel, a world leader in manufacturing chemicals from natural fats and oils, will perform its ATP-funded work at its research facility located in Ohio, where the headquarters for its oleochemicals business is located. Other contributing companies and organizations include Sulzer Chemtech (Toronto, Canada), SpinTek Membrane Systems, Inc. (Huntington Beach, Calif.), Bend Research, Inc. (Bend, Ore.), and Argonne National Laboratory (Argonne, Ill.).

연구과제명 : (98-05-0020) A Phage-Display-Based Platform Technology for Engineering Selective Catalysts
회사명 : Dyax Corporation
연구분야 : Catalysis/Biocatalysis
연구기간 : 3.0년
전체연구비(추정) : $3,825,497.00
ATP 지원금 : $1,700,221.00
연구요약 :
Traditional methods for improving the performance of industrial enzymes rely on random mutagenesis of candidate enzymes, followed by screening a large number of individual mutants for improved catalytic properties. Dyax Corp. has in mind an entirely new, breakthrough approach, Phage Display, to rapidly develop highly selective enzymes, which can be used to synthesize valuable chemicals and pharmaceuticals. In phage display, foreign DNA is incorporated into the genetic material of phages (bacterial viruses) so that the corresponding foreign proteins are attached to the outer surface of the phages. Because of the very large number of offspring that viruses produce, Dyax can use phage display to generate huge libraries

containing most of the mutations likely to influence an enzyme's catalytic activity. Dyax already has used phage display to optimize a protein's amino acid sequence in one region of a peptide chain. In this ATP project, however, amino acid substitutions will be generated in several widely separated regions of an enzyme's polypeptide chain. The resulting phage display libraries then will be screened for enzymes having optimal activity. Dyax will optimize three enzymes for the production of chemicals used in making popular antibiotics, anti-asthmatic drugs, liquid crystals for flat-panel displays, unnatural sugars, and antiviral agents. The research is high risk because it is impossible to predict the effects of mutations on the active site of an enzyme. Without additional help, Dyax, a small, start-up company, cannot divert sufficient resources from its near-term, commercial opportunities for the development of this technology. If successful, the project will result in a platform technology with major impacts on the $375 billion U.S. chemical industry, the growing market (in excess of $90 billion by the year 2000) for enantiomerically pure forms of synthetic drugs, and the agrochemical industry. The proposed technology could reduce significantly the time needed to discover and develop novel enzyme-catalyzed industrial processes, and dramatic reductions could be achieved in the production costs and time to market of fine chemicals and pharmaceuticals. Professor Alexander Klibanov of MIT will provide consulting services in industrial enzymology, and the Bioprocessing Facility of Worcester Polytechnic Institute (Worcester, Mass.) will carry out large-scale fermentations to produce enzymes isolated during the ATP project.

⑤ Photonics Manufacturing Competition Results (10개 과제)

연구과제명 : (98-02-0001) Micro-Opto-Electro-Mechanical Systems Manufacturing
회사명 : Xerox Corporation
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 3.0년 (1998년 10월)
전체연구비(추정) : $13,963,150.00
ATP 지원금 : $6,914,104.00
연구요약 :
The United States dominates the global market for microelectromechanical systems but controls less than 10 percent of the market for photonics components. A new market now is emerging for combinations of these technologies. To provide an infrastructure for the eventual mass production of such devices at low cost, Xerox Corp., together with Maxim Integrated Products (Sunnyvale, Calif.); Microcosm Technologies, Inc. (Raleigh, N.C.); Optical Micro-Machines (San Diego, Calif.); Standard Microsystems Corp. (Hauppauge, N.Y.); and Microscan Systems, Inc. (Renton, Wash.), will develop technologies for efficient manufacturing of micro-opto-mechanical systems (MOEMS). Infrastructure support for this project will include the Industry-Cornell University Alliance for Electronic Packing (Ithaca, N.Y.); Cornell Nanofabrication Facility (Ithaca, N.Y.); the Center for Integrated Circuits and Sensors (Ann Arbor, Mich.); and Washington Technology Center (Seattle, Wash.). MOEMS will have many uses in generating, modulating,

guiding, amplifying, and detecting optical radiation. The consortium plans to develop a robust, low-cost process that controls the optical and other properties of devices and assembles and aligns them precisely, for multiple applications. The innate sensing and actuating capabilities of MOEMS systems will be used to automate on-chip assembly alignment, and calibration. Computer-aided design tools will be adapted to model optical systems. The partners will use the new process to fabricate prototype MOEMS devices at Standard Microsystems Corp., a commercial foundry. The ATP project brings together a team of technology developers and end users that otherwise would not exist to tackle complex, multidisciplinary research. If successful, the project would position the United States to dominate the emerging multibillion-dollar MOEMS market and increase its share of the roughly $40 billion photonics market. The technology will have broad applications in telecommunications, imaging, medicine, entertainment, and information systems.

연구과제명 : (98-02-0016) 100-Millimeter Semiconductor Wafer Processing Technology for InP-Based Photonic Devices
회사명 : Sensors Unlimited, Inc.
연구분야 : Optics and Photonics
연구기간 : 3.0년
전체연구비(추정) : $3,129,757.00
ATP 지원금 : $1,800,000.00
연구요약 :
Indium phosphide (InP) semiconductor wafers play a central role in the $1 billion market for imaging and optical communications technology. If the costs of InP-based devices (or chips) could be reduced, then many valuable new applications would be possible. Sensors Unlimited plans to develop and demonstrate new technology for manufacturing InP wafers that are 100 millimeters (mm) in diameter, double the current standard size, which would enable up to six times as many chips to be produced from each wafer. A major technical challenge will be to drastically modify conventional processing methods to minimize breakage of the very fragile 100 mm InP wafers. In addition, techniques must be developed for depositing uniform, high-quality indium gallium arsenide (InGaAs) device structures on the InP substrates. To add the precise amounts of necessary impurities, the company plans a novel diode fabrication step in which zinc will be diffused across the wafer at a temperature where InP normally decomposes. The company also plans to develop non-destructive techniques for determining wafer quality and demonstrate the fabrication of chips for infrared cameras. The ATP funding is expected to accelerate this research by three to five years. If successful, the project will reduce the cost of InP-based chips from $2,500 to $400 each and boost production volume. These more sensitive chips will be used in near-infrared cameras, which can increase safety and save lives by detecting ice on aircraft and roadways and improving night-time surveillance. Spillover benefits in many industries will include increased bandwidth in fiber-optic communications, affordable

collision-avoidance systems for cars, and non-invasive medical testing. Even if not fully successful, the project is expected to reduce costs and processing time for InP wafers. Economic benefits to the nation are expected to be in the hundreds of millions of dollars and include areas such as security and surveillance, health care, inspection, and telecommunications.

연구과제명 : (98-02-0021) Low-Cost WDM Optical Amplifier and Switch Manufacturing Technology
회사명 : GenOA Corporation
연구분야:Electronics/Computer Hardware/Communications
연구기간 : 2.5년
전체연구비(추정) : $5,341,800.00
ATP 지원금 : $2,000,000.00
연구요약 :
To accommodate growing use and data-heavy applications on fast fiber-optic communications networks, low-cost broadband optical amplifiers will be needed to increase bandwidth. Amplifiers now cost $10,000 to $35,000 each. To reduce these costs drastically, GenOA, a small start-up company, plans to develop low-cost technology for manufacturing a new type of optical amplifier. The proposed amplifier promises high speed, high efficiency, and use outside of the traditional amplifier bands. The new technology is not yet practical due to serious technical flaws that prevent it from operating at the power levels required in fiber-optic systems. The company plans to overcome this challenge by applying principles similar to those used in the electronics industry to increase the power output of the system. The company will model and build prototype amplifier technology and integrate it with a special circuit in a geometry that optimizes performance. The high level of technical risk and required investment has discouraged adequate venture capital funding for this project. The ATP funding not only will increase chances for technical success and reduce time to market for products later commercialized but will help ensure that this U.S.-invented technology also is commercialized in this country first. If successful, the new technology will reduce dramatically the cost of integrating and deploying optical amplifiers. The technology is likely to capture a major share of the rapidly growing $1 billion market for optical amplifiers and could boost significantly U.S. market share in photonics manufacturing. Spinoff benefits will include the wide deployment of low-cost terabit networks. Research equipment and facilities will be provided by the University of California at Berkeley, and custom fabrication services will be provided by several U.S. foundries.

연구과제명 : (98-02-0023) Optical Polymers and Manufacturing Processes for Low-Cost WDM Devices and Systems
회사명 : Lightwave Microsystems
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 3.0년
전체연구비(추정) : $10,363,359.00

ATP 지원금 : $5,097,550.00
연구요약 :
The capacity of telecommunications networks could be increased vastly by wider deployment of wavelength division multiplexed (WDM) fiber-optics, but only if the costs of manufacturing and assembling WDM components can be reduced. Following the example set by the electronics industry when it devised new technologies to mass produce integrated circuits, Lightwave Microsystems Corp. and B.F. Goodrich Performance Materials (Cleveland, Ohio) plan to develop new materials, device structures, and fabrication processes that will lead to low-cost manufacturing of integrated photonic assemblies. The intent is to enable local and urban networks to use WDM, in which multiple signals at slightly different wavelengths are combined into one signal and then separated at the receiving end. Sophisticated wavelength-selective components are needed to handle all the different wavelengths. New classes of passive, active, and amplifier polymers will be created and used in designing low-cost waveguides (which connect optical elements) and switches, amplifiers, and integrating lasers to activate the optics. New processes for fabricating integrated components on wafers will be developed and used to make prototype devices, including reconfigurable multiplexers (which add and drop signals), cross-connects for dynamic routing, and low-cost optical amplifiers to improve signal quality. The ATP funding will accelerate the joint research greatly and enable the development of key technologies that otherwise would not be pursued. If successful, the project could lead to threefold or greater reductions in the costs of WDM systems, saving billions of dollars on the installation of WDM in cable television and telephone networks and enabling all-optical WDM networks. In addition, the new device designs may increase network flexibility and robustness, increase the speed of computers and optical modems, and improve optical data-storage capacity and access time. The University of Alabama at Birmingham will generate device specifications and assist with testing, and the Department of Chemistry at Kent State University (Kent, Ohio) will help design and synthesize materials.

연구과제명 : (98-02-0024) An Integrated Simulation Environment for Photonics Manufacturing
회사명 : Telcordia Technologies (formerly Bell Communications Research, Inc.)
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 5.0년
전체연구비(추정) : $22,750,450.00
ATP 지원금 : $10,735,698.00
연구요약 :
Although photonics technology is becoming more important in communications, imaging, data storage, and other systems, the U.S. photonics industry is struggling. A key deficiency is the lack of an open development framework and integrated simulation tools for evaluating photonic components, systems, and network designs quickly, reliably, and inexpensively before they are built. An eight-member consortium led by Bell Communications Research plans to develop an

open, multilevel computer simulation environment that will reduce the time and costs associated with manufacturing photonics components by a factor of five while also increasing reliability and yield. The planned system will accommodate an expandable library of tools that can generate designs at the network, equipment, component, and device levels. Efficient data exchange will enable designers to predict the effects of changes at one level on other levels. In addition to developing and validating the models and tools, the consortium will optimize overall system performance. The key technical challenges will be to achieve sufficient accuracy and speed of prediction at all levels as well as adequate integration, both among the new tools and between them and the existing electronics simulation framework. The ATP funding will enable the joint venture partners--commercial and academic software developers and vendors, photonics designers, and manufacturers of photonics systems and network equipment--to design an open, integrated simulation environment with interoperable tools instead of pursuing proprietary subelements of the system to meet individual needs. If successful, the project will help the U.S. photonics industry prosper in a growing market. The new technology will be applied first in the communications sector but also will help reduce costs and improve products in many other industries, including medicine, transportation, computers, defense, and entertainment. The other partners are Lightwave Microsystems Corp. (Santa Clara, Calif.); RSoft, Inc. (Ossining, N.Y.); Science Applications International Corp. (McLean, Va.); SDL, Inc. (San Jose, Calif.); Columbia University (New York, N.Y.); and Nortel Networks (McLean, Va.). A key subcontractor is Hewlett-Packard Co. (Westlake Village, Calif.).

연구과제명 : (98-02-0031) Advanced Processes for Photonic Manufacturing
회사명 : SDL, Inc.
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 3.0년
전체연구비(추정) : $5,835,260.00
ATP 지원금 : $2,859,295.00
연구요약 :
Optoelectronics manufacturing typically involves a laborious, semi-manual process of assembling optics, lasers, and other components into devices. This costly packaging process results in expensive devices. SDL, Inc., is leading a joint venture to develop new technologies for automated batch processing that, if later commercialized, could reduce substantially manufacturing costs and time to market for many optoelectronic devices while also increasing yield. The research team--four companies constituting a vertically integrated supply chain--will build a universal fixture holding 10 to 100 mounts, a robotics system that can handle and accurately position fragile optical components, and new technology for attachment of components in place. A laser with an expanded beam shape will be used as a means of relaxing the alignment tolerances, which are normally very tight, for optical fibers and lenses. Simulation tools will be developed to model laser designs, and automated test equipment will be built to

measure the optical and electrical characteristics of packages very rapidly. In addition, integrated optoelectronic chips will be designed to incorporate fewer and smaller components that can be assembled by robots. The team will demonstrate the new technologies by making a laser module for an optical-fiber network. The ATP funding will enable the team to pursue parallel development of an integrated set of path-breaking technologies instead of individual projects on lower-risk elements of this concept. If successful, the project will lead to order-of-magnitude reductions in the costs of photonics components, potentially saving the U.S. photonics industry several billion dollars annually in packaging and testing as early as 2002 and boosting its 10 percent share of the photonics market, projected to exceed $100 billion by around 2005. The new technology will have broad applications in telecommunications, information and sensor technology, health care, and education. The other partners in the joint venture are Adept Technology, Inc., (San Jose, Calif.); RSoft, Inc. (Ossining, N.Y.); and Newport Corp. (Irvine, Calif.).

연구과제명 : (98-02-0034) IMOS Infrastructure for Photonics Manufacturing
회사명 : Digital Optics Corporation
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 2.0년
전체연구비(추정) : $2,880,726.00
ATP 지원금 : $1,656,174.00
연구요약 :
The optoelectronics industry continues to rely on costly manual assembly of disparate components, lacking the systems-level engineering capability, testing methods, and other technologies needed for automated processing of integrated devices. Emulating the approach used by the microelectronics industry to make very small, inexpensive integrated circuits, Digital Optics Corp. will develop and demonstrate the processes needed to implement prototype wafer-scale integration of miniaturized optoelectronic components. The project centers around the concept of an integrated micro-optical system (IMOS), which is a low-cost, compact module (a few millimeters wide) consisting of optics, lasers, detectors, and electronics that are aligned and assembled on a wafer into complex, three-dimensional systems. Many technical challenges must be overcome to make IMOS a reality. Various software packages and data formats must be integrated into simulation and design tools that account for the thermal and mechanical interactions of the components, mounting fixtures, and coatings. New processes must be developed to align and bond wafers, integrating diffractive and refractive optics. Advanced heat management methods and reduced alignment tolerances will be needed. In addition, lithographic techniques and materials must be adapted to make uniform, high-precision micro-optics. Other challenges include wafer-level integration of components, including bonding of lasers to optics, and the development of methods for automated testing and connecting components. If successfully developed, the new technology will enable substantially reduced opto-electronics device cost, size, and development cycles. The ATP funding will accelerate the research greatly,

leading to the commercialization of IMOS several years sooner than otherwise would be possible. The technology will offer valuable economic and quality-of-life benefits through its use in numerous next-generation commercial and military products for telecommunications; data storage; retail applications; and sensors for medical, environmental, and industrial applications. In addition, the low cost and small size of the modules will expand markets and lead to new products and jobs. Suppliers of components such as laser diodes, detectors, and optics also will benefit from the increased demand.

연구과제명 : (98-02-0055) Chemical Imaging for Semiconductor Metrology
회사명 : ChemIcon, Inc.
연구분야 : Optics and Photonics
연구기간 : 3.0년
전체연구비(추정) : $6,531,571.00
ATP 지원금 : $2,936,781.00
연구요약 :
The cost of medical X-ray machines, night-vision equipment, and other photonics systems (such as those used in industrial process control) based on II-VI and III-V semiconductor materials could be reduced if the manufacturability of the semiconductors used in such equipment was improved. Many economically important semiconductors are very difficult to manufacture--yields are low, costs are high, and the industry lacks the key metrology tools needed to monitor and improve production processes. To that end, ChemIcon, Inc., and II-VI, Inc. (Saxonburg, Pa.), plan to design and demonstrate an easy-to-use instrument for automated, non-destructive inspection of structural defects in compound semiconductor wafers. The instrument, known as Chemical Imaging for Semiconductor Metrology (CHISM), will digitally fuse high-resolution data gathered with several quantitative imaging techniques and interpret the results in real time. The system will consist of a laser, computer, and various imaging components to gather data on semiconductor composition and structure. Polarized light will be used to identify strain defects, and imaging infrared absorption and photoluminescence will provide additional details about defects and material quality. Imaging Raman spectroscopy then will be used for a more detailed assessment of defect composition, structure, and morphology (i.e., size, shape, and architecture). The greatest technical challenges lie in developing software algorithms that operate in real time and that correlate sensor data to processing defects that limit device performance. The research team will develop optics to identify and analyze defects smaller than 1 micron and employ tunable filter technology using liquid crystals. The CHISM will be used at key processing steps to determine how and when defects form in semiconductor devices. The ATP funding will accelerate the development of this technology by an estimated 10 years. If proven successful, the CHISM will increase the speed and effectiveness of defect identification and characterization, thereby increasing yield for semiconductor devices that have been difficult to produce. Manufacturing cost may be reduced by up to 60 percent. The potential market for the instrument

exceeds $250 million among manufacturers of semiconductors, microelectromechanical systems, coatings, and thermoplastics. Subcontractors include Cambridge Research and Instrumentation, Inc. (Boston, Mass.); the Naval Research Laboratory (Washington, D.C.); Sanders Microelectronics Center (Nashua, N.H.); West Virginia University (Morgantown, W.Va.); and a consultant, Dr. Ray Wick (Albuquerque, N.M.).

연구과제명 : (98-02-0058) Manufacturable Solid-State Lighting
회사명 : Nitres, Inc. (formerly Widegap Technology, LLC)
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 3.0년
전체연구비(추정) : $5,882,386.00
ATP 지원금 : $2,882,369.00
연구요약 :
Standard white lights have several major drawbacks, including the inefficiency of incandescent lamps and the hazardous material (mercury) contained in fluorescent lamps. Both of these problems could be eliminated if lamps were made of light-emitting diodes (LEDs). Widegap Technology (WiTech) and the General Electric Co. (Schenectady, N.Y., and Cleveland, Ohio) plan to develop new materials and processing technologies to demonstrate cost-effective manufacturing of solid-state, LED-based white lights. The joint venture will capitalize on the recent advent of high-efficacy, short-wavelength LED devices to make lamps offering three times the light output, much greater efficacy (50 lumens per watt), and 100 times the lumens per dollar than that offered by existing white LEDs. To accomplish this objective, the companies will improve the performance of gallium nitride (GaN) semiconductor devices, or chips, through advances in LED structure and heat management. An inorganic phosphor blend will be integrated into the chip or packaging to efficiently convert the short-wavelength radiation emitted by the precisely "tuned" LED to visible white light. Processes for making GaN materials will be modified to achieve high quality and yield, and novel silicone-based polymers will be fabricated to make packaging that will not be discolored by the short-wavelength light. The new technologies then will be used to make proof-of-concept flashlights and light bulbs. The fabrication of reliable, uniform devices with all the requisite characteristics while maintaining low cost will be very difficult. The project brings together a start-up that has cutting-edge GaN technology and a major U.S. lighting manufacturer to create a technology to challenge the solid-state LED market, where foreign competition is strong. If successfully developed, the new technology could save many millions of dollars in energy costs and create new markets for chips and bulbs in applications ranging from automotive lighting to traffic signals and computer backlighting. The new materials and device designs also will benefit the semiconductor and photonics industries. Non-lighting applications for the LEDs could include projection displays, high-density optical data storage, satellite and cellular communications devices, and laser surgery.

연구과제명 : (98-02-0061) DataPipe
회사명 : 3M Company
연구분야 : Electronics/Computer Hardware/Communications
연구기간 : 3.0년
전체연구비(추정) : $8,454,363.00
ATP 지원금 : $4,175,976.00
연구요약 :

Exponential increases in computer processing speed soon will outpace advances in the data-carrying capacity of the cables and wires that connect the elements of computing and communications networks. A logjam is likely if interconnections are not improved. A vertically integrated team of six companies led by 3M will develop scalable infrastructure technologies to enable low-cost manufacturing of multiple generations of wide, parallel optical data links offering roughly 10 times the capacity of the best available commercial technologies. To achieve high link performance at low cost, the research team will develop an array of new technologies. These will include precision-molded ceramic connectors, transceivers consisting of optoelectronic devices integrated with low-cost integrated circuits (or chips) to reduce the number of parts and simplify assembly, "smart link" controls to adjust performance and relax manufacturing tolerances, low-cost alignment techniques for mating optoelectronic devices to fiber arrays, and modeling and simulation tools for redesigning links to achieve new performance objectives. The companies plan to make and test a 36-fiber demonstration link. The target data rate for each fiber is 1 to 2 gigabits per second, with manufacturing costs comparable to conventional copper wires. If successful, the project could enable U.S. companies to dominate the market for ceramic multifiber connectors, projected to reach $3 billion by 2006. Productivity would rise in many industries because cost-effective supercomputing would be possible using clusters of inexpensive desktops. Spin-off benefits could include high-precision ceramic components for the medical and automotive industries and optoelectronic component subassemblies for printing, bar-code scanning, and sensors. The other partners in the joint venture are Honeywell Technology Center (Minneapolis, Minn.); RSoft, Inc. (Mountain View, Calif.); Coors Ceramics Co. (Golden, Colo.); CFD Research Corp. (Huntsville, Ala.); and Precitech, Inc. (Keene, N.H.). Simulation software will be developed by the Center for High Technology Materials at the University of New Mexico (Albuquerque, N.M.).

⑥ Premium Power Competition Results (13개 과제)

연구과제명 : (98-03-0002) Preparation and Fundamental Evaluation of Catalytic Materials for Energy Applications
회사명 : Superior MicroPowders
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 3.0년 (1998년 10월)

전체연구비(추정) : $3,842,811.00
ATP 지원금 : $2,000,000.00
연구요약 :
Superior MicroPowders (SMP) proposes to develop a novel manufacturing process for producing high-purity, well-characterized electrocatalysts for use in batteries and fuel cells. If successful, their project will remove a major barrier to the development of two potentially important electric power technologies : metal/air batteries and proton exchange membrane (PEM) fuel cells. Rechargeable zinc/air batteries could threaten the dominant lithium-ion batteries of foreign competitors for the premium notebook computer and mobile communications markets, but at present they are in limited use. PEM fuel cells also have a limited market now, but with improved cost, power, and life expectancy would appeal widely to homes, businesses, and eventually electric vehicle manufacturers. Both the batteries and the cells rely on electrocatalysts that are primarily precious metal/carbon composite powders, but the performance of these catalysts has fallen far short of ideal. This is blamed on the properties of the constituent particles. Performance could be maximized if the uniformity in size (on the order of microns--millionths of a meter), shape, composition, and other characteristics of the particles could be better controlled at these particle sizes. SMP plans to develop a novel processing method, determine the suitability of the resulting powders for battery and fuel-cell applications, and determine how to control the powder properties as manufacturing capacity increases to satisfy demand. This processing method allows control over two features of electrocatalyst powder structure that are critical to their performance : control over the macrostructure --particle size, morphology, and particle-size distribution-- that is expected to enable more advanced deposition methods and electrode architecture; and better control over the microstructure by improved dispersion of the catalyst (typically a precious metal) within each particle to achieve improved electrochemical performance. A small company, SMP does not have the resources to pursue this technology without ATP support. Success, however, would broadly enable other technologies powered by the improved batteries and fuel cells. The advances from a successful project, and even knowledge gained from partial success, would benefit many kinds of batteries and fuel cells and could lead to molecularly engineered powders for other applications.

연구과제명 : (98-03-0008) Modular 2KVA Fuel Cell Power Plant with Live Replaceable, Self-Hydrating, PEM Smart Cartridges
회사명 : Avista Labs
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 2.0년
전체연구비(추정) : $3,224,510.00
ATP 지원금 : $1,999,786.00
연구요약 :

Fuel cells generate electricity without combustion through electrochemical reactions in which hydrogen from a hydrogen-rich fuel and oxygen from air combine to produce electricity, water, and heat. Simple, quiet, clean, uninterruptible fuel cells to supply electric power would be attractive to many homes and businesses if the cells can be made to meet or beat the cost of energy supplied by utilities. Washington Water Power's affiliate, Avista Labs, proposes to break this cost barrier with an innovative design for making proton exchange membrane (PEM) fuel cell power units. Avista Labs' fuel cell power units are composed of PEM cartridges that can be replaced without interrupting generation and can use the water produced in conjunction with fan-forced air to promote cooling and self-hydration. These features simplify system performance by reducing balance-of-plant to a minimum. The advanced cartridges will incorporate embedded control functions to protect membrane electrode assemblies (MEAs) from conditions leading to loss of life or failure. To reach the aggressive cost goal, Avista Labs will have to press the state of the art in the ways components are designed and made. Avista Labs faces significant challenges in the areas of innovative current collection; integration of a compact, low-cost fuel processor; substantial improvements in MEA and cartridge production methods; and finally in the area of integrating the interconnect, control, and protection electronics. If the design challenges can be met, they should enable the eventual production of modular, cost-effective 2-5 kilowatt fuel cell power units. Catalytica Advanced Technologies (Mountain View, Calif.) and REB Research & Consulting (Oak Park, Mich.) will be involved in the fuel processor development. Molecular Simulation, Inc. (San Diego, Calif.) and other U.S. firms will cooperate on other aspects of the project and in the supply of services and materials. The ATP funding will enable Avista Labs to accelerate development of their novel fuel cell technology by several years. Initial applications will include backup power and situations where high-quality power is needed. In addition to providing a new source of cost-effective, high-quality, decentralized power, a successful project would encourage greater use of alternate fuels such as methane, methanol, and propane.

연구과제명 : (98-03-0011) Passive Magnetic Bearings for Power Quality Flywheel Systems
회사명 : Trinity Flywheel Power
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 2.0년
전체연구비(추정) : $1,618,175.00
ATP 지원금 : $800,000.00
연구요약 :
Flywheels floating in magnetic fields and spinning at supersonic speeds soon may provide backup power to protect computer systems and continuously operating machinery from costly momentary power outages and sharp voltage "spikes." The nation loses some $12 billion every year from such problems. Flywheels can release higher short-term power than virtually any other energy storage medium, and every dollar spent on backup flywheel systems saves an

estimated three dollars in losses. A typical flywheel is a cylinder about one foot high and nine inches in diameter, made of a composite rotor weighing some 60 pounds, and spinning at up to 600,000 rpm. Serving as a generator, a single flywheel could supply up to 250 kilowatts--enough to maintain power for a small hospital's critical equipment (or the lights and appliances in 125 houses) for about 20 seconds until emergency power sources take over. The life and performance of flywheels are limited mainly by the drawbacks of conventional bearings. Trinity Flywheel Power proposes to develop long-lived flywheel systems with levitating magnetic bearings that need no lubrication or maintenance, and never wear out. The greatest problem the company faces is shaping and maintaining a magnetic field with high precision to keep the whirling, powerful flywheel stable over its 10- to 20-year life. Instabilities could cause the unsecured flywheel to release its energy instantaneously within its containment. Complicated, expensive systems that actively adjust for instabilities have proved impractical. Trinity proposes to design a practical, passive system for levitating the rotor using a combination of permanent magnet pairs and induced current circuits. A major difficulty arises because there are no mathematical models to analyze the extremely complex interplay of varying mechanical, magnetic, and electrical forces. Trinity will attempt to create these models, assisted by Lawrence Livermore National Laboratory (Livermore, Calif.), which pioneered levitating magnetic bearings. A small start-up company, Trinity has been unable to attract private capital for this research because of its high technical risk. Successful passive magnetic bearings, however, will be more cost effective than traditional ball bearings because they are subject to considerably less wear. The basic technology might result in practical magnetic bearings for low-friction motors, pumps, and other machinery with rotating parts and could lead to improvements in magnetically levitated trains and other vehicles. Even partial success could produce magnetic technology to reduce loads in ball bearing systems.

연구과제명 : (98-03-0022) Novel Process for High-Efficiency Copper-Indium-Gallium-Diselenide (CIGS) Photovoltaic Modules
회사명 : International Solar Electric Technology, Inc.
연구분야 : Energy Resources/Petroleum
연구기간 : 3.0년
전체연구비(추정) : $1,541,333.00
ATP 지원금 : $1,294,680.00
연구요약 :
A major obstacle to widespread adoption of solar energy is the high cost of cells that convert sunlight to electricity. International Solar Electric Technology, Inc. (ISET), proposes to develop a low-cost fabrication technology for one of the best-performing, but as yet uneconomical, thin-film solar cells. These are based on a compound known as CIGS, composed of copper, indium, gallium, and selenium. CIGS now is made by depositing and combining the constituent elements on the substrate in vacuum. Achieving the right ratio of elements uniformly throughout

the thin-film layer is extremely difficult, and high-volume manufacturing is prohibitively expensive. ISET's solution is to start with chemical compounds of the CIGS elements, thereby achieving a fixed chemical composition. These compound materials are suspended as powder pigments in a liquid to make an ink which can be "painted" over large areas and, in principle, easily made into working solar modules. As there is no vacuum, and the ratio of the elements is fixed in the powder, this technique offers simple but precise fabrication that should be less expensive than other methods. Adding gallium to the compound to make CIGS presents major challenges by greatly complicating the chemistry, however. The company will research the effectiveness of various gallium chemistries to form CIGS, search for a method of doping CIGS to maximize performance, and investigate the experimental technique of rapid thermal processing for making these solar cells. If successful, ISET believes the technology could be used to manufacture cells that convert 17 percent of incoming solar energy into electricity. Cost of manufacturing solar cells for terrestrial use would be less than $1 per watt generated, which is the threshold for creating a broad market. The first terrestrial application will be for high-quality power in digital switching equipment used for wireless communications. Specialty versions will be used in space, primarily for Low Earth Orbit satellites, where cost is especially important. ISET is a small company, and ATP support will allow them to develop the basic photovoltaic technology to the point where it could attract private support. In addition to the early application in solar energy power modules for remote and distributed applications such as satellites, Earth stations, and cellular sites, the basic ISET non-vacuum manufacturing technology also might be important for manufacturing other large-area, thin-film, electronic devices.

연구과제명 : (98-03-0026) Higher Voltage, Lower Impedance Aerogel Ultracapacitor
회사명 : PowerStor Corporation
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 2.0년
전체연구비(추정) : $3,353,540.00
ATP 지원금 : $2,000,000.00
연구요약 :

The next generation of personal computers, cell phones, pagers, and similar electronic devices requires advanced high-power ultracapacitors to generate bursts of power when needed. Ideally, these new components would operate at 40 percent higher voltage than present ultracapacitors, exhibit only 5 percent of the electrical resistance and 2 percent of the power-robbing inductance, and last through at least a billion charge/discharge cycles--1,000 times more than present technology allows. PowerStor Corp. proposes to achieve these advances by radically pushing the performance envelope of ultracapacitors based on electrodes of aerogel carbon, a form of the element sometimes called "frozen smoke," with an extremely high surface area and a large number of ultrafine pores. The company will explore new ways to make the aerogel that would result in improved characteristics and will investigate metal oxide-aerogel composites with high surface area. Aiming for a rating of 3.5 volts--compared to the 2.5 volts of present capacitors--PowerStor will develop new organic electrolytes. The company will miniaturize the capacitors and design them as flat packs that can be mounted like semiconductor chips in the end products. Key technical barriers include developing a stable electrolyte for the higher voltage and controlling the aerogel synthesis chemistry to achieve optimum device performance. Subcontractors Ocellus, Inc. (Alameda, Calif.) will develop means to enhance the properties of aerogel carbon; Covalent Associates Incorporated (Woburn, Mass.) will advance the state of the art of organic electrolytes; and Rockwell Science Center (Thousand Oaks, Calif.) will provide electrochemical characterization. Since Powerstor is a small company, ATP support is necessary to develop the novel technology to the point where it can attract private investment. Successful development will create an enabling technology that can power the next generation of notebook computers and cellular phones. A host of additional applications is expected to follow, including other consumer products, automotive electronics, and systems to control electric power. Anticipated advances in electrolyte technology also could improve the performance of batteries.

연구과제명 : (98-03-0027) Asymmetric Supercapacitor Based Upon Nanostructured Active Materials
회사명 : US Nanocorp, Inc.
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 3.0년
전체연구비(추정) : $900,000.00
ATP 지원금 : $441,000.00
연구요약 :
Today's supercapacitors, while offering the high burst-power performance important to next-generation mobile electronics, suffer from low energy capacity when compared to batteries. A joint venture led by US Nanocorp aims to change this by developing a new kind of supercapacitor with energy densities (20 watt-hours per kilogram) comparable to that of batteries while delivering superior burst power and virtually unlimited cycle life (more than 100,000 recharges.) The technology developed by this project will be broadly enabling for many uses, including cell phones, uninterruptible power supplies, and eventually hybrid gasoline/electric automobiles. The joint venture also includes JME, Inc. (Shaker Heights, Ohio); Florida Atlantic University (Boca Raton, Fla.); and Eveready Battery Co. (Westlake, Ohio). Unlike today's devices that use two electrodes of the same material, this project will use asymmetric electrodes--made of different materials--yielding a device with double the capacitance of conventional capacitors and eight times the energy storage capability. To achieve the high surface areas needed for high capacitance, the partners propose to make their electrodes with nanostructured materials--particles whose size is on the order of billionths of a meter. The supercapacitors will owe much of their advanced performance to the vast surface areas that nanoparticles afford--just one gram of nanostructured carbon has an amazing surface area of 400 square meters. In striving for one of the first practical applications of nanotechnologies, US

Nanocorp and Florida Atlantic will advance the state of the art in developing novel anodes and cathodes in a whole new supercapacitor device structure. The partners face the challenge of demonstrating that nanomaterials can be made with good electrochemical and physical properties in a working supercapacitor device. JME will design, fabricate, and evaluate prototypes, and Eveready will conduct full-scale test evaluations. The new supercapacitors are anticipated to replace batteries in many applications, offering the advantages of an almost indefinite number of charge/discharge cycles; rapid cycling (over 100 times a second); high currents (over 2,000 amps); no maintenance; and non-toxic, relatively inexpensive components. A successful project is expected to yield a myriad of new applications to portable electronic devices and create new basic technologies contributing to battery improvements and nanostructured materials development.

연구과제명 : (98-03-0029) Lightweight, Flexible, High-Efficiency CIS-Alloy Tandem Photovoltaic Devices
회사명 : Global Solar Energy, L.L.C.
연구분야 : Energy Resources/Petroleum
연구기간 : 3.0년
전체연구비(추정) : $2,792,359.00
ATP 지원금 : $1,999,939.00
연구요약 :
Practical use of photovoltaic (PV) technology, which converts sunlight to electricity, is constrained by price, conversion efficiency, and the weight of existing systems. Advances in PV technology, especially reductions in cost, would expand existing markets and create new ones. Global Solar Energy plans to develop new materials and processes for making lightweight copper-indium-diselenide PV modules offering a conversion efficiency of 20 percent. The "tandem device" design will consist of two stacked cells made of light-absorbing layers of polycrystalline metal alloy thin-film materials (with each layer tuned to a certain portion of the spectrum) fabricated on lightweight, flexible polymer substrates. Analytical models will be developed to describe and predict device performance. Materials will be identified and their photoelectronic properties optimized for both top and bottom cells and the junction between them. "Intelligent" processing sensors and software will be developed to control large-area, high-yield device manufacturing. In addition, technology will be developed to interconnect cells into modules. Data on actual device structure and performance will then be used to analyze the potential for producing 150 watts per kilogram in a space-based solar array. The ATP funding will accelerate the development of this technology. If successfully developed and later commercialized, the technology will enable 10-fold reductions in the cost of space-based PV arrays for satellite-based telecommunications, military, and other applications and increase the efficiency and affordability of terrestrial PV systems. Projected module costs (which constitute about 50 percent of total system costs) would be less than $1 per watt, low enough to dramatically expand the $600 million world market for PV technology. Benefits to the nation

could include the widespread use of broadband satellite networks (the "Internet in the Sky") and environmental advantages such as reduced use of non-renewable fuels and fewer harmful air emissions. The new thin-film technology also could be applied to make a variety of new or improved optical, sensor, and other types of products. Key subcontractors include the University of Delaware's Institute of Energy Conversion (Newark, Del.) and ITN Energy Systems, Inc. (Wheat Ridge, Colo.).

연구과제명 : (98-03-0030) Reduced-Temperature, Electrode-Supported, Planar (RTESP) Solid Oxide Fuel Cell (SOFC) System for Premium Power Applications
회사명 : Materials and Systems Research, Inc.
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 3.0년
전체연구비(추정) : $3,046,294.00
ATP 지원금 : $1,990,847.00
연구요약 :
Conventional electric power systems have several drawbacks, including interruptibility, air pollution, and high energy-distribution costs. Fuel cells, which convert chemical energy (from the electrochemical oxidation of gaseous fuels) into electricity, could provide on-site electric and thermal energy while eliminating distribution costs and blackouts and reducing air pollution. Materials and Systems Research plans to design and demonstrate compact solid oxide fuel cell (SOFC) modules offering 70 percent to 85 percent efficiency that are suitable for stand-alone distributed power applications. SOFCs are superior to other types of fuel cells because of their high-efficiency solid-state design and the potential to use various types of fuel. However, existing technology is too costly to be practical. The company plans to reduce costs by using inexpensive materials and processes and maximizing power density. Stacks of high-performance cells will be integrated with novel processing technology that efficiently converts fuel to gas in modular units of 2 to 5 kilowatts, which can be combined to make larger systems. The units will run on natural gas or hydrogen. Small research cells offering high power density at low temperatures (650 degrees Celsius) have been demonstrated, but technical breakthroughs are needed to achieve this performance in stacks of 30 to 60 cells that are compatible with the fuel processing technology. ATP funding will enable this small company to perform the necessary research and development. A cost-effective process will be developed for making single cells, which will be designed to maximize surface areas and minimize power losses. A new strategy for stacking cells will be devised using inexpensive metallic interconnects. If successfully developed and later commercialized, the new technology could be valuable to both residential and commercial customers beset by power outages or high energy costs, or who have no electricity at all (as in rural communities or developing countries). Key subcontractors include the Gas Research Institute (Chicago, Ill.), Hydrogen Burner Technology (Long Beach, Calif.), and the Department of Materials Science and Engineering at the University of Utah (Salt Lake City, Utah).

연구과제명 : (98-03-0050) Advanced Materials and Processes for Cost-Effective High-Power Ultracapacitor Modules
회사명 : Maxwell Energy Products, Inc.
연구분야:Energy Storage/Fuel Cell, Battery
연구기간 : 1.83년
전체연구비(추정) : $4,219,032.00
ATP 지원금 : $2,000,000.00
연구요약 :

As the world becomes more and more digital, industrial processes and electronic and communications products are becoming more sensitive to power disturbances. A promising solution is ultracapacitor technology, which provides longer power bursts than capacitors and much greater power density than batteries. Maxwell Energy Products plans to develop new materials and device designs for a new generation of ultracapacitors offering three times the performance of the company's existing device at one-third the cost. To achieve this goal, voltage per cell must be increased from 2.3 to 3.5 to increase energy storage capacity, and capacitance (the property that permits energy storage) must be increased by 70 percent to store 3.9 times the energy per unit size or cost. A new module building block will be developed that easily can be used to make integrated ultracapacitors from small to large capacities. New electrolyte materials will be researched to improve performance, and integrated modules of practical size (12, 24, and 48 volts) will be designed that provide adequate cell balancing and voltage control. In addition, overall material and packaging costs must be reduced. The ATP funding will significantly accelerate this research. If successfully developed and later commercialized, the new ultracapacitors could save U.S. industry billions of dollars annually in lost productivity, scrap, and rework now attributed to power disruptions. In addition, the new technology could reduce fuel use and costs in automotive applications and extend the life of battery-operated consumer electronics and telecommunications devices, from cellular telephones to toys and power tools. The combined annual market for the low-cost "energy in a box" is estimated to range from $3 billion to $6 billion. In addition, sales of ultracapacitors and related equipment would increase, and thousands of new jobs could be created. Sandia National Laboratories (Albuquerque, N.M.) will develop electrolytes, and the Tennessee Center for Research and Development (Knoxville, Tenn.) will provide testing services.

연구과제명 : (98-03-0054) Superstrate to Enable Cost-Effective Solar Electric Power Generation
회사명 : MicroCoating Technologies
연구분야 : Energy Resources/Petroleum
연구기간 : 3.0년
전체연구비(추정) : $5,980,728.00
ATP 지원금 : $2,958,323.00

연구요약 :
Arrays of solar cells to convert sunlight to electricity will become widely affordable when module manufacturing costs can be reduced to less than $1 per watt, according to industry analysts. A joint venture led by MicroCoating Technologies (MCT) proposes a method to help reach this goal by making one of the key constituents, transparent conductive oxides (TCOs) with higher quality, at as little as one-quarter the present effective cost. Many thin-film photovoltaic cells consist of a sheet of glass coated with the light-sensitive semiconductor layer on several layers of TCO thin films that serve as optical performance enhancers and electrodes. MCT plans to develop its proprietary combustion chemical vapor deposition (CCVD) process to deposit these transparent "superstrate" layers on glass as part of the glass-making process. Unlike other thin-film deposition processes, the open-atmosphere CCVD technique does not require a closed vacuum or reaction chamber, which means it potentially could be directly integrated with the float line as part of a continuous glass-making process. Fuels containing dissolved, film-forming precursor chemicals are atomized and fed to a series of flames. Combustion generates the thin-film vapors, which condense and deposit on the glass in a precisely engineered layer to form the superstrate. Compared to present methods, CCVD processing will cost as little as one-tenth the capital and operating expenses, can produce better-quality coatings at rates up to 100 times faster, and use more effective starting materials at as little as one-hundredth the cost. As a bonus, CCVD deposits layers with a good uniform microstructure, which in turn influences the microstructure and performance of the semiconductor layer. These advantages will increase the cell's efficiency and remove impediments to widespread utilization of solar power. The project involves significant technical risk because CCVD has never been applied successfully to any commercial manufacturing process, much less the harsh environment of a glass float line. ATP support will enable the partners to accelerate, and increase the scope of, the research. The MCT joint venture also includes the largest North American flat glass manufacturer, PPG Industries, Inc. (Pittsburgh, Pa.), and the largest solar cell maker, Amoco/Enron Solarex (Frederick, Md.). If successful, the project not only will provide a broadly enabling technology for solar power but also could produce basic technology to improve manufacture of flat-panel displays, other glass coatings, and a wide variety of other clean energy devices.

연구과제명 : (98-03-0055) Distributed Premium Power Fuel Cell Systems Incorporating Novel Materials and Assembly Techniques
회사명 : Plug Power, LLC
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 2.0년
전체연구비(추정) : $9,737,848.00
ATP 지원금 : $4,737,848.00
연구요약 :

A joint venture consisting of Plug Power, a fuel cell manufacturer, and W.L. Gore & Associates, Inc. (Elkton, Md.), a leading manufacturer of membrane electrode assemblies for fuel cells, proposes to concentrate on creating fuel cell systems based on PEM (proton exchange membrane) technology that can tolerate high levels of carbon monoxide. Fuel cell systems suitable for powering a typical residence, they believe, can be made for less than $3,000--the price expected to make fuel cells commercially competitive with grid-delivered power. Fuel cells can be thought of as batteries that won't run down as long as a fuel--hydrogen--and oxygen in air are continuously supplied. Since distributing hydrogen on the scale of other fuels is impractical today, PEM cell systems make their own hydrogen from common fuels such as natural gas and propane. The resulting hydrogen, however, is contaminated with carbon monoxide. Cells are weakened significantly with as little as 50 parts per million of carbon monoxide. Other gases present in the reformed hydrocarbon gas stream also impact the performance of the fuel cell stack and will be considered in this project. The joint venture partners will develop new materials and designs more resistant to this poisoning, raising permissible carbon monoxide levels to a remarkable 3,000 parts per million. The project also involves re-engineering other components to operate in higher levels of carbon monoxide than currentdesigns allow. These alterations will mandate so many other modifications that the joint venture will develop totally new, improved fuel cell systems. The multiple novelties present a very high risk. In particular, improving the cell core--membrane electrode assembly, gas diffusion layer, bi-polar separator plates--demands substantial advances in the state of the art. Success, however, will provide clean, blackout-free, stand-alone electricity that will cost 10 to 20 percent less than present supplies. The first cells, rated at 300 watts and two kilowatts, will provide power for remote applications and backup power for computers. Even partial success will improve performance of existing cells. ATP support enabled the teaming of Plug Power and Gore, and a project that could make a significant leap forward in fuel cell technologies, rather than small, cautious improvements over many years of development. This should accelerate the commercial and residential acceptance of PEM fuel cells, leading to increased use of hydrocarbon fuels.

연구과제명 : (98-03-0056) Propane-Fueled Fuel Cell Power System for Telecommunications Applications
회사명 : H. Power Corporation
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 2.0년
전체연구비(추정) : $6,376,772.00
ATP 지원금 : $3,159,324.00
연구요약 :
A joint venture formed by H Power Corp. proposes making fuel cells about the size of a large box of breakfast cereal and weighing only 14 pounds to replace rechargeable batteries in telecommunications. Miniaturization and field deployment of telecommunications systems demand power supplies that are small, light, cost competitive, ultrareliable, and robust. Batteries with

these features are made mostly outside the United States. Fuel cells with propane canisters, however, would last up to four times as long as batteries of about the same weight. They represent a unique opportunity for America to compete vigorously in this new market. Fuel cells work much like batteries, except that they draw power from hydrogen and oxygen, which react electrochemically instead of by combustion. H Power will work with Epyx/Arthur D. Little, Inc. (Cambridge, Mass.), developer of fuel processing systems. The companies will base their cells on PEM (proton exchange membrane) technology, which has the broadest potential for commercialization. Epyx will shrink its reformer, the subsystems that use propane and other widely available high-energy-content fuels to make hydrogen. One of the most challenging tasks will be designing the catalytic structures in the reformer and its associated systems. If the reformer generates too much carbon monoxide, a contaminant produced as a byproduct, cell performance degrades, constituting a major hurdle in developing and commercializing small cells. H Power will redesign its smaller PEM cells now used in specialty applications to allow use of common fuels. The company also makes multikilowatt cells and will modify their design for telecommunications applications of up to six kilowatts. The partners have targeted a product cost of $1,500 per kilowatt, where fuel cells are expected to compete with batteries for telecommunications. In this application, the new fuel-cell design will enable telecommunication installations in more remote locations with improved service and reliability, while reducing maintenance and service requirements. Success is expected to spawn many applications, including emergency power equipment, small marine and terrestrial vehicular propulsion systems, and portable generators.

연구과제명 : (98-03-0057) Advanced Lithium Solid Polymer Battery Development
회사명 : Ultralife Batteries, Inc.
연구분야 : Energy Storage/Fuel Cell, Battery
연구기간 : 3.0년
전체연구비(추정) : $15,263,192.00
ATP 지원금 : $7,262,632.00
연구요약 :
The United States seeks to become the world's leading producer of high-performance rechargeable batteries for portable electronic devices and commercial space vehicles. To achieve this goal, a joint venture led by Ultralife Batteries proposes to develop a solid polymer lithium-ion battery that will significantly outperform existing batteries. Ultralife, a leading developer and manufacturer of advanced lithium batteries, has formed this joint venture with Eagle-Picher Industries, Inc. (Joplin, Mo.), the largest supplier of satellite batteries, and Lockheed Martin Missiles & Space Co. (Sunnyvale, Calif.), a leading supplier of space and launch vehicles. Major subcontractors, such as Sandia National Laboratories (Albuquerque, N.M.), also will play key roles in the project. The partners will incorporate new, ultrahigh-capacity electrode materials into Ultralife's existing solid polymer cells, creating batteries with significant competitive

advantages over the liquid-electrolyte lithium-ion batteries that currently dominate the high-performance battery market. Pound for pound, the new batteries will pack twice the energy of existing batteries. They also will provide up to four times as many charge/discharge cycles as present batteries and include more advanced electronic control circuitry. With a stable solid polymer electrolyte, the new batteries also will be safer and more environmentally friendly than liquid-electrolyte lithium-ion batteries. The unique solid polymer material will create major design advantages as well. The new batteries will be fabricated in ultrathin, flexible formats, enabling product designs that would be impossible with existing battery technology. Low-Earth-Orbit telecommunications satellites illustrate the dramatic impact this enabling battery could have, since existing batteries constitute some 10 percent of the entire mass of these satellites. With 1,600 satellite launches expected over the next 10 years, the reduced weight and cost associated with the new ultrahigh-capacity solid polymer batteries could save over $1.3 billion. The greatest challenge facing the partners will be the development of advanced, electrode materials. If successful, the new batteries will contribute significantly to reducing the size and weight, yet simultaneously increasing the run-time, of notebook computers, cellular telephones, commercial satellites, and many other mobile electronic products.

⑦ Microelectronics Manufacturing Infrastructure Competition Results (9개 과제)

연구과제명 : (98-06-0008) Wafer-Scale Applied Reworkable Fluxing Underfill for Direct Chip Attach
회사명 : Motorola, Inc.
연구분야 : Microelectronic Fabrication Technology / Abrasives, Adhesives, Ceramics, Coatings, and Composites / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 4.0년 (1998년 10월)
전체연구비(추정) : $8,684,308.81
ATP 지원금 : $4,189,806.71
연구요약 :
"Direct chip attach" (DCA) components are growing in use in electronics applications because they reduce product size and weight and enhance electrical performance. However, a typical surface-mount-technology (SMT) assembly line cannot easily implement DCA technology-separate equipment suites and processes must be implemented at substantial cost. A joint venture led by Motorola, Inc., (Schaumburg, Ill.) will develop the materials, design, processing, and assembly technologies needed for a wafer-scale process that will enable SMT lines to implement a reworkable DCA technology. In the proposed concept, a specially designed underfill material will be applied to the entire silicon wafer. The coated wafer will be cut to form single components that can be handled like other components in SMT lines. The coated dies will be placed on printed wiring boards (PWBs), where the underfill will provide the fluxing activity needed for soldering, the mechanical reinforcement needed for reliability and reworkability, if needed. This process will eliminate costly steps such as underfilling each die individually and a separate curing step during assembly. Several years of material synthesis and formulation

studies will be needed to develop an underfill material that is photosensitive (so it can be removed), reworkable using heat or chemicals (to enable in-plant and field repairs), and acts like a solder flux. In addition, various technologies will be evaluated or developed for processes such as applying the material to the dies, adding solder "bumps" to the wafer, and aligning the dies on PWBs using pattern recognition techniques. Compared to the present DCA assembly process, the new approach is expected to reduce labor costs by 25 percent, per-unit costs by 20 percent, and initial capital layout costs by $500,000 per assembly line. In addition, many new American jobs will be created in wafer production facilities and SMT equipment and materials supply houses. ATP support will help U.S. industry to achieve world leadership in DCA technology, a highly competitive arena experiencing rapid growth. ATP cost-sharing will enable significantly accelerated implementation of the DCA technology, leading to integration of packaging operations with IC fabrication, and could help the United States recapture a significant portion of the packaging industry, projected to be $28 billion by the year 2001. The vertically integrated research team includes Jabil Circuit (San Jose, Calif.), Loctite Corp. (Rocky Hill, Conn.), and Auburn University (Auburn, Ala.). Cornell University (Ithaca, N.Y.) will be subcontracted to help develop the underfill material.

연구과제명 : (98-06-0012) Micro-Contact Springs for High-Performance Probing and Packaging
회사명 : Xerox Palo Alto Research Center
연구분야 : Microelectronic Fabrication Technology
연구기간 : 4.0년
전체연구비(추정) : $9,896,155.00
ATP 지원금 : $4,933,158.00
연구요약 :
Rapid increases in the speed and density of integrated circuits (ICs) have outpaced advances in electronic testing and packaging. It has become increasingly difficult--and expensive--to build test equipment to probe and "burn in" ICs or to design efficient packaging simply because the devices are so small, the necessary contacts so tiny and closely spaced. A solution may lie in a new "micro-spring" technology invented recently at the Xerox Palo Alto Research Center (Xerox PARC). Mechanical stress is engineered into thin metal films deposited on a substrate by conventional lithography. The controlled stress gradients cause one end of the metal strip to curl up off the substrate, forming tiny spring contacts as an integral part of the wafer or substrate. The springs can be arranged to carry power and signals, and--because they are so flexible--can be used to manage thermomechanical stresses in device packages and make reliable, high-density probe contacts for testing and burn-in. Xerox PARC (Palo Alto, Calif.); the Georgia Institute of Technology - Computer Aided Simulation of Packaging Reliability (CASPaR) Laboratory (Atlanta, Ga.); and MicroModule Systems (Cupertino, Calif.) propose to model, design, fabricate, and test durable, cost-effective test and packaging technologies based on micro-spring devices. The partners plan to demonstrate a probe card with more than 4,000 probe

points that can reliably test advanced ICs at high frequency with minimal contact force and demonstrate high-density flip-chip interconnections on glass and other low-cost substrates. The ATP project will bring together industry and university researchers with expertise in micro-springs, materials, testing, and packaging that otherwise would not have come together. The new technologies could lead to as much as a 40 percent reduction in IC testing costs and a 10-fold reduction in high-density-board testing costs. Besides tapping a future $500 million market for high-density probes and a $5 billion market for high-density flip-chip packaging, the technical advances will lead to further device miniaturization with reduced power needs and costs, and greater operating frequency and portability. Micro-springs will give U.S. industry a "leapfrog" technology in interconnection and testing to outperform foreign competitors. The initial benefits will go to the U.S. semiconductor and printed-circuit-board industry, projected to be more than $100 billion by the year 2000, and to the high-speed digital printers industry, with a present market of $3 billion. Additional spillover benefits can be expected in the areas of automated test equipment, flat-panel displays and other glass-based products, and optoelectronic systems.

연구과제명 : (98-06-0018) Early Prototype Non-Gallium Ion Beam for Lithography and Wafer Manufacturing
회사명 : Micrion Corporation
연구분야 : Semiconductors / Microelectronic Fabrication Technology
연구기간 : 2.0년
전체연구비(추정) : $2,309,143.79
ATP 지원금 : $1,581,605.34
연구요약 :
Focused ion beam (FIB) systems have been used in microelectronics manufacturing for almost 20 years to process silicon wafers, perform failure analysis and lithographic mask repairs, and carry out many other tasks. However, conventional FIB tools based on gallium ions are close to their physical performance limits and will not perform well as the size of electronic devices shrinks. Among their deficiencies, the small amounts of gallium implanted on the wafer can degrade significantly the performance of future smaller, denser integrated circuits and the beam cannot be made sufficiently small or bright. Micrion Corp. (Peabody, Mass.) proposes to develop technologies for non-gallium FIB sources and optics for lithography of devices with features smaller than 100 nanometers and for in-situ monitoring of wafer fabrication. The new FIB source will provide a beam diameter that is two to four times smaller and 10 to 1,000 times brighter than conventional gallium-based tools. The company will evaluate two new technologies--gas field ion sources (GFIS) and multicusp (MC) radiofrequency ion sources--to determine how best to meet future requirements for beam size, brightness, energy range, and current density. Micrion will build one prototype system and demonstrate beam transport, image acquisition, measurement of beam quality, and continuous beam operation for a week. Either approach involves significant technical challenges. Micrion also plans to determine whether, in

some applications, a gas source might supplant scanning electron microscopes, which are ill-suited for nanometer-scale structures. If successful, the ATP project is expected to halve the time to market for the new FIB system, expand the global market for FIB systems, and allow a small U.S. company to maintain a leadership position in the global FIB market. Dramatically improved FIB technology will have a significant impact on the U.S. semiconductor industry, enabling advanced lithography techniques for reducing device size and improving yield, reliability, and throughput in manufacturing. If the technology is indeed applicable to the SEM market, additional benefits will come to machine shops, chemical and gas companies, and power supply manufacturers.

연구과제명 : (98-06-0025) Membrane Probes for Wafer, Package, and Substrate Testing
회사명 : Cascade Microtech, Inc.
연구분야 : Microelectronic Fabrication Technology
연구기간 : 3.0년
전체연구비(추정) : $5,366,451.00
ATP 지원금 : $1,996,798.00
연구요약 :
The need for new testing approaches has become increasingly urgent as integrated circuits (ICs), packages, and off-chip interconnects have gotten denser, faster, and more complex. Testing remains one of the key technical barriers preventing widespread exploitation of high-density interconnect substrates (HDIS) and advanced packaging technologies. There is a particular need for large-area, high-frequency probing for massively parallel testing. Companies lacking parallel testing capabilities will be at a serious cost disadvantage in the future. Cascade Microtech will design and demonstrate large-area membrane probes for parallel testing of ICs, arrays of chip-scale packages, and HDIS. This requires a quantum leap beyond today's state-of-the-art in probe density and number of contact points. The company also will increase process capacity for reliably supplying high volume production customers. Significant technical barriers in probe design and processing must be overcome to provide the requisite signal routing, interconnections, dimensional accuracy, planarity, and electrical bypass features. Challenging issues include thin-film processing, assembly, and test methods and how to maintain accurate contact-point positions over a broad temperature range as both the probe and device under test expand and contract. Today, the highest pin count (input/output or I/O points) in a single chip is about 2,000. If successful, the ATP project will enable Cascade to increase the area of its probes from six square centimeters to 100 and extend pin count from 800 contacts and 500 I/O lines to at least 6,000 contacts and 4,000 I/O lines. Contact resistance, wear lifetime, planarity, compliance, and high-frequency electrical performance will all be maintained or improved. This will reduce substantially the costs of testing ICs, chip-scale packages, and high-density interconnect substrates and enhance the high-frequency capabilities of parallel testing. More accurate test results will increase yields by several percentage points across all three product types. Additional

economic benefits will be realized as the technology enables more efficient test and process control schemes such as at-speed wafer testing and wafer mapping. If successful, the technology will be commercialized first in the United States, enabling American firms to reap the cost advantages 6 to 24 months before their international competitors. The timely attempt to meet these aggressive goals would not occur without ATP support.

연구과제명 : (98-06-0028) Gas-Cluster Ion-Beam Manufacturing Tool for Next-Generation Semiconductor Devices
회사명 : Epion Corporation
연구분야 : Semiconductors / Microelectronic Fabrication Technology
연구기간 : 3.0년
전체연구비(추정) : $4,136,981.00
ATP 지원금 : $2,000,000.00
연구요약 :
As the semiconductor industry moves toward making smaller devices (with features of 100 nanometers or less) on larger silicon wafers (300 millimeter diameter), new materials and processing technologies will be needed. The tiny devices and ultrathin films of the future must have precise compositions, very low contamination levels, and smooth interfaces. Gas-cluster ion beam (GCIB) technology--in which clusters of electrically charged atoms or molecules are accelerated and scanned across target surfaces--is a promising tool for achieving these requirements because it offers atomic-scale control of near-surface composition and can smooth materials to subnanometer levels. However, existing GCIB equipment produces currents that are too low for high-yield manufacturing. Epion plans to develop high-current GCIB technology for depositing and smoothing ultrathin, high-quality films for gates and dielectric layers in future microelectronic devices. The project will require an entirely new approach to ion beam formation and transport. The project is more ambitious than Epion would be able to undertake on its own. Epion plans to develop new nozzle designs that will enhance the efficiency of beam formation as well as new methods for beam ionization, extraction, filtering, and transport. The company also will develop and validate new processes for preparing semiconductor interfaces and thin-film deposition. A prototype high-current GCIB source will be built and its operational performance validated. To verify the quality of the GCIB-processed dielectric layers, Epion will collaborate with SEMATECH (Austin, Texas), the University of Texas (at Austin), North Carolina State University, Santa Clara (Calif.) University, and the University of Houston. If the ATP project is successful and the technology is commercialized, annual sales of manufacturing equipment that employs GCIB could exceed several hundred million dollars within a decade, Epion estimates. GCIB components have the potential to improve performance of next-generation semiconductor manufacturing equipment using 300 mm wafers. Significant economic benefits from this technology will come from the semiconductor equipment market, projected to be larger than $25 billion in the year 2000. Secondary applications in surface and near-surface materials processing

could spawn new industries and market benefits. GCIB could be used, for example, to deposit transparent conductors for flat-panel displays and process magnetic materials for data storage devices.

연구과제명 : (98-06-0030) Novel High-Performance Wafer-Level Reworkable Underfill Materials for Flip-Chip Packaging
회사명 : National Semiconductor Corporation
연구분야 : Microelectronic Fabrication Technology / Abrasives, Adhesives, Ceramics, Coatings, and Composites / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 3.0년
전체연구비(추정) : $5,761,093.00
ATP 지원금 : $2,851,841.00
연구요약 :
As electronic devices become smaller, "flip chip" packaging is increasingly attractive because it provides ultrahigh density integrated circuit interconnections on a substrate similar to a printed-circuit board. The chips are laid face down on the substrate, and the short connections across the chip face boost performance over that provided by traditional wire bonds. However, the flip-chip attachment method requires a protective underfill material, currently an epoxy-based resin, which is applied and cured very slowly during assembly, is susceptible to moisture, and makes it impossible to rework the chip if necessary. National Semiconductor Corp. and National Starch and Chemical (Bridgewater, N.J.) plan to develop new, thermoplastic underfill materials and processes for flip-chip and other advanced packaging techniques. The ATP provided the catalyst to bring them together. The proposed material will be highly processible, reusable, and resistant to moisture and ionic contamination. In addition, it will be laid down during wafer processing instead of during the flip-chip assembly process. The challenges lie in developing materials that withstand the rigors of wafer processing, cure at the proper time, and adhere to the wafer, substrate, and solder. Two processes for depositing the underfill will be evaluated to achieve the optimal properties at the lowest cost. The Packaging Research Center at the Georgia Institute of Technology (Atlanta, Ga.) will evaluate the interfaces between the new materials and various surfaces. The new technologies will eliminate long underfill flow times (now up to five minutes per component) and shorten cure cycles (now one to four hours), reducing overall chip underfill production time from hours to minutes and increasing output 500-fold. The approach also is expected to save 50 percent to 75 percent of current unit costs and enhance package reliability. The ATP project will provide a knowledge base, materials infrastructure, and technical tools that will promote the use of advanced packaging technologies, helping U.S. electronics companies implement flip-chip technology quickly to make smaller, less costly products with enhanced functionality and performance. Flip-chip components currently constitute about 1 percent of worldwide IC production, but that figure is expected to rise to 10 percent by 2002, a market worth up to $2 billion. The proposed technology would make it

possible to perform packaging process at the wafer level, which will help U.S. industry capture a significant portion of the $28 billion (projected for 2001) worldwide advanced packaging industry.

연구과제명 : (98-06-0052) Ultra-Low Dielectric Constant Materials for Integrated Circuit Interconnects
회사명 : Dow Chemical Company
연구분야 : Electronic Instrumentation/Sensors and Control Systems / Microelectronic Fabrication Technology / Semiconductors
연구기간 : 3.0년
전체연구비(추정) : $17,605,771.00
ATP 지원금 : $8,556,629.00
연구요약 :
State-of-the-art integrated circuits (chips) contain some 3 to 6 million transistors and more than 800 meters of wiring. Within the next 10 years, chips will contain 1 billion or more transistors and 10,000 meters or more of wiring. To minimize electrical cross-talk between such closely packed wires and ensure optimum chip performance, the semiconductor industry requires dramatically improved insulators for separating the wires. Although there have been major advances in this technology, an ideal material with ultra-low dielectric constant has not yet been found. Dow Chemical and the IBM Almaden Research Center (San Jose, Calif.) propose to invent and optimize porous polymeric materials, an emerging class of highly effective insulators. The Dow/IBM team will investigate several candidate materials and evaluate their suitability for long-term use through several future generations of high-density chips as feature sizes shrink and the demands on the dielectric material get tougher. Technical challenges include developing ways to make fully closed pores of uniformly small size, achieving pore volume low enough to provide adequate mechanical properties, and devising simple and reliable production processes. In addition, the team must create a viable materials solution, with an adjustable dielectric constant as low as 1.5 that will span multiple generations of future integrated circuits. Two materials will be investigated : inorganic materials derived from organosilicate polymers and organic thermosetting polymers. The new materials will be characterized and integrated into multilayer copper-wire interconnect test structures, which will be evaluated for yield, performance, and reliability. Researchers at Stanford University (Palo Alto, Calif.), the University of Maryland (College Park, Md.), and Washington State University (Pullman, Wash.) will perform some of the studies and tests, and Dendritech, Inc. (Midland, Mich.) will provide some of the pore-generating materials. The ATP project will enable the development of candidate solutions to meet industry needs in a timely manner. Widespread use of the new technologies will help enable the electronics industry to continue the trend of performance increases and cost reductions. The new materials will offer spillover benefits in other electronics technologies requiring low-loss materials and in the development of future computer hardware and software.

연구과제명 : (98-06-0054) Advanced Embedded Passives Technology
회사명 : Advanced Embedded Passives Technology Consortium (c/o NCMS)
연구분야 : Microelectronic Fabrication Technology / Abrasives, Adhesives, Ceramics, Coatings, and Composites / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 4.0년
전체연구비(추정) : $16,106,500.00
ATP 지원금 : $7,804,654.00
연구요약 :

In circuit board manufacture, much of the assembly effort is expended on "passives" (resistors and capacitors). They account for up to 90 percent of component placement and take up to 40 percent of the circuit board real estate. Market pressures for new products with more features, smaller size, and lower cost virtually demand smaller, simpler circuit boards, and reducing the number of discrete passives is an obvious strategy. In addition, the need to fit passive components on the circuit board with appropriate connections imposes constraints on the design of the board which limit the speed of the circuit to about 0.5 gigahertz. One possible solution to both issues is to embed the passive components in the structure of the circuit board itself. The Advanced Embedded Passives Technology Consortium, sponsored by the National Center for Manufacturing Sciences, proposes to develop the new materials, design tools, and processing technology needed for the large-scale use of embedded passive devices in electronics manufacturing. The major high-risk tasks include developing new materials with the necessary electrical, mechanical, and thermal characteristics; taking these materials and integrating them into the existing manufacturing process for printed circuit boards; and creating the necessary design tools that engineers would need to design new products with embedded passives technology. The Consortium team brings together companies of all sizes representing equipment manufacturers, printed-wiring board manufacturers, materials suppliers, and software developers to provide a broad range of expertise. Members of the project include the National Center for Manufacturing Sciences, Inc. (NCMS) (Ann Arbor, Mich.), Compaq Computer Corp. (Houston, Texas), Delphi Delco Electronics Systems (Kokomo, Ind.), Dupont High Performance Films (Circleville, Ohio), Dupont Photopolymer & Electronic Materials (Research Triangle Park, N.C.), IBM (Endicott, N.Y.), Interconnect Technology Research Institute (Austin, Texas), HADCO Corp. (Salem, N.H.), MacDermid, Incorporated (Waterbury, Conn.), Merix Corp. (Forest Grove, Ore.), 3M Co. (St. Paul, Minn.), Northern Telecom, Inc. (Nortel) (McLean, Va.), Nu Thena Systems, Inc. (McLean, Va.), and Ormet Corp. (Carlsbad, Calif.). Such a project to introduce a major leap in the design and performance of circuit boards entails significant risks--hence the need for the ATP --but the payoff would be denser, more reliable assemblies capable of significantly higher speeds and cost less. Successful development of the technologies would enable U.S. companies to build their market share in the $28 billion printed wiring board industry.

연구과제명 : (98-06-0057) Intelligent Mask Inspection System for Next-Generation Lithography
회사명 : KLA-Tencor Corporation
연구분야 : Microelectronic Fabrication Technology
전체연구비(추정) : $43,355,000.00
ATP 지원금 : $18,912,000.00
연구요약 :

The continuing ability to make smaller, faster, and cheaper microchips has enabled the semiconductor industry to grow at an average rate of 15 percent annually. Driving the fast-paced growth has been the constant advancement of lithography techniques. This advancement depends critically on the production and inspection of "masks"--the equivalent of photographic negatives--that are used to inscribe circuit patterns on silicon wafers. In the near future, the smallest features on masks will be so small that the wavelengths of even deep ultraviolet (DUV) light will be too large to fit through them. Lithography techniques will have to use alternate sources of radiation, such as electron beams or light sources that are of much smaller wavelength than the visible range like extreme ultraviolet (EUV). But moving into this regime--wavelengths below 100 nanometers--will lead to additional manufacturing challenges. This project will first determine whether DUV light can be used to inspect EUV and electron-beam (SCALPEL) masks. If not, then inspection systems based upon new radiation sources will be required. Much remains unknown : what new categories of defects, unique to EUV or electron-beam masks, might crop up and have to be detected, for example? Without a reliable mask-inspection system there will be no practical way to manufacture future generation chips. Failure to develop such an advanced inspection system would reduce significantly the growth of the semiconductor industry, projected to be $200 billion in year 2000. To address this problem, KLA-Tencor proposes to lead an industry joint venture to develop a mask-inspection system that will be sensitive enough for sub-100 nanometer lithography. In addition to first assessing the nature of the defect-detection problem, developing a practical inspection system will require at least three major advances : new software capable of assessing the importance of defects; innovative algorithms that detect as many defects as possible; and innovations that reduce system noise. If successful, the ATP project may remove a significant--potentially show-stopping--roadblock to future progress in lithography and consequently the entire U.S. semiconductor industry. Partners in the joint venture include DuPont Photomask, Inc. (Round Rock, Texas), EUV LLC (Livermore, Calif.), Lucent Technologies (Murray Hill, N.J.), and Photronics, Inc. (Jupiter, Fla.).

⑧ Selective-Membrane Platforms Competition Results (5개 과제)

연구과제명 : (98-07-0001) High-Temperature Hydrogen Selective Membrane Platforms
회사명 : Praxair, Inc.
연구분야 : Separation Technology / Abrasives, Adhesives, Ceramics, Coatings, and

Composites / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 4.0년 (1998년 10월)
전체연구비(추정) : $3,065,600.00
ATP 지원금 : $1,514,900.00
연구요약 :
Hydrogen is a key feedstock in the chemical, electronics, petrochemical, and refining industries and also can be used as a clean fuel. Efficiency improvements in the generation or purification of hydrogen could save millions of dollars annually while reducing environmental pollution. In particular, if an improved hydrogen-separation membrane process can be run at high temperatures, then it can be combined efficiently with a conversion process to produce hydrogen from a low-cost feedstock. Conventional hydrogen separation membranes are based on polymers and cannot operate at high temperatures. Praxair, Inc., and its subsidiary Innovative Membrane Systems, Inc. (Norwood, Mass.), will work on new hydrogen generation technology with Walter Juda Associates (Needham, Mass.), which has developed a hydrogen-generation system that employs a palladium-based membrane at high temperatures. To expand the scope, lower the cost, and improve the efficiency of this promising technology, high-temperature metal-polymer membranes will be developed. The proposed membranes will consist of an ultrathin layer of metal alloy integrated with a polymeric support. It will be packaged into a module containing either bundles of hollow fibers or flat-sheet membranes. The technical challenges are to produce a device with an extremely thin defect-free membrane capable of stable operation at high temperatures. Tufts University (Medford, Mass.) will perform the modeling required to design a reactor that effectively reforms low-cost feedstocks and optimizes the flow of gases in the membrane reactor. ATP provided the incentive for this joint venture to come together. If successfully developed, the new technology will provide a new route to low-cost hydrogen production. The ATP project will greatly accelerate progress in developing this innovative membrane platform, bringing together a small company with an innovative concept, academic modeling expertise, a membrane manufacturer, and a designer of hydrogen production systems. If ultimately commercialized, the technology could reduce the cost of producing hydrogen for the chemical and electronics industries by 20 percent to 30 percent, increase by 25 percent the value of certain fuels used in refining by enabling more efficient recovery of hydrogen, and accelerate the development of hydrogen-fueled automobiles with zero emissions. In addition, the research could promote progress in other high-temperature membrane-based gas separations.

연구과제명 : (98-07-0005) Stable Liquid Membranes
회사명 : Facilichem
연구분야 : Separation Technology / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 2.6년
전체연구비(추정) : $2,479,523.00

ATP 지원금 : $2,000,000.00

연구요약 :

Liquid membranes are a promising but underutilized, technology that could greatly reduce the economic and environmental costs of separating gases, liquids, and contaminants from mixtures. The idea is to introduce the mixture to be separated on one side of a support structure of some sort that holds in place a specially tailored liquid separating agent. The agent is designed to selectively allow the desired product to pass through from the mixture. Liquid membranes can be designed to be highly selective, but despite 30 years of research, the problem of how to make the membrane structures sufficiently mechanically stable has kept the technology from widespread industrial use. Facilichem plans to design and validate practical membrane technology that will remain stable indefinitely. The company has demonstrated, at the laboratory scale, hand-built modules containing thick membranes. In the ATP project, a process will be developed for large-scale manufacturing of new types of thinner membranes, and they will be assembled in a new module geometry that could be mass produced. Membrane chemistry can be fine-tuned for specific applications, and stable operation of the unit will be validated at bench scale. The ATP made it possible to coalesce this cross-industry team needed to develop practical liquid membranes and already has interested possible end users. If the technology is successfully developed and later commercialized, it will probably be used first to make high-margin, low-volume specialty chemicals for the pharmaceutical, agricultural, and food industries. The technology could reduce capital costs in amino acid manufacturing, provide the first economical method of recovering heavy metals from wastewater, and reduce processing costs in hydrocarbon separations. For example, a suitable liquid membrane for separating propylene from propane is predicted to cost only one-third as much as conventional distillation. SRI International (Menlo Park, Calif.) will provide analytical support and membrane development services, and Spectrum Laboratories (Laguna Hills, Calif.) will make the membrane modules. EPRI (Palo Alto, Calif.) and Edison Technology Solutions (Irwindale, Calif.) also will participate.

연구과제명 : (98-07-0006) Development of Solvent-Compatible Polymeric Membranes Systems for Liquid Separation

회사명 : Cargill, Inc.

연구분야 : Separation Technology / Polymers Synthesis & Polymer Fabrication Technologies

연구기간 : 5.0년

전체연구비(추정) : $8,338,465.00

ATP 지원금 : $3,752,308.00

Separation of certain foods, drugs, and other products from organic mixtures currently relies on energy-intensive distillation, in large part because existing membrane technology, although energy efficient, cannot tolerate organic solvents. To overcome this obstacle, Cargill and Osmonics, Inc. (Minnetonka, Minn.), plan to develop a new approach to economical polymeric membrane systems for processing non-aqueous liquids (those lacking water). The major technical challenge will be to develop polymeric membranes/systems that both separate out the desired components and are compatible with organic solvents and high operating temperatures. Approaches including manipulating polymer molecules and finished film will be explored. Modeling will be performed to develop a theoretical understanding of solvent/membrane interactions. The new materials will be packaged in a solvent-compatible module that simultaneously maintains the integrity of membrane separation and transport properties. In addition, new cleaning technologies, including processing techniques, will be developed to remove contaminant fouling and extend membrane life. Prototype systems will be designed for three target separations : vegetable oil from aliphatic solvents, organic drugs from polar organic solvents, and petrochemicals from aromatic solvents. Substantial energy savings are possible because membranes typically require less than 5 percent of the energy used in distillation, which currently consumes 1 million barrels of fuel oil daily in the United States. If successfully developed and later commercialized, the new technology could save tens of millions of dollars annually in the food industry. It also will reduce airborne and wastewater emissions of harmful chemicals. The ATP provided the catalyst to bring together a major membrane developer with a major end user. This team will greatly accelerate the development of practical systems and expand the range of applications. The University of Kentucky Research Foundation (Lexington, Ky.) will perform modeling studies, and the Center for Interfacial Engineering at the University of Minnesota (Minneapolis, Minn.) will provide access to membrane-testing equipment.

연구과제명 : (98-07-0012) Facilitated Transport Membrane Platforms
회사명 : Praxair, Inc.
연구분야 : Separation Technology / Abrasives, Adhesives, Ceramics, Coatings, and Composites / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 3.0년
전체연구비(추정) : $3,572,050.00
ATP 지원금 : $1,428,819.00
연구요약 :

Certain gases are critical in manufacturing. Carbon dioxide, for example, is used to produce carbonated drinks, and oxygen is used in furnace-based processes such as steel making. Purification of these gases is costly. Praxair, Inc., proposes to synthesize, characterize, and demonstrate a practical "facilitated transport" gas-separation technology that will reduce costs and increase gas purity. Whereas conventional separation systems rely solely on diffusion of gas molecules in response to pressure differentials, the proposed system will accelerate this process by adding components that improve gas selectivity and permeability. The new technology will consist of porous membranes containing special sites designed to bind temporarily to particular gas molecules, promoting their transport through the membrane. Two types of membranes will be evaluated : polymeric systems that are compatible with current manufacturing methods, and mixed inorganic-polymer coatings that offer better pore-size control. Technical issues include how best to incorporate active sites, achieve stability in real-world conditions, and seal and repair the system. ATP cost-sharing will greatly accelerate the pace of this high-risk research and provide intellectual and physical resources that will increase the probability of success. The project will focus on systems for separating carbon dioxide from low-quality sources such as landfill gas and separating oxygen from air. If successfully developed and commercialized, the new technology will reduce the cost of separating these gases by up to 30 percent and increase gas purity. Benefits would include the economical on-site production of commercial-quality carbon dioxide from waste gas streams, a substantial energy savings, and wider use of oxygen in place of air in industrial furnaces, which would reduce fuel use by 25 percent to 60 percent while increasing efficiency and reducing emissions. The new technology also could be valuable in other applications, such as separation of hydrocarbons used in the petroleum industry. Praxair will design and test selective sites and perform modeling studies. A subsidiary, Innovative Membrane Systems (Norwood, Mass.) will design and test polymeric membranes. Additional support will be provided by consultants from the University of New Mexico (Albuquerque, N.M.) and the State University of New York (Buffalo, N.Y.).

연구과제명 : (98-07-0013) TIPS Ultrafiltration Membranes for Biological Separations
회사명 : Baxter International, Inc.
연구분야 : Separation Technology / Polymers Synthesis & Polymer Fabrication Technologies
연구기간 : 3.0년
전체연구비(추정) : $2,609,642.00
ATP 지원금 : $975,000.00
연구요약 :
The membranes currently used in hemodialysis and other medical applications are not fully effective in purifying biological materials, a shortcoming that imposes substantial economic costs and may result in complications, disease, or even death. A critical problem with these membranes is the relatively broad distribution of pore sizes--particularly since there is a relatively small difference in size between desired and undesired biologic entities. Baxter International plans to provide the technological means for improving biological separations by developing a process for manufacturing membranes with uniformly tiny pores. Conventional ultrafiltration membranes are made by a complex phase-separation process based on the gradual diffusion of one solution into another. ATP cost-sharing will make it possible for Baxter to investigate an alternative but risky fabrication process called thermally induced phase separation (TIPS), in which solidification of the membrane is induced by a change in temperature. Because heat transfer is faster and is easier to control than diffusion, TIPS membranes are more reproducible and have fewer defects and more uniform pore size. The major technical hurdle is to reduce TIPS pore size substantially from the proven micrometer size range down to the 10- to 50-nanometer size range. To that end, various types and concentrations of materials will be evaluated and optimized, and the thermal quenching process will be adapted to solidify membranes as rapidly as possible. Baxter will design, test, and validate the effectiveness of

prototype membranes for hemodialysis and virus removal applications. If successfully developed and commercialized, the new technology could double the removal rate for a key toxin during hemodialysis and reduce dialysis complications and the billions of dollars now spent on associated costs. In addition, the technology could increase by orders of magnitude the removal of viruses from biopharmaceuticals derived from human blood. Because many other biopharmaceutical products lie in the size range targeted in this project, the new technology could have additional applications in biomedical separations. Some of the development work will be performed by subcontractors. Membranes will be made by the Chemical Engineering Department at the University of Texas (Austin, Texas), and the TIPS process will be scaled up by A/G Technology Corp. (Needham, Mass.)

⑨ Adaptive Learning Systems Competition Results (2개 과제)

연구과제명 : (98-09-0012) Real Adaptive Intelligent Learning Systems (RAILS)
회사명 : eCollege.com (formerly Real Education)
연구분야 : Computer Systems and Software Applications
연구기간 : 3.0년
전체연구비(추정) : $2,643,160.00
ATP 지원금 : $1,877,800.00
연구요약 :
Although the World Wide Web now is accessible almost everywhere, on-line instruction is not catching on as rapidly. In large part this is because courses must be assembled manually and cannot be adapted easily to individual student needs. Currently, less than 10 percent of U.S. colleges and universities offer on-line courses. To tap into a potentially vast market for distance learning, Real Education will develop the technologies needed to enable non-programmers to design courses rapidly and provide materials and interactive instruction that are customized for each student. The company plans to integrate latent semantic analysis (LSA), an automated method of deriving meaning from text, with radial basis function (RBF), a neural network that enables software to improve its own performance through machine-learning algorithms. The key technical challenge will be to integrate these two techniques, which are proven but have yet to be combined, to create an intelligent tutoring system that processes documents rapidly and precisely in response to the needs of the learners. The proposed system will include a smart searching capability that is expected to improve retrieval of relevant documents for on-line courses (current web search engines retrieve only 30 percent of relevant documents plus many irrelevant ones). The system also will sort documents by topic into possible course paths, reducing the time required to organize courses. In addition, the proposed system will develop an internal model of each student to provide customized instruction and automatically tag courseware to keep track of it among the enormous volume of on-line educational material. Thomas K. Landauer Usability, Inc. (Boulder, Colo.), will help develop LSA knowledge

representations for uses in prototype LSA/RBF systems. The ATP project will greatly accelerate the development of tools that will dramatically increase the availability of on-line courses, improve educational quality by adjusting courses to student needs, and reduce the cost of developing and modifying courses by as much as 60 percent. Within a few years, the potential market for on-line courses could include 50 million K-12 students, 65 million college students, and 80 million corporate employees or other adults requiring continuing education.

연구과제명 : (98-09-0038) Courseware Conversion Factory : Re-Engineering Objects for Web-Based Instruction on Demand
회사명 : Teknowledge Corporation
연구분야 : Computer Systems and Software Applications
연구기간 : 3.0년
전체연구비(추정) : $4,322,871.00
ATP 지원금 : $2,000,000.00
연구요약 :
Converting printed classroom course materials into electronic form remains a major and labor-intensive hurdle in the development of Internet-based education and training courses. A single hour of computer-based training costs about $10,000 to produce. These costs could be reduced substantially if existing printed course materials, both text and illustrations, could be converted through a mass production process into customized on-line courseware objects. Teknowledge Corp. proposes a "Courseware Conversion Factory" to enable non-programmers to do such conversions systematically, rapidly, and cost effectively. Their solution : develop a powerful, open framework that integrates a variety of existing authoring tools and reusable educational software objects. A key component will be a knowledge-based coach that guides developers in restructuring traditional course content using the tools provided by the Factory, and the best available instructional practices. Other elements include tools for rapidly converting paper materials into reusable software objects tagged according to a semantic classification scheme; an integrated set of authoring tools to organize tagged content objects into courseware; and on-line repositories that store and retrieve objects, and capture feedback from users. Technical challenges include development of a system that can provide pedagogical advice based on developer objectives; principled integration of diverse authoring and conversion tools, and development of reusable content objects. Without ATP support, private funding for Internet-based instructional technology is likely to focus on low-risk proprietary tools and content objects, which tend to be knowledge-poor and difficult to reuse. The technology is most likely to be used in the corporate training sector (a $4 billion market by 2001), the military (a market exceeding $400 million), and education (a $5.7 billion market in 1996, growing at 6.5 percent annually). Teknowledge also plans to transfer the technology into its Sales Associate (E-Commerce) product. Testbeds will be established at Asymetrix Learning Systems (Bellevue, Wash.), Defense Acquisition University (Alexandria, Va.), and the U.S. Air Force Academy

(Colorado Springs). Consulting services will be provided by Woolf & Co. (Amherst, Mass.) and researchers at Lackland Air Force Base (Texas) and Mississippi State University. Asymetrix, Macromedia (San Francisco), and Hewlett Packard (Palo Alto) have signed technology cooperation agreements for Teknowledge's Courseware Conversion Factory.

(4) 1999년 (37개 과제)

① General Competition (37개 과제)

연구과제명 : (99-01-1008) Tissue Engineered Heart Valve Prostheses
회사명 : Tissue Engineered Heart Valve Prostheses
연구분야 : Biotechnology
연구기간 : 3년(1999년 10월)
전체 연구비(추정) : $4,128 K
ATP 지원금 : $1,991 K
연구요약 :
About 80,000 heart valve replacements, including many repeat operations to replace damaged or diseased prostheses, are performed annually in the United States. Prosthetic valves now on the market have drawbacks, such as a lack of capacity to grow as young patients mature. In a three-year ATP project, St. Jude Medical, Inc., a leading supplier of heart valves, will attempt to develop a tissue-engineered heart valve prothesis that, once implanted, will attract the patient's own endothelial cells (which line the interior of organs) and fibroblasts (which synthesize matrix proteins and give rise to connective tissue). The development of an endothelial cell layer on the blood-contacting surfaces of the valve should reduce the development of blood clots, infection, and possibly calcification. Recruitment of fibroblasts to the interior of the valve should improve durability and allow for growth and remodeling with changes in the patient's anatomy, making this technology an attractive therapy for children. Two synergistic strategies will be pursued : use of a chemical growth factor to attract endothelial cells, and signaling and binding mechanisms to recruit blood-borne stem cells that will mature into endothelial cells and fibroblasts. Several different matrix materials will be evaluated for use as a substrate for cell growth. If successfully developed, the new technology can be expected to capture much of the $650 million global market for heart valves and substantially reduce health care costs. The technology also could be adapted for other blood-contacting prostheses, such as vascular grafts used in coronary bypass operations, a potential market exceeding $1 billion. The ATP funding will accelerate development of the technology by several years. Private funding for the research is limited because feasibility of the concept is not yet proven. Academic and medical researchers from the University of Minnesota (Minneapolis, Minn.), the University of Pittsburgh (Pittsburgh, Pa.), the University of Washington (Seattle, Wash.), and other leading institutions will be subcontracted to perform specific tasks.

연구과제명 : (99-01-1009) A Functionally Specific Three-Dimensional Polymer Implant for Articular Cartilage Repair and Regeneration
회사명 : THM Biomedical, Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $1,730 K
ATP 지원금 : $1,161 K
연구요약 :

More than 1 million procedures involving treatment of damaged cartilage are carried out annually in the United States, at a cost exceeding $1 billion. Cartilage does not heal itself, and no treatment exists that repairs the entire defect permanently. In a three-year ATP project, THM Biomedical, Inc., will attempt to design, fabricate, and demonstrate a bioresorbable implant intended to effect the repair and regeneration of articular cartilage defects, including the layer attached to the bone. (Articular cartilage covers the opposing surfaces of all moving joints in the body to minimize friction.) The technology is based on the theory that an implant can engender the simultaneous growth of adjacent but diverse tissue types. The proposed implant differs from other similar technologies in that it will be stratified to accommodate different layers of cartilage and their varying biological functions. A synthetic implant structure made of a proprietary polymer will be integrated with substances and cells found in early wound-healing tissues. Once implanted, it will recruit precursor cells for bone and cartilage from the surrounding tissues, effectively culturing cells within the body and repairing lesions around torn cartilage by reestablishing the bond with the bone and restoring the transluscent surface. ATP support is essential for timely demonstration of the proposed technology -- THM tried to obtain private financing but was unsuccessful because investors perceive the research as taking too long to pay off. If successfully developed, the technology will offer a simple, rejection-free device that could greatly reduce the need for hip and knee replacements, 350,000 of which are now performed annually in the United States at a cost of $25,000 each. If partially successful, the project will significantly advance the technologies needed for engineering skin, blood vessels, livers, kidney, and other organs. Some tasks will be subcontracted to the Hospital for Joint Diseases Orthopaedic Institute (New York, N.Y.) and Malcolm and Dorothy Coutts Institute for Joint Reconstruction and Research (San Diego, Calif.)

연구과제명 : (99-01-1011) Colloidal Gold as a Targeted Drug/Gene Delivery System
회사명 : CytImmune Sciences Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,754 K
ATP 지원금 : $2,000 K

연구요약 :

Most drugs and other therapeutics have a systemic effect on healthy and unhealthy cells. There are often toxic side effects. The unique chemical properties of colloidal gold (tiny gold particles that remain evenly distributed in a solution) make it a promising vehicle for delivering drugs or genes to specific target cells. Colloidal gold is used as a protein marker by chemists and also is used for medical purposes, although its therapeutic mechanisms are not completely understood. CytImmune Sciences, Inc., proposes to develop a novel cancer treatment using colloidal gold to deliver cytokines (which modulate the body's immune system) such as tumor necrosis factor. The company will evaluate the optimum size of the gold particles, study the pharmacokinetics and safety issues, and determine whether and how gold-cytokine complexes eliminate tumors. Studies evaluating colloidal gold for gene therapy to replace defective or missing genetic material also are envisaged. In the gene therapy research, the company will exploit the capability of a colloidal gold particle to bind and deliver genetic materials to target cells. CytImmune hopes to demonstrate cytokine treatment and gene therapy with enhanced safety and efficacy, enabling these cancer treatments to achieve their full potential. If successfully developed and later commercialized, the technology could reduce the toxicity of many drugs and transform the practice of oncology to emphasize therapies that harness the body's natural defenses. Colloidal gold is inexpensive to manufacture and therefore should be a very cost-effective way of improving the health of the world population. The collection of convincing preclinical data will be accelerated by the ATP funding, thus making it more probable that CytImmune can find a private-sector partner for conducting clinical trials. The research will be carried out in collaboration with the National Cancer Institute (Bethesda, Md.) and EntreMed, Inc. (Rockville, Md.).

연구과제명 : (99-01-1021) Development of Perivascular Endothelial Cell Implants
회사명 : Reprogenesis, Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,054 K
ATP 지원금 : $2,000 K
연구요약 :

Coronary artery disease afflicts 13 million Americans and is the leading cause of death in the United States. Treatments such as angioplasty and bypass surgery often fail eventually because of restenosis, or narrowing of blood vessels. The failure of mechanical interventions is often due to loss of function and integrity in endothelial cells, which line the interior of blood vessels and provide both structural integrity and substances that control blood vessel architecture. In a three-year ATP project, Reprogenesis, Inc., proposes to design and test an endothelial cell implant with the aim of enhancing the success rate of interventions. The company has found that endothelial cells grown within a polymer matrix, implanted around rat or pig arteries injured by the balloon used in angioplasty, greatly reduced the proliferation of lesions. The company will develop an animal model for bypass graft surgery, apply the cell implants, and evaluate the effects. Next, an injectable method will be developed to deliver the cells, such that they maintain their potential for inhibiting lesions without further injury to the blood vessel. The company also will identify a line of human endothelial cells to use in the implants and will initiate clinical trials to determine the safety, feasibility, and preliminary efficacy of the therapy. The implant technology by itself could reduce restenosis after peripheral and coronary bypass operations, and the injectable method would prevent restenosis associated with angioplasty and other non-invasive procedures. Currently there are 1.5 million coronary artery bypass grafts and transcatheter procedures each year in the U.S. and approximately 40 percent fail due to restenosis, resulting in annual costs of over $1 billion. The technology also could be adapted to provide similar biochemical control for other body structures or processes; it could, for example, be used to treat restinosis resulting from organ transplantation. Reprogenesis attempted to obtain private funding for the research, but venture capitalists and pharmaceutical companies wish to see further progress before considering the investment. The Harvard/MIT Biomedical Engineering Center (Cambridge, Mass.) will be subcontracted to perform the animal surgeries.

연구과제명 (:99-01-1027) The Living Chip - A Cell-Based Biochip For Drug Discovery
회사명 : Cadus Pharmaceutical Corporation
연구분야 : Biotechnology
연구기간 : 2년 (1999년 10월)
전체연구비(추정) : $3,629 K
ATP 지원금 : $2,000 K
연구요약 :

Drug companies now spend millions of dollars annually to screen hundreds of thousands of compounds to identify promising new drug candidates. Demand is growing for technologies that can screen new drug compounds more rapidly and efficiently. In a two-year project, Cadus Pharmaceutical Corp. proposes to develop a "biochip" screening system that will greatly simplify and accelerate the discovery of new drugs. The basic element of the proposed system will be a compact disk-sized wafer containing up to 100,000 wells in which to place samples -- more than 1,000 times as many wells per unit area as the current industry standard for biochips. Each well will be a square, bottomless pinhole (or through-hole) in which cells in liquid will remain in suspension. Recombinant yeast cells, into which the genetic code for a key human receptor molecule has been inserted, will be used to make an assay that can identify agonists and antagonists to this receptor. A manufacturing method will be devised based on the company's novel micro-machining concept to make wafers that can be stacked and the contents of the corresponding through-holes mixed together. The entire system, called LivingChipTM, would consist of a stack of wafers and/or modules, one containing the test cells and others containing essential components such as test compounds, developer solution, detection system, reagent dispenser, and hardware/software. If successfully developed and later commercialized, the new technology could reduce the cost of drug discovery by a factor of tens or hundreds, providing the basis for a multibillion-dollar market. Other potential applications include genomics, parallel synthesis of chemical libraries, and material discovery. The project also will strengthen the U.S. technology base in microfabrication and fluidics transfer. The ATP co-funding will enable Cadus to attempt to invent the technologies needed to attract support from instrument companies for commercialization and to have a beta test system installed by the end of 2001.

연구과제명 : (99-01-1042) Protein Expression Screening
회사명 : GeneTrace Systems, Inc.
연구분야 : Biotechnology
연구기간 : 2년 (1999년 10월)
전체연구비(추정) : $2,679 K
ATP 지원금 : $1,996 K
연구요약 :
With the development of a single drug costing an average of $500 million, and only 30 percent of approved drugs recovering these costs, the pharmaceutical industry is under growing pressure to streamline and optimize the identification of novel therapeutics. To address this need pharmaceutical companies require methods for rapid collection of large amounts of data to help them elucidate the complex, disease-causing interactions between gene products -- such as proteins -- and the environment. Most cellular activity is controlled by proteins, but existing techniques for protein analysis are laborious. In a 33-month project, GeneTrace Systems, Inc., proposes to develop a rapid, low-cost assay technology that can monitor the production levels and activity of hundreds of proteins simultaneously. The technology is a protein probing technology that can be used in a manner analogous to current DNA and RNA probing technologies. As designed, the technology is extremely sensitive and takes advantage of the company's proprietary, high-throughput mass spectrometers to detect and quantify the relative ratios of the proteins and to record the information in a database. The main advantage of the proposed technology design is the capability to run many individual experiments at once. Research challenges include the development of specific probing methods, processes for mass spectrometric analysis, and integration of the various steps into a coherent process that can be automated. If successfully developed and commercialized, the new technology could accelerate the development of therapeutics for previously intractable diseases and enhance the chances of success in expensive and prolonged clinical trials. GeneTrace has sought out ATP funding because of the high risk nature of this research project.

연구과제명 : (99-01-1060) Cloning Pigs : A Solution To Overcoming Rejection In Organs For Transplantation
회사명 : PPL Therapeutics, Inc.
연구분야 : Biotechnology

연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,481 K
ATP 지원금 : $2,000 K
연구요약 :
Thousands of Americans die each year while waiting for organ transplants, primarily because of a growing shortage of organs from human donors. A promising but problematic solution is the use of pig organs and tissue. However a significant obstacle is hyperacute rejection (HAR) of the transplanted tissue, triggered when the human immune system recognizes a specific sugar molecule on the surface of pig cells and organs. Currently the impact of HAR can be reduced but not eliminated. In a three-year ATP project, PPL Therapeutics, Inc., proposes to accelerate the medical use of pig organs by genetically altering pig cells to prevent HAR. The company will "knock out" (inactivate) the pig gene that modifies the sugar molecule, which in turn activates the human immune response. This piece of the experimental work has been particularly difficult. However PPL has recently achieved success in this homologous recombination technology in a related system -- the sheep. Thus, this team is poised to be the first to successfully genetically engineer a pig cell. These genetically altered cells will then be used to clone pigs whose organs and tissues do not have any residues of this sugar. If successful, the ATP project is expected to reduce the risk of crucial follow-on research sufficiently to attract private-sector investors and to make the transplant of pig organs and tissues both viable and commercially feasible. The use of pig organs would offer tremendous health, economic, and social benefits by providing sufficient organs to meet the demand, reducing the tens of billions of dollars now spent annually caring for patients with organ failure, and improving their quality of life. PPL projects a market for animal transplants of nearly $6.5 billion within 10 years of launch. In addition, the new technology will create new industries and enable advances in other fields, such as treatment of vascular disease, the science of embryology, and development of animal models for human diseases. PPL sought private-sector partners to share the risk of this research but was told that a genetically altered pig would need to be created first. The parent company of PPL is based in the United Kingdom, but the ATP-funded research and any resulting manufacturing will be carried out in the United States. The University of Washington (Seattle, Wash.) will be subcontracted to assist with the genetic alterations.

연구과제명 : (99-01-1062) Bioengineering Of A Liver Assist Device
회사명 : Organogenesis, Inc.
연구분야 : Biotechnology
연구기간 : 2년 (1999년 10월)
전체연구비(추정) : $4,175 K
ATP 지원금 : $2,000 K
연구요약 :
More than 43,000 Americans die each year from liver disease. Organ transplant, the only

effective treatment for acute liver failure, is limited by a shortage of donor organs and costs more than $300,000 per procedure. The development of an effective new treatment would substantially reduce both mortality and costs. In a two-year ATP project, Organogenesis, Inc., will attempt to develop a liver assist device (LAD) prototype for use outside the body to provide critical therapeutic functions for patients with liver failure. The concept of a LAD is not new, but existing designs have not demonstrated convincing benefits, in part because of difficulties with oxygen transport and the tissue culture architecture. Organogenesis plans to overcome these and other hurdles by developing innovative device configurations that can support as many as 10 billion liver cells without significant loss of their differentiated therapeutic functions. The company will evaluate pig and human liver cells and various planar device configurations with built-in oxygenation. Efforts will be made to maximize the density of cells loaded into the bioreactor cartridges. In addition, the company proposes to develop processes for cryopreserving the cells, seeding cells into the device, preventing direct contact between patients and the LAD cells, and aseptic manufacturing. The ATP funding will significantly accelerate development of the LAD technology by Organogenesis, a small company with limited resources. If successful, the LAD will reduce mortality by stabilizing patients with liver failure so they are good candidates (and can wait) for a transplant, or by providing external support while the patients' own livers regenerate. Additionally, the annual savings in health care costs could run into hundreds of millions of dollars. In addition to these benefits, the project will advance the development of other cell-based therapies. Massachusetts General Hospital (Cambridge, Mass.) will be subcontracted to develop small and large animal models of liver failure.

연구과제명 : (99-01-1067) T Cell Production In An Artificial Thymus
회사명 : Cytomatrix
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $2,250 K
ATP 지원금 : $1,750 K
연구요약 :
Cancer, viral infections, immunosuppression, and other conditions can be treated by boosting the body's immune system. Among the most powerful parts of the immune system are T lymphocytes, which, in conjunction with accessory cells, can produce highly specific and effective responses to many foreign agents. T cells are made in the thymus gland. In a three-year ATP project, Cytomatrix will attempt to develop an artificial thymus prototype capable of producing functional T cells for immunotherapy. The natural thymic environment will be recreated in the company's biocompatible, three-dimensional cell growth matrix called Cellfoam, which is made of metal and carbon. The device enables the long-term growth of stem cells and their natural differentiation into T cells -- without the addition of serum or other factors that might enhance differentiation but disrupt the balance and value of the cells produced.

The ATP project will optimize production of T cells, develop T cells that are specific to targeted antigens, and test the therapy in an animal model. The project will focus on developing a Cellfoam bioreactor for use outside the body; eventually, the company hopes to produce an implantable device. Among its advantages, the proposed technology will enable the production of T cells tailored to fight specific diseases. Cytomatrix sought private-sector funding but was unsuccessful because of the early stage and high risk of the research. The ATP support could hasten development of the artificial thymus by up to three years, cutting time to market from as much as 10 years to five. If successfully developed and commercialized, the new technology will enhance treatments for some illnesses or even cure or prevent them, while increasing the nation's productivity by reducing workdays lost due to illness. The demand for this type of product is great : The annual U.S. market for T cells produced in an artificial thymus is approximately $2 billion, and about one-tenth of the U.S. population (20 million people) undergo some form of immunotherapy each year.

연구과제명 : (99-01-1085) Genoprocessor : A Microfabricated High-Performance Genotyping System
회사명 : Kiva Genetics, Inc.
연구분야 : Biotechnology
연구기간 : 2년 (1999년 10월)
전체연구비(추정) : $4,000 K
ATP 지원금 : $2,000 K
연구요약 :
Tiny genetic differences among individuals are believed to account for their susceptibility to many diseases as well as their response to drugs. As scientists progress in identifying the chemical makeup of human genetic material, there will be a tremendous need for affordable genotyping services to identify individual genetic variations as a basis for drug design and other medical and scientific purposes. In a two-year ATP project, Kiva Genetics, Inc., proposes to develop an automated, miniaturized DNA analysis system that can perform up to 100,000 genotyping assays per day at a low cost. Most of the processes involved -- such as extracting, amplifying, and separating pieces of genetic material -- have already been performed individually; the challenge is to link the steps together into a reliable, integrated, easily manufactured system that can process many samples in parallel. The company will attempt to develop methods to transfer samples and reagents between and within modules, new chemistries for genotyping and clean-up, and software to analyze the data generated. A series of four technology platforms of increasing sophistication and power will be developed and validated. The ATP funding will accelerate the development of a fully integrated system that, if successful, will greatly increase genotyping speed while reducing costs 10-fold. Once the technology is viable, the company plans to use it to offer genotyping services to geneticists and researchers from the pharmaceutical and agricultural industries. Eventually commercial versions will be developed for use in clinical trials. If successfully developed and commercialized, the technology will change

how drugs are prescribed and how new drugs are developed by permitting smaller and faster clinical trials with better results. The project will have spin-off benefits in microfluidics and assaying, yielding advances ranging from better lab instruments to tailored therapies. ATP funding will allow Kiva to pursue this path-breaking research that could change the fundamental paradigm for genotyping and convert its concept into a state-of-the-art device.

연구과제명 : (99-01-1089) BioArtificial Muscle Implants For Sustained Protein Delivery
회사명 : Cell Based Delivery, Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,085 K
ATP 지원금 : $2,000 K
연구요약 :
Chronic diseases impose an annual economic burden of $450 billion on the United States alone. Proteins can be injected to treat some conditions, but the therapy is costly, cumbersome, and often has side effects. A potentially more efficient and less expensive alternative is an implant that corrects for the deficient or reduced protein output of the native cells. In a three-year ATP project, Cell Based Delivery, Inc., will attempt to design implantable bioreactors created from human muscle tissue that release therapeutic proteins in a predictable, site-specific manner. The technology will be based on engineered human tissues containing genetically modified cells that can synthesize a range of proteins with predictable, long-term dosing. The devices can be implanted under the skin, in muscles, or elsewhere in the body for either systemic or localized treatment. The ultimate goal of this project will be a bioreactor based on BioArtificial Muscle (BAM) cultured from cells obtained from patients with long-standing cardiovascular disease. Genes encoding recombinant proteins will be transduced into the BAM, which will then be implanted into the patient to treat the disease. The company hopes to demonstrate controlled protein production at appropriate sites in small and large animal models. The proposed technology relies on several clinically approved techniques but differs from other biotechnological approaches because it both produces and delivers proteins within the body, will function for a long time period, and is reversible. If successfully developed and later commercialized, the technology could expand the $13 billion market for existing recombinant proteins, open new markets for molecules in development, and hasten the clinical application of human genes and proteins discovered in the future. Pharmaceutical and medical companies are very interested in the technology but require further preclinical data before investing in product development and clinical testing. The ATP funding will accelerate the development of the human BAM platform for cardiovascular applications, moving the technology into clinical trials within three years. The platform also could be used to treat many other major disorders, from cancer to diabetes. Clinicians and researchers at Brown University, Rhode Island Hospital, and the Miriam Hospital (Providence, R.I.) will perform the human biopsies and animal surgeries.

연구과제명 : (99-01-1104) Microfluidics Device for Diagnosis of Nosocomial Agents (MeDiNA)
회사명 : Motorola, Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $8,975 K
ATP 지원금 : $4,392 K
연구요약 :

The incidence of life-threatening bacterial infections has been rising in recent years, along with increases in the virulence and drug resistance of the bacteria. Traditional diagnoses require great expertise, expensive equipment, and time. The development of an inexpensive diagnostic device that could profile bacteria rapidly would help to identify, treat, and control the spread of such infections. In a three-year project, a joint venture led by Motorola Labs' Physical Sciences Research Laboratories plans to develop and demonstrate a prototype "DNA chip" that performs all sample preparation and genetic analysis functions needed to diagnose infectious diseases rapidly. A miniature, disposable plastic device is envisioned. To integrate all sample preparation steps on one chip, the team will pursue several innovative concepts. Sophisticated, three-dimensional device structures will be designed and then produced in batches using novel microfabrication techniques involving molding and bonding. The project will advance DNA chip technology beyond the state of the art by exploiting each team member's unique capabilities. Motorola will be responsible for device design, fabrication, and test station development. The other members of the joint venture are CFD Research Corp. (Huntsville, Ala.), which will develop modeling tools for device optimization and monitoring reactions, and Arizona State University (Tempe, Ariz.), which will provide expertise in immunology and relevant subfields of biology. If successfully developed and later commercialized, the technology will be sufficiently sensitive, specific, rapid, and low in cost to be used in doctor's offices and hospitals, and for environmental studies. The technology could expand the market for point-of-care devices, now expected to reach $1.3 billion by 2000, and find additional applications in the agriculture, food, and pharmaceutical industries. The new fabrication techniques will also be applicable to other types of microdevices for biomedical and other applications. The ATP funding enabled partners with complementary expertise to be assembled and will accelerate technology development by at least two years.

연구과제명 : (99-01-1106) New Treatment Paradigm for Central Nervous System Disorders Involving Human Mesenchymal Stem Cells
회사명 : Osiris Therapeutics, Inc.
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,687 K
ATP 지원금 : $2,000 K

연구요약 :
Diseases and injuries affecting the central nervous system (CNS) lead to death and disability in millions of patients and cost the U.S. economy more than $80 billion annually. Existing therapies are costly and can only alleviate symptoms of these conditions temporarily; they cannot cure. In a three-year ATP project, Osiris Therapeutics, Inc., will attempt to develop and test a novel treatment approach in which mesenchymal stem cells (MSCs) -- precursors of connective tissue -- are injected into the brain to improve or even cure chronic CNS disorders. Obtained from adult bone marrow and cultured outside the body, the stem cells are expected to provide three functions : delivery of genes that generate therapeutic products, regeneration of lost or damaged cells, and suppression of immune disorders. The central challenge is to deliver an effective dose of cells consistently; although mesenchymal cells have an intimate relationship with the CNS, it is not known whether they will differentiate into nerve cells or nervous system tissue. Osiris will deliver stem cells to rat brains and measure cell survival, proliferation, distribution, and differentiation. The company will also insert new genes into stem cells for the production of therapeutic products and measure the resulting product levels in animals. Finally, the company will assess whether implanted cells suppress localized immune reactions, such that they could preserve or slow the progression of autoimmune diseases. If successfully developed and later commercialized, the new technology would be used initially to treat Parkinson's disease, multiple sclerosis, and traumatic brain injury, which together afflict more than 3 million Americans. Successful treatment could save the nation an estimated $6.6 billion annually. Additional applications may include stroke and spinal cord injury. The U.S. market for MSC therapy is estimated at $1.4 billion, and international markets would be two to three times higher. At this early stage, the technology is too unproven to attract private capital, and Osiris has only limited resources to pursue it on its own. ATP co-funding will accelerate the research by three to five years. MCP Hahnemann University (Philadelphia, Pa.) will be subcontracted to collaborate on experiments.

연구과제명 : (99-01-1113) Inactivation of Genes in the Pig by Homologous Recombination and Nuclear Transfer
회사명 : Alexion Pharmaceuticals
연구분야 : Biotechnology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,406 K
ATP 지원금 : $1,999 K
연구요약 :
Genetically altered animals could have tremendous therapeutic potential for transplantation therapies, but the technology for creating them is inefficient and largely underdeveloped. While several examples of cloned animals currently exist, there are significant challenges (low efficiency, multiple genetic modifications, unpredictability in gene insertion) which engender these

experimental protocols with high technical risk. Indeed, the two critical technologies of nuclear transfer and germline transmission have yet to be demonstrated in the pig, which is the best candidate animal as a future source of cells, tissues, or organs. It is not yet possible to knock-out (inactivate) genes controlling the expression of highly immunogenic pig proteins and carbohydrates that cause the human immune system to reject the transplanted tissue. In this three-year ATP project, Alexion will attempt to develop methods for generating, screening, selecting, and propagating cells containing a gene knock-out and then use the nuclei from those cells to generate cloned animals with the desired change. The company will breed these animals to several of their derived transgenic lines that express human genes essential to inhibiting the human immune system from rejecting the transplant. The combination is expected to dramatically reduce immune rejection and enable the development of pig cells to be considered for use in human transplantation. Thus, the team hopes to overcome a critical roadblock toward producing a whole new class of donors for transplantation therapy. The ATP co-funding for this project is needed to produce the raw materials for the follow-on, privately funded clinical studies that are necessary before the technology can enter the operating room. Once the appropriate cells and tissue are available, private capital can be obtained for the follow-on research. If successfully developed and commercialized, the new technology could transform transplantation therapies and have vast economic impacts on the United States. For example, broader use of pig kidney transplants instead of dialysis could save the federal government as much as $2 billion annually. The ready availability of standardized, genetically engineered organs could become a $6.5 billion market in 10 years. Spin-off benefits of the project will accrue to the tissue engineering field and agriculture industry.

연구과제명 : (99-01-2017) Low Cost Low Light Level Video Camera
회사명 : Intevac, Inc.
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 2년 (1999년 10월0
전체연구비(추정) : $10,540 K
ATP 지원금 : $5,270 K
연구요약 :
Intevac, Inc., and National Semiconductor Corp. (Santa Clara, Calif.) plan to develop new sensors and an automated manufacturing method to enable the production of low-cost, high-performance low light level (LLL) cameras. Today's LLL cameras, derived from military research, cost as much as $10,000 apiece -- too expensive for most applications. Intevac and National Semiconductor believe that the price will be reduced significantly utilizing breakthrough advances in electronics and manufacturing. The advanced sensors also will make possible a new generation of affordable digital still cameras. Unlike present LLL cameras, which work well only in darkness, the new cameras will perform just as well in all types of lighting conditions, including bright daylight. In this project, CMOS chip technology, now used to make most

computer chips, will be used to fabricate a chip with the necessary camera and sensor electronics. This chip will be incorporated with the camera's image intensifier to form the new LLL camera. Because CMOS technology is relatively inexpensive, the new cameras woud be inherently less costly, but only if an automated assembly process can be developed. The combination will enable the development of an affordable camera product that will revolutionize industrial and home security systems as well as law enforcement applications. The project's success depends on three critical innovations : making the new chip, incorporating the chip with the camera's image intensifier and creating the automated manufacturing equipment. ATP support will enable the two companies to pursue this challenging and high-risk project.

연구과제명 : (99-01-2029) Ultra-Compact Packaging Technology For Telemedicine, Telecommunications And Next Generation I/O (NGIO)
회사명 : Picolight Incorporated
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 2년 (1999년 10월0
전체연구비(추정) : $4,565 K
ATP 지원금 : $2,000 K
연구요약 :
The wide use of very fast (multi-gigabit-per-second) digital connections for telemedicine, telecommunications, and computer input/output will be possible only with dramatic reductions in the price and size of fiber-optic transceivers, a combined transmitter and receiver component. Current technology is too bulky and costly to be bundled in a wide range of consumer products, including desktop and laptop computers. In a two-year ATP project, Picolight, Inc., will attempt to develop advanced packaging technologies and prototype miniature fiber-optic datacom transceivers, with the aim of reducing standard transceiver size 100-fold and manufacturing cost by a factor of 10. To achieve this goal, innovative optics and electronics will be developed to replace traditional metal housings. The company will also develop a chip platform for mounting electronic and opto-electronic devices, processes to make high-quality micro-optics, and automated testing procedures. The ATP funding will accelerate the development of the technology by two years, enabling a U.S. company to be the first to develop superior datacom products at low prices, preventing a serious data bottleneck that otherwise will hinder enterprise networking. If successfully developed and later commercialized, the new technologies will make scaleable, fiber-optic transceivers cost competitive with any copper-based solution. Using this technology in desktop and laptop computers as well as other consumer products also will offer consumers improved quality, speed, and throughput in data transmissions. The economic impact will be substantial : In telecom switches, for example, the new transceiver would provide four times today's performance at half the cost. The new technology could also be used in other optoelectronic devices, such as displays, photocopiers, and fax machines. Subcontractors include the University of Southern California (Los Angeles, Calif.), Digital Optics Corp. (Charlotte, N.C.),

and the University of Alabama at Birmingham.

연구과제명 : (99-01-2039) MID-IR Cavity Ring-down Spectroscopy
회사명 : Informed Diagnostics, Inc.
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 23개월
전체연구비(추정) : $4,829 K
ATP 지원금 : $2,000 K
연구요약 :
Portable systems are sorely needed to detect explosives, chemical-warfare agents, and drugs, especially for security applications. In medicine, an advanced method to monitor concentrations of drugs and other substances continuously in real time would save tens of thousands of lives and billions of dollars in hospital costs each year. Informed Diagnostics, Inc., proposes to develop a lightweight, hand-held system to measure tiny concentrations of specific molecules in air using an innovative laser detection technique called Mid-IR Cavity Ring-Down Spectroscopy. A laser beam is bounced back and forth in a mirrored cavity. After the beam is turned off, it takes only a few microseconds for all of the photons to escape from the mirrors -- the "ring-down time" -- and this time is shorter if gas molecules are present inside the cavity that absorb some of the photons. CRDS can provide a sensitive detector by using lasers tuned to just the precise infrared absorbtion frequencies for specific molecules. However this requires innovations in lasers, optics, coatings, and detectors for the mid-infrared region, and the inherent financial and technical risks have discouraged R&D investment. A small company, Informed Diagnostics needs ATP support to overcome the initial technical risks to the point where private investment becomes available. If successful, the project ultimately will enable portable CRDS systems that can quickly detect a wide range of explosives and other hazardous agents. In addition to yielding portable detectors, the work also aims to produce larger units that are 100 times more sensitive than the conventional detection by gas chromatography and mass spectrometry. There would be important applications in medicine as well. A small unit testing exhaled breath of patients suffering from severe diabetes could save about $1 billion annually in hospital costs by preventing ketosis attacks requiring emergency care. CRDS also could be used in emergency rooms to determine whether unconscious patients have overdosed on drugs, saving about 10,000 lives and $500 million annually by avoiding expensive procedures. Informed Diagnostics plans to work with several other firms in developing the technology, including Lucent Technologies (Murray Hill, N.J.), Aculight Corp. (Bothell, Wash.), and Ovation Semiconductor (Rochester, Minn.), as well as Loyola University (New Orleans, La.) and Stanford University (Stanford, Calif.)

연구과제명 : (99-01-2050) Integrated MEMS Reactor Gas Monitor Utilizing Novel Thin Film Chemistry For The Closed Loop Process Control And Optimization Of Plasma Etch And Clean Reactions In The Manufacturing Of Microelectronics

회사명 : ATMI, Inc.
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 3년
전체연구비(추정) : $3,774 K
ATP 지원금 : $1,711 K
연구요약 :

As the world's semiconductor manufacturers transition from producing 200 to 300 millimeter silicon wafers, and as pressure increases to cut emissions of polluting chemicals and gases, the industry needs to move from post-process wafer measurements to precise, real-time process monitoring to reduce waste. One common source of waste is the gases used to etch chip features on the wafers -- gases that continue to flow into the reactor chamber after the job has already been completed, but which cannot be regulated because there is no effective way to measure the concentration of the gases in the chamber. ATMI plans to solve this problem with a new class of miniature, precision sensors for providing constant feedback as wafers are being processed. Because the harsh, corrosive environment of a wafer processing reactor will rapidly degrade almost any sensor, the ATMI "reactor gas monitors" will be disposable -- cheap enough to replace after a few preventative maintenance cycles. The innovative monitors will incorporate sensing devices in a microelectromechanical system (MEMS) -- a device with moving parts that are nearly too small to be seen with the naked eye. The project involves several major technical challenges : development of better polymer film sensing materials; learning how to combine just the right measuring techniques and sensing materials to accurately distinguish between similar types of chemicals; enhancing sensor performance with sophisticated data-analysis methods; and assembling the sensors in a small, inexpensive, yet sturdy package capable of surviving the searing temperatures and caustic chemistry inside processing reactors. The window of opportunity to develop those technologies is narrow, however; they must be ready for integration into the new wafer fabrication lines now being planned or wait until the next major shift in production technology provides another opportunity to retool. A small company, ATMI does not have the R&D resources to complete the development work in time without ATP support. The company will work with researchers at the Massachusetts Institute of Technology (Cambridge, Mass.) and IntelliSense Corp. (Wilmington, Mass.).

연구과제명 : (99-01-2051) MEMS-Based Infrared Micro-Sensors
회사명 : Ion Optics, Inc.
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $1,380 K
ATP 지원금 : $753 K
연구요약 :

There is a large potential market for low-cost, mass-market gas and chemical sensors for home safety (reliable carbon monoxide and natural gas detectors, for example) and automotive applications, but no suitable mass-market technologies. Existing microelectronic chemical sensors too often produce false alarms because they are overly sensitive and not specific enough. Laboratory equipment, on the other hand, uses infrared absorption spectroscopy. This is too expensive for home use because it is comprised of many discrete electro-optical components. Ion Optics, Inc., proposes to develop a mass-market technology for infrared-absorption-based sensors by integrating all the necessary elements of a gas sensor into a single, integrated circuit component that can be manufactured in high volumes at low cost. The sensor-on-a-chip concept will exploit technologies used to fabricate integrated circuits and MEMS (microelectromechanical systems) to create devices that emit and detect signals predominantly at a specific infrared wavelength. The chip will fit in a molded plastic optics unit and reflect the beam through a small gas cell. If any molecules of the target gas are present in the cell, they will absorb some of the infrared radiation -- the amount absorbed giving a measure of the concentration of the gas. The design reduces the number of parts needed to construct an infrared gas sensor to a minimum with very low energy requirements -- it could operate on battery power like a home smoke detector. The major benefits from this technology would be in improved public health and safety, by enabling accurate, affordable, and reliable home carbon monoxide monitors, natural gas alarms, on-board automotive sensors, and indoor air-quality sensors. Ion Optics is a small company with limited resources. Without ATP support, development of its innovative sensor technology would be delayed up to 10 years. The Jet Propulsion Laboratory of the California Institute of Technology (Pasadena, Calif.) will participate in the project as a subcontractor.

연구과제명 : (99-01-2069) Bulk GaN And Homoepitaxial Device Manufacturing
회사명 : General Electric Company Corporate Research and Development
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $4,600 K
ATP 지원금 : $2,254 K
연구요약 :
A material called gallium nitride is making possible a new class of high-performance optoelectronics and microwave technology, from blue lasers that quadruple the storage capacity of compact disks, to high power microwave devices, super-resolution laser printers, and environmentally safe, ultra-efficient lighting that outshines conventional products. Gallium-nitride technology is enabling researchers to produce new types of light-emitting diodes that combine the benefits of fluorescent and incandescent lights, but with far greater efficiency. Future electronics applications include high-definition television and video disk players, technology for wireless Internet access, satellite communications, and automotive electronics. However widespread commercial use of gallium-nitride technology will require a way to produce gallium

nitride in bulk at low cost. To date, no company has developed a low-cost method for producing high-quality bulk gallium nitride. A major stumbling block is the material's extremely high melting point and other factors that prevent gallium-nitride crystals from being "grown" using conventional methods. Researchers at the General Electric Company and Sanders, a Lockheed Martin company (Nashua, N.H.), propose to solve this problem by growing the material with a high-pressure, high-temperature apparatus similar to that used to make synthetic diamond. Under this ATP project, they intend to adapt these methods to produce large-area wafers of gallium nitride. The joint-venture partners have been unable to fully fund this technology development because of uncertain and possibly high technical risks. ATP funding will enable them to pursue a concept that offers extraordinary payoff to U.S. industry if successful -- the project will help U.S. industry leapfrog the technologies of Japanese competitors, who otherwise will dominate the gallium-nitride-device market, projected to be $3 billion by 2006. Working with General Electric and Sanders will be researchers from Cornell University (Ithaca, N.Y.).

연구과제명 : (99-01-2085) Development Of Lead-Free Solder Electroplating Technologies
회사명 : Lucent Technologies, Inc.
연구분야 : Electronics/Computer / Hardware/Communications
연구기간 : 2년 (1999년 10월)
전체연구비(추정) : $3,179 K
ATP 지원금 : $1,272 K
연구요약 :
About 10,000 tons of tin-lead solder are used annually in various components and circuit boards, but government regulations, particularly in Japan and the European Union, are moving toward banning the use of lead in electronics equipment and requiring manufacturers to bear the cost of disposal of lead-bearing products as hazardous waste. Economic analysis suggests that if Japan and the EU ban lead-based electronics, the U.S. industry stands to lose an estimated $420 billion in the three-year period beginning 2002 -- unless it has a competitive substitute for the proprietary lead-free manufacturing methods that foreign competitors are believed to be close to perfecting. The Electroplating Chemicals and Services (EC&S) venture of Lucent Technologies proposes a two-year project to develop commercially viable processes for electroplating tin-silver and tin-bismuth solder as a drop-in replacement for tin-lead solder. Doing so will require a precise understanding of the chemical reactions and the growth of material being electroplated onto surfaces. Tin and lead have been used for years because they are an ideal combination for electroplating; they are deposited almost simultaneously as voltage is applied. The more environmentally benign combinations of tin-silver and tin-bismuth are much less naturally compatible, and efforts to develop lead-free solder chemistry that can be used with the industry's existing equipment and processes have been frustrated by complex and unknown reactions in the plating solutions. EC&S plans to solve this problem by studying precisely what is happening in the reactions with a novel combination of spectroscopy and scanning tunneling

microscopy. These detailed in situ measurements of the chemical processes that take place in various lead-free solder compositions should enable EC&S to develop practical industrial electrochemistry techniques and materials to enable "drop-in" replacements for lead-based solders. EC&S is a venture of Lucent Technologies focused on developing and marketing electroplating chemicals to the electronics industry. ATP's minority support will enable EC&S to pursue a high-risk development effort of a technology that is critically important for the U.S. electronics industry as a whole.

연구과제명 : (99-01-3012) Robust Extraction of 3D Models From Video Sequences
회사명 : Geometrix, Inc.
연구분야 : Information Technology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,081 K
ATP 지원금 : $1,954 K
연구요약 :
Three-dimensional computer models of real-world scenes have myriad potential uses in architecture, construction, art, entertainment, forensics, military planning, industrial training, and many other fields. Little of this is actually done, however, because constructing 3D models of complex scenes is difficult and very expensive. It can take a week to build a single useful 3D model and months to build a complete simulation database. Geometrix, Inc., proposes to put the power of 3D modeling in every computer user's hands by developing software to "scan" the real world into 3D digital databases using only conventional camcorder images for input. Humans can extract 3D detail from 2D pictures without conscious thought, but algorithms that allow a computer to deduce the shapes, relative positions, and orientations of objects from pictures are complex. Many theoretical approaches have been developed over the past two decades. Geometrix's proposal is to take theoretical solutions developed in universities, make them robust enough for use in real-world imaging problems, and combine several different methods for extracting 3D data in the same system with a higher-level stage that resolves ambiguities and errors by comparing the results of each method to decide on the best interpretation of the image. If fully successful, a scene-of-crime technician, for example, will be able to videotape the surroundings of a crime scene in a few minutes, return to the lab, and have the computer generate a detailed 3D reconstruction of the scene for analysis and use in courtroom testimony. Key measurements such as tire skid marks or bullet trajectories might even be automatically calculated by the computer. A small company, Geometrix has developed limited-purpose products that extract 3D information from images under controlled conditions, but the proposed project goes far beyond any existing capability in the world. Geometrix has tried and failed to secure venture capital for this work. ATP funding will enable the company to treble its work in algorithm development and attempt to achieve the results necessary to make 3D video modeling rapidly available to broad markets. 3D graphics today make up about a third of the $60 billion

graphics market, representing the work of about 250,000 professional graphics creators. Geometrix's video technology, if successful, could expand the field of people capable of creating 3D graphics content to several million, dramatically expanding the impact and applications of the field.

연구과제명 : (99-01-3026) Open Software Tools For Condition Based Maintenance
회사명 : United Technologies Corporation - United Technologies Research Center
연구분야 : Information Technology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $9,383 K
ATP 지원금 : $4,691 K
연구요약 :

Condition-based maintenance has become a key tool for efficiency and cost savings in many U.S. plants. Condition-based maintenance systems use sensors, automated diagnostics, and predictive models to schedule equipment maintenance when the machine actually needs it -- neither too soon, as might happen with simple preventive maintenance schedules, nor too late. One of the major benefits is that CBM minimizes the time that equipment is out of service -- for this reason the concept has been embraced in situations where down time is very expensive, such as for combat aircraft or high-volume auto assembly lines. But CBM can also dramatically reduce the costs of maintenance through better management of the complex web of parts suppliers and maintenance firms that make up the maintenance supply chain. Those systems that exist are expensive, unique, custom designed, point solutions. CBM has not been widely implemented outside of the high-end industries mentioned largely because the initial costs to set up such a system are high. United Technologies Corporation has entered into a joint research venture with i2 Federal, Inc., (Irving, Texas) with the goal of simplifying and lowering the introductory cost of CBM by developing and demonstrating a set of generic, widely applicable software tools for value assessment, planning, design and implementation of enterprise-wide condition-based maintenance. A comprehensive enterprise-wide CBM system involves incredible complexity. A machine-wear model might have to track thousands of individual units, each with hundreds of factors to be tracked and modeled; each maintenance action may involve a specific supply chain of spare parts, repair actions, vendors, required staff skills, and the like. As a result, there have been no general software solutions to large-scale implementation of CBM. Because of the sheer size and complexity of the generic problem, this project involves substantial technical barriers. In particular, the optimization tools will involve significant advances in the state of the art. ATP funding will permit the partners to move beyond simple point solutions for their own needs to develop a more broadly applicable CBM toolset for U.S. industry. The partners anticipate that at least $30 billion in maintenance costs in the U.S. economy could be saved annually through widespread use of CBM.

연구과제명 : (99-01-3055) Adaptive Web Learning Guides
회사명 : Extempo Systems, Inc.
연구분야 : Information Technology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $2,333 K
ATP 지원금 : $1,994 K
연구요약 :

The power and flexibility of the World Wide Web suggests the possibility of a protean learning environment that tailors itself in both style and content to each individual learner's needs and capabilities. To achieve this vision, however, educators will need powerful software tools that can distill the educational content available and create learning experiences that suit both learners and teachers. In a three-year ATP project, Extempo Systems, Inc., (Redwood City, Calif.) will develop and test Adaptive Web Learning GuidesTM and affordable tools for customizing these guides to help users of Web-based educational material. The guides will appear as animated characters who converse in natural language, manipulate Web content, and adapt their assistance to user needs. The guides will also maintain records of learner achievement and provide feedback. The authoring tools will enable educators without programming skills to define a guide's interactive teaching manner by describing the learners, situations, content, and desired presentation style. To realize these concepts, Extempo plans to exploit and integrate existing ideas and designs from artificial intelligence, instructional systems, and cognitive research on student preferences and teaching strategies. The greatest challenge will be to create smart, flexible, and personable guides that will inspire affection and trust and function as effective instructors. Extempo's proprietary Imp Character TechnologyTM will provide the foundation needed for this project. The ATP co-funding will enable Extempo to develop technologies that are broadly applicable to many industries as well as K-12 public education; without this support, any new learning systems would probably be narrowly specialized for individual markets. If successfully developed and commercialized, the new technologies will create new forms of learning systems, extend the reach of educators, help provide access to learning experiences for users who are not computer savvy, and help workers acquire new job skills.

연구과제명 : (99-01-3061) Spoken Language User Interface (SLUI) Toolkit
회사명 : BCL Computers
연구분야 : Information Technology
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $2,348 K
ATP 지원금 : $1,817 K
연구요약 :

Speech-based input systems are becoming ever more desirable with the advent of handheld computers. Spoken language provides a natural and convenient method of communicating with the computer, but a spoken-language user interface (SLUI) for an application program is difficult to create. The situation is analogous to the early days of graphical user interfaces : before standardized interfaces every application programmer also had to learn graphics programming. Natural-language processing is far more complex than GUI programming. Automatic speech recognition systems exist to take spoken words and translate them to symbols, but to build a true SLUI the programmer needs to understand concepts in human linguistics, syntactic parsing and human discourse theory to effectively translate a natural language sentence into input for an application program. BCL Computers proposes a SLUI Toolkit that will allow programmers to rapidly develop spoken-language input for new and existing applications without a detailed knowledge of linguistic theory. The programmer will specify a sample set of input sentences for each task, and the Toolkit will analyze them and generate a front-end application which is fine-tuned for understanding relevant naturally spoken command sentences. Natural-language processing is a notoriously difficult field, and developing a SLUI Toolkit powerful and general enough to be useful to programmers working in a wide variety of application areas will require BCL to overcome a number of technical challenges, ranging from algorithms to deal with ambiguity in natural language to designing effective "wrappers" to interface with the target application programs. The resulting SLUI also must be compact and efficient enough to work well within the resources of a handheld computer. ATP funding will assist BCL in proving the feasibility of the high-return, high-risk technology in the SLUI Toolkit. BCL will raise venture funds to commercialize and widely disperse the Toolkit. An SLUI toolkit could transform and expand the uses of handheld computers in much the same way that the Graphical User Interface transformed the world of desktop computers. SLUIs will also be useful in many applications -- car radios, for example -- where hands-free operation is desirable.

연구과제명 : (99-01-3079) The Federated Intelligent Product Environment (FIPER)
회사명 : Ohio Aerospace Institute
연구분야 : Information Technology
연구기간 : 4년 (1999년 10월)
전체연구비(추정) : $21,437 K
ATP 지원금 : $10,708 K
연구요약 :

Improvements in design technologies and processes have greatly enhanced product quality and reduced time to market in many industries. Competitive pressure to enhance quality further while reducing life cycle costs is creating a need for even more innovation in design. In a four-year project, a joint venture led by the Ohio Aerospace Institute will develop and demonstrate technologies that will transform the present serial design process to make it truly concurrent with manufacturing, thus reducing design time, improving quality, and potentially reducing the cost of creating new products. The Federated Intelligent Product EnviRonment (FIPER) will be an open software environment distributed across platforms and locations offering Web-based services that can be used in designing and making a broad range of products. Among the planned innovations, technology will be developed that links product requirements analysis to product geometry and automates design tasks. A central challenge will be to design an architecture that can fully integrate proprietary tools, including the three leading computer-aided design (CAD) platforms. In addition, knowledge-based systems will be designed to automatically revise component geometry in response to analyses of cost, performance, and producibility issues, which will be integrated into the knowledge base. FIPER demonstrations will focus on a jet engine, nacelle (shelter structure for the engine), and fuel nozzle. The other partners in the joint venture are the BFGoodrich Aerospace Aerostructures Group (Chula Vista, Calif.), Engineous Software, Inc., (Morrisville, N.C.), General Electric Aircraft Engines (Cincinnati, Ohio) together with GE Corporate Research and Development (Niskayuna, N.Y.), Ohio University (Athens, Ohio), and Parker Hannifin Corp. (Mentor, Ohio). The ATP funding will enable the team to develop and demonstrate a general solution for a range of applications and platforms; without this support, the technology would be proprietary and designed to address a limited set of problems. If the technology is successfully developed and later commercialized, team members project that the U.S. manufacturing sector could save a total of $2.2 billion annually.

연구과제명 : (99-01-3080) Intelligent Networked Simulation And Control
회사명 : Real-Time Innovations, Inc.
연구분야 : Information Technology
연구기간 : 3년
전체연구비(추정) : $2,667 K
ATP 지원금 : $1,998 K
연구요약 :
One of the most difficult tasks in the development of a complex system such as an aircraft or a process control system for a large plant is the successful integration of dozens or hundreds of individual modules supplied by different vendors. Controllers, software, sensors, displays, actuators, and many other components must be tested together to assure that the final system actually works. Today, the only way to do this is expensive and time consuming -- bring all of the components and participants together at a single test site. Real-Time Innovations, Inc., proposes a three-year project to create a high-speed, distributed networking technology that allows such complex tests to be conducted from multiple remote sites. Each vendor will be able to configure a link to the test network that connects with their device or subsystem. The network will orchestrate the signals between all the subsystems, allowing them to be tested just as if they were wired together on a conventional testbed. Creating the control framework for such a network that works as well as a conventional testbed involves several major challenges. Each module must be synchronized with the simulation, possibly at the microsecond level -- a

difficult task over a wide-area network. It also should be possible to save and recall the entire state of the simulation at any point -- but the simultaneous "saving" of the memory of multiple modular systems across a wide-area network in a given instant is an extremely difficult problem. A successful distributed simulation network will give industry an extraordinarily powerful tool for developing complex systems. RTI estimates that in the aerospace industry alone such simulations could save the industry $300 million per year. It also would allow smaller companies to compete more effectively for supplier contracts, spurring competition and innovation. And the modular nature of the system would make it possible to constantly improve the test software, something which is nearly impossible with many of today's testbeds. RTI, a small company, has been unable to secure outside funding for this project because of its high risk and relatively long time-line. RTI will work with the Stanford University Aerospace Robotics Laboratory in the development of the technology.

연구과제명 : (99-01-4025) Motors And Generators For The 21st Century
회사명 : IAP Research, Inc.
연구분야 : Manufacturing(Discrete)
연구기간 : 4년 (1999년 10월)
전체연구비(추정) : $9,058 K
ATP 지원금 : $4,397 K
연구요약 :
If electrical motors and generators could be made smaller and lighter for less money while still delivering the same energy output, the savings to the transportation industry would be significant. IAP Research, Inc., and its partners Delco Remy America (Anderson, Ind.) and Select Tool & Die Corp. (Dayton, Ohio) propose a cooperative venture to develop motors with double the performance at half the cost of production of conventional electric motors. The project has three related research goals. At present, large amounts of copper wire and iron are used in the stators and rotors of motors to push a magnetic field through air -- a poor conduit. Instead, the partners propose to "squeeze out the air" from the windings of copper wire by embedding the wire in an iron powder and polymer composite squeezed into a solid mass. The squeezing process, called "dynamic magnetic compaction" (DMC), uses a strong magnetic field to generate tremendous forces that squeeze the materials together in an instant. The IAP team also will use DMC to create very thin (less than 1 mm thick) neodymium-iron-boride (NdFeB) magnets on the surface of an iron composite rotor to provide high-performance permanent magnets at a low cost. Finally, the partners will develop the technology to manufacture the stators and rotors each in a single step using powdered materials and DMC, replacing the multiple-step process now required. If successful, the project will enable lightweight motors with double the output torque and power (per-unit-volume) at about half the production costs of today's electric motors. The first target market is expected to be cranking motors and alternators for the automobile industry, a $5.2 billion world market ($1.5 billion in the U.S. alone). The composite manufacturing

techniques also would be expected to have impact in the much larger general electric motor and generator market. Because of the significant technical risks involved -- three separate innovations must be achieved for the project to succeed -- and their limited R&D resources -- IAP is a small product-development firm and its partners are in an industry with thin profit margins -- the joint venture needs ATP support to establish the technical feasibility of making motors with this new approach and to achieve its R&D goals in a reasonable time.

연구과제명 : (99-01-4035) Model Driven Intelligent Control Of Manufacturing
회사명 : STEP Tools, Inc.
연구분야 : Manufacturing(Discrete)
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $2,908 K
ATP 지원금 : $1,999 K
연구요약 :
Although manufacturing design is now largely done with sophisticated computer-aided design and manufacturing (CAD/CAM) systems, control of the machine tools that actually produce the parts (or the molds used to produce a part) is comparatively primitive, using numeric codes that specify the path of the cutting tool. To better integrate the manufacturing process and allow more flexible use of machine tools, STEP Tools, Inc., will attempt to create the software environment for an intelligent manufacturing system that shares data between product design, process planning, and the machine tool controllers. Central to the project will be the development of a data-sharing system -- an extension of the STEP and STEP-NC standards for design and manufacturing plan data -- that includes product definition, process characteristics, and details about the cutting tool and related fixtures in a database. A key innovation will be to put more "intelligence" in the machine tool controllers, allowing them to generate from the product and process information in the database the necessary tool path and cutting instructions. Over three years, the project plans to develop a prototype integrated data-sharing system for design-to-manufacturing, incorporating all the necessary information from product definition to set-up requirements in the shared database. By replacing a data exchange process that has been in place for over 50 years, STEP Tools hopes to provide manufacturers with increased productivity, reduced product variation and process faults, increased speed to market, improved supply chain management, and create flexibility in using capital assets. In addition, the introduction of new manufacturing systems will provide a boost to software suppliers and the machine tool control industry. The major impact would be in the durable goods sector, which ships over $500 billion in goods annually. ATP support will allow STEP Tools, a small development company, to bring together the vendors of numerically controlled machine tools and of CAD/CAM systems, who up to now have been unable to bridge the technical gap separating them. Major subcontractors on the project will include Allied Signal (Kansas City, Mo.), a CAD tool developer; Bridgeport Machines, Inc., (Bristol, Pa.), a machine tool controller vendor; and the

Center for Automation Technologies at Rensselaer Polytechnic Institute (Troy, N.Y.)

연구과제명 : (99-01-4040) Photovoltaic Micro-Concentrator Systems
회사명 : SunPower Corporation
연구분야 : Manufacturing(Discrete)
연구기간 : 3년
전체연구비(추정) : $3,509 K
ATP 지원금 : $2,000 K
연구요약 :
Photovoltaic power systems that generate electricity directly from sunlight have generally taken one of two paths : inexpensive flat plate systems that simply use the light impinging on a photovoltaic cell, and more costly -- but far more efficient -- concentrator systems that use a Fresnel lens or other optics to intensify the light hitting the cell. SunPower Corp. proposes to combine the virtues of both in a low-profile system with a photovoltaic cell the size of a small integrated circuit chip mounted in a molded plastic concentrator. To accomplish this SunPower will use a novel non-imaging concentrator developed at the Polytechnic University of Madrid that, for 200-fold concentration, is compact and maintains a high light-collection efficiency while reducing sun-tracking requirements by a factor of six. If successful, their devices will have significant manufacturing and performance advantages, but this will require research to solve current performance problems with small silicon photocells. The combined silicon cell and micro-concentrator unit should be easily mass produced and suitable for assembly into "flat-plate" modules that are far more efficient than conventional flat solar panels, or into simplified roof-top tracking concentrator systems at a projected cost approaching $1 per watt. If successful, the technology could help revive the U.S.'s declining share of the world photovoltaic market, which has dropped from 80 percent in 1980 to 37 percent in 1998. ATP funding will allow SunPower, a small company with limited funds, to develop the technology rapidly enough to compete with foreign competitors. SunPower will subcontract to the Institute of Solar Energy at the Polytechnic University of Madrid, Spain, and Advanced Thermal Systems (Larkspur, Colo.)

연구과제명 : (99-01-4070) High Performance Rechargeable Alkaline Battery
회사명 : Rechargeable Battery Corporation
연구분야 : Manufacturing(Discrete)
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $3,797 K
ATP 지원금 : $2,000 K
연구요약 :
Existing rechargeable batteries are fine for use in small electric devices but lack the combination of high energy-storage capacity at low cost needed for more demanding applications such as

cordless electric lawn mowers, electric bicycles and scooters, and expanding portable electronics applications. To meet the demands of these applications -- and possibly electric vehicles -- Rechargeable Battery Corp. has been developing a new battery technology called secondary zinc alkaline manganese-dioxide (SZAM?. SZAM batteries use manganese oxide cathodes into which small amounts of bismuth have been added as well as a new proprietary separator/electrolyte system to ensure that only certain types of ions can move through the battery. Potentially, SZAM cells would have the energy storage capacity of today's advanced lithium-ion batteries at the cost per kilowatt-hour of traditional lead-acid (automobile) batteries. In addition, the materials used in the SZAM cells are both environmentally safe and non-toxic. If RBC's experimental technology is to be used in commercially viable batteries, however, several significant technological breakthroughs must be achieved, including cathode and anode technologies able to maintain structural integrity over many cycles of discharge and recharge, and effective separators that prevent migration of both bismuth and zinc ions between cathode and anode. A small, privately financed company, RBC does not have the resources to complete development of the basic SZAM technology quickly enough to meet stiff foreign competition without support from the ATP. Successful development of the technology could allow penetration into many segments of the $30 billion per year worldwide battery industry for applications ranging from consumer electronics to electric and hybrid vehicles. RBC will subcontract portions of the research to several firms with specific areas of expertise, including Yardney Technical Products (Pawcatuck, Conn.), Superior Graphite Co. (Chicago, Ill.), the University of Texas at Austin, and the Lawrence Berkeley National Laboratories (Berkeley, Calif.)

연구과제명 : (99-01-6015) Advanced Rechargeable Lithium Polymer Sulfur Batteries
회사명 : PolyPlus Battery Company
연구분야 : Advanced Materials/Chemicals
연구기간 : 2년 (1999년 10월0
전체연구비(추정) : $7,835 K
ATP 지원금 : $3,819 K
연구요약 :

In the $22 billion global battery market, demand is growing rapidly for rechargeable lithium batteries, such as those that power laptop computers and other wireless electronic devices. All major commercial suppliers of rechargeable lithium batteries are currently located in Asia, but this two-year project led by PolyPlus Battery Co. could change that. The joint venture will attempt to develop and test rechargeable lithium-sulfur batteries offering a longer cycle life, higher energy density, lower manufacturing costs, smaller size, and greater safety than existing lithium-ion batteries. The proposed technology will consist of lithium negative electrodes, sulfur positive electrodes, and a polymer gel electrolyte; this combination has one of the highest theoretical energy densities of all known chemically reversible (rechargeable) systems. The key technical challenge is to make a highly reversible lithium electrode. The planned lithium electrode

-- an ultrathin composite foil of lithium on glass -- should minimize corrosion of the electrode, reduce the complexity of cell assembly, and improve safety. The team also will attempt to develop polymer electrolytes incorporating sulfur-compatible solvents and high-speed technology for coating the sulfur electrodes. Venture capitalists are reluctant to support battery research because the associated materials development takes a long time to bring to market. The ATP funding is critical to the formation of a synergistic research team. PolyPlus will develop processes for depositing the layer of glass and specify the battery chemistry. The other partners are Sheldahl, Inc., (Northfield, Minn.), which will develop the lithium metal electrode, and Eveready Battery Co., Inc., (Westlake, Ohio), which will develop the gel electrolyte and cathode and construct the laboratory batteries to be tested. If successfully developed and later commercialized, the new technology will be marketed initially for laptop computers and cell phones, a $2 billion market in the U.S. today that is expected to grow to $10 billion by 2010. Ultimately, the new technology could capture a substantial portion of the global market for power sources for everything from pagers to power tools.

연구과제명 : (99-01-6021) A Strategy For Reclaiming U.S. Leadership in High Value Polymers (Polyolefins)
회사명 : Catalytica Advanced Technologies, Inc.
연구분야 : Advanced Materials/Chemicals
연구기간 : 3년 (1999년 10월)
전체연구비(추정) : $10,920 K
ATP 지원금 : $4,870 K
연구요약 :
Polyolefins are valuable materials because they resist chemical attack, but this same attribute makes them difficult to dye, paint, or combine with other polymers. A small change in molecular structure could overcome these and other limitations, provided that catalysts could be found to effect that change. In a three-year ATP project, a joint venture led by Catalytica Advanced Technologies, Inc., will attempt to develop rapid synthesis and screening technologies that can identify catalyst structures for making new polymers for high-performance applications. The other partners are CombiChem, Inc., (San Diego, Calif.) and Exxon Chemical Company (Houston, Texas). The research team expects to discover catalysts more efficiently than with a typical combinatorial approach by using a computational system to guide catalyst synthesis, thereby expanding the range of available structures. CombiChem's existing software tools for organic molecules will be extended to process and analyze molecules containing transition metals. In addition, techniques and instruments must be developed for synthesizing and characterizing polymers. The primary target is an oil-resistant polymer suitable for use in belts and hoses for automotive engines. As a potential spin-off, it may also be possible to produce a new polymer useful in health care applications. Successful development and commercialization of the program could boost the United States into a leadership position in a $1 billion global market for new

polymers with superior high-temperature tolerance, oil resistance, and colorability. The economic impact could be substantial; as an example, the materials may double the service life of auto belts and hoses, which, if used in all cars worldwide, could reduce maintenance costs by up to $3 billion annually. ATP support for this project has been sought as a result of the very high level of technical challenges and the fact that the commercial focus is outside of Exxon's current areas of product emphasis.

연구과제명 : (99-01-6027) Combinatorial Tools and Advanced Data Analysis Methods for Heterogeneous Catalysis : An NDI and UOP Joint Venture
회사명 : Nonlinear Dynamics Incorporated
연구분야 : Advanced Materials/Chemicals
연구기간 : 5년 (1999년 10월)
전체연구비(추정) : $29,817 K
ATP 지원금 : $14,610 K
연구요약 :
To maintain its competitive advantage, the U.S. chemical industry needs new methods for developing catalysts that enhance innovation and reduce cycle times. Breakthroughs are needed for platinum-based catalysts, which are costly and have undesirable side effects. In a five-year project, Nonlinear Dynamics, Inc., and UOP LLC (Des Plaines, Ill.) propose to develop novel combinatorial methods to discover materials for replacing or enhancing platinum in heterogenous catalysts, reducing the time and cost associated with discovering new catalysts. Heterogeneous catalysts are complex, often containing multiple active components on a variety of unique support structures. The properties and performance of these catalysts are affected by each of the component materials, their arrangement, and processing conditions, thus making it very difficult to optimize the design. The project will require developing tools and methods for catalyst synthesis and evaluation as well as for informatics, including data management, analysis, mining, and predictive performance modeling. Two levels of automated parallel synthesis and evaluation are planned : a discovery subsystem to identify the most promising "hits" for further study, and a focus subsystem to investigate catalytic properties in detail. The research will require new approaches to parallel synthesis, miniaturized assays that rapidly predict bulk catalytic properties, and new data and analysis techniques. As a demonstration, a catalyst and process will be developed for propane dehydrogenation which converts paraffins to olefins (principally for polypropylene, a huge market.) The generality of the approach will be demonstrated by its application to catalytic reforming, which makes low-pollution, high-octane gasoline. If successful, the new technologies could increase the efficiency of catalyst research and development, saving billions of dollars in materials production annually, reducing waste in industrial processes, and creating new industrial sectors. The ATP co-funding enabled the two companies to cooperate and will accelerate technology development by at least five years. Subcontractors include researchers at Pennsylvania State University (University Park, Pa.) and the Illinois Institute of

Technology (Chicago, Ill.).

연구과제명 : (99-01-6041) Application Of Molecular Gate Technology To Oxygen Enrichment Of Air Streams And Simplified Purification Of Natural Gas
회사명 : Engelhard Corporation
연구분야 : Advanced Materials/Chemicals
연구기간 : 3년
전체연구비(추정) : $4,499 K
ATP 지원금 : $1,799 K
연구요약 :

An estimated 10-15 percent of U.S. natural gas reserves are sub-quality because of contamination, and existing purification methods are complicated and costly. Similarly, oxygen is among the most important bulk chemicals produced in the United States, but high production costs preclude potentially important new applications. Engelhard Corp. will attempt to develop and demonstrate advanced separation technologies that can be "tuned" to the exact molecular size needed for the one-step purification of natural gas or the generation of oxygen-enriched airstreams. The research will exploit a new concept called Molecular GateTM technology, a sieve-like titanium silicate lattice that contracts to yield controllable, uniform pore sizes. The project will try to demonstrate, for the first time, the simultaneous removal of nitrogen, water, carbon dioxide, and hydrogen sulfide from natural gas. Both pressure-driven adsorption and membrane approaches will be pursued. The challenge is to achieve precise, reproducible, and robust control over a wide range of pore sizes associated with the separation of many commercially important molecules. The new adsorbents will enable flexible, simplified, environmentally friendly separations. If successful, the new technology could yield an additional $1.4 billion of marketable natural gas per year, with potential applications in other fields, such as removal of sulfur dioxide from stack gases and alcohol dehydration. Oxygen-enriched airstreams from this new method could improve the economics of transportable oxygen for medical needs and provide for cleaner-burning diesel engines. This technology is at too early a stage for Engelhard to find suitable industrial partners, and ATP co-funding will enable Engelhard to build partnerships with academic institutions without whose scientific and engineering expertise this project could not proceed. Certain analysis, modeling, and fabrication tasks will be performed by subcontractors Cleveland State University (Cleveland, Ohio), University of South Alabama (Mobile, Ala.), and University of Massachusetts (Amherst, Mass.).

연구과제명 : (99-01-6058) Ceramic Matrix Composites For Advanced Engine Components
회사명 : Siemens Westinghouse Power Corporation
연구분야 : Advanced Materials/Chemicals
연구기간 : 3년

전체연구비(추정) : $7,235 K
ATP 지원금 : $3,545 K
연구요약 :
The use of ceramic matrix composites (CMCs) in gas turbines enables superior fuel efficiency and reduced emissions and maintenance costs, but the necessary performance of these materials in extreme engine environments has never been achieved. In a three-year project, a joint venture led by Siemens Westinghouse Power Corp. proposes to develop and demonstrate a CMC system for advanced gas turbines for power generation. The team will rely on an innovative concept for a "hybrid composite" that protects components against the effects of extreme temperatures and environmental conditions. The hybrid-composite approach uses oxide-oxide materials that enable the formation of complex parts and offer processing cost benefits but to date have not withstood the high temperatures that prevail in gas turbines. Other partners in the joint venture are Solar Turbines, Inc., (San Diego, Calif.) and Engineered Ceramics, Inc. (San Diego, Calif.). If successfully developed and later commercialized, the new technology could drive a fifty-fold increase in the market for high-temperature ceramic composite materials, to nearly $1 billion annually. In addition to reducing engine fuel costs and increasing the power output of small and mid-sized industrial turbines, the use of CMCs would reduce emissions and associated clean-up costs. The technology might also enable gasoline engines to operate without a cooling system. The use of CMC components in turbines is still considered too unknown and risky an option for manufacturers to devote sufficient resouces to R&D. ATP support will allow the partners to develop a prototype system that will demonstrate the viability of the technology and catalyze industry investment, accelerating product introduction by three to five years. Siemens Westinghouse is a wholly owned subsidiary of a German company but will perform the ATP-funded research and any related manufacturing in the United States. Project subcontractors will include Iowa State University (Ames, Iowa), Thermal Wave Imaging, Inc., (Lathrup Village, Mich.), MSNW, Inc., (San Marcos, Calif.), Gateway Materials Technology, Inc., (Mt. Prospect, Ill.), Arnold Engineering Development Center (Arnold Air Force Base, Tenn.), and Stolper Fabralloy (Brookfield, Wis.).

연구과제명 : (99-01-6069) Combinatorial Methodology For Coatings Development
회사명 : General Electric Corporate Research and Development
연구분야 : Advanced Materials/Chemicals
연구기간 : 3년
전체연구비(추정) : $6,328 K
ATP 지원금 : $3,128 K
연구요약 :
Coatings can greatly enhance material performance in a wide range of applications, including plastic auto body panels and flat panel displays -- markets in which foreign companies are taking over the lead. Accelerated development of new coatings could enable U.S. companies to

introduce new products faster and recapture these markets. In a three-year ATP project, GE Corporate Research and Development and Avery Dennison Corp. (Pasadena, Calif.) will attempt to develop combinatorial methods that will achieve several orders of magnitude increase in the rate of screening new coatings for the auto and information display industries. Combinatorial methods -- the automated parallel synthesis and evaluation of many variations of a useful chemical structure -- will be difficult to extend to coatings because of the complex interrelationships among composition and processing variables. The joint development partners will develop hardware, software, and information management systems designed to support ultrafast, precise, and highly sensitive screening of libraries of high-density coatings that incorporate systematic variation in composition and processing. Then, large and diverse collections of materials will be formulated and screened for key properties (e.g., chemical and temperature resistance) and the most promising coatings will be demonstrated on flexible flat-panel displays and weather-resistant clearcoats for auto body panels. The ATP co-funding enables the two companies to collaborate and will accelerate the time to market and commercialization at least three years. If successfully developed and later commercialized, the new technology will reduce product development time by as much as 50 percent, at the same time improving product quality. The economic impact on the two target industries alone could approach $2 billion annually. Even if partially successful, the project will generate coatings development tools that could be applied to products ranging from aircraft engines to food packaging. The project will also enable small and mid-sized companies to use combinatorial methods.

[부록 3] RIKEN 연구과제 개요

1. Institute Laboratories[( )안은 책임자]

RIKEN의 각 연구소별 연구주제는 다음과 같다.

(1) Antibiotics Laboratory (Dr. H. Osada)

- 연구영역 : In order to reveal molecular mechanisms of proliferation, differentiation and apoptosis of eukaryotic cells, our approach has been reached in the field of organic chemistry, biochemiistry, and molecular biology. The Antibiotics Laboratory is now focusing on the isolation of new compounds from microbial metabolites which regulate the mammalian cell cycle, apoptosis, protein phosphorylation and dephosphorylation. The inhibitors are named bioprobes because they are useful to investigate the complex biochemical processes of the mammalian cell functions. Mechanism study of bioprobes is a basic research for the development of new chemotherapeutic agents.
- 연구주제 : ① Screening of novel bioprobes, ② Chemistry and biology of bioprobes, ③ Identification of molecular targets of bioprobes

(2) Animal and Cellular Systems Laboratory (Dr. A. Takatsuki)

- 연구영역 : Major concerns are focused on glycobiology. Currently in progress are elucidation of the mechanism of intracellular trafficking of glycoproteins and the role of their saccharide moiety in expression of their biological functions after arrival to their respective destinated sites.
- 연구주제 : ① Intracellular Translocation of Glycoproteins, ② Function of Glycoproteins, ③ Intestine Microbes

(3) Applied Laser Chemistry Laboratory (Dr. K. Takeuchi)

- 연구영역 : Applied Laser Chemistry studies for laser-assisted isotope separation and material design are the multidisciplinary objectives of this laboratory. Through the efforts in modeling the new separation/reaction phenomena, the design procedures for new processes, reactors and functional materials are being established.
- 연구주제 : ① Applied cluster science, ② Laser isotope separation of nranium and silicon, ③ Fullerenes

(4) Atomic Physics Laboratory (Dr. Y. Yamazaki)

- 연구영역 : The Laboratory aims at a comprehensive understanding of (i) dynamic interactions of exotic charged particles such as multiply charged ions, radioactive ions, antiprotons, etc. of meV to GeV range with various targets and (ii) atomic properties of collision products keeping widespread view over neighboring fields like surface physics, radiation physics, nuclear physics, and physical chemistry. To pursue these subjects, the Ring Cyclotron, Heavy Ion Linac, ECRIS at RIKEN, and other facilities in and outside of Japan are employed. The Laboratory leads in developing 1) ultra slow exotic beams of multiply charged ions, radioactive ions, antiprotons, etc., and 2) a high resolution recoil momentum spectrometer with ultra cold gaseous targets, microcapillary targets, multiply charged ion-photon merging system, etc. Theoretical work focuses on dynamic interactions of atoms and molecules with photons, electrons, muons, mesons, antiprotons and ions.

- 연구주제 : ① Interaction of multiply charged ions with atoms, molecules, clusters, surfaces, and crystals, ② Production and spectroscopy of antiprotonic atoms and antihydrogen, ③ Production and control of hollow atoms (stabilized highly and multiply excited states), ④ Multi-fragmentation of clusters, potential sputtering from surfaces, and radiation damage on solids induced by multiply charged ios, ⑤ Spectroscopic studies of multiply charged ions, ⑥ Developments of ultra slow multiply charged ions and antiprotons, ⑦ Theoretical studies of atomic and molecular processes and their applications.

(5) Biochemical Systems Laboratory (Dr. I. Endo)

- 연구영역 : We are charging in the following three major subjects in this laboratory. They are bioprocess engineering, genome analysis and robotics. Basic concepts of these subjects are to study and apply the function of living organisms. Studying these subjects, we are aiming to develop interdisciplinary new technologies in the field of chemical engineering.
- 연구주제 : ① Bioprocess Engineering, ② Genome Analysis, ③ Robotics

(6) Bioorganic Chemistry Laboratory (Dr. M. Tsujimoto)

- 연구영역 : The main subject of the Bioorganic Chemistry Laboratory is identification and functional characterization of clinically important proteins such as cytokines and enzymes. For example, we recently cloned the cDNA encoding cytosolic PAF-acetylhydrolases I and II. Strikingly, we found that the type I enzyme consisted of three subunits and the a-subunit was a product of LIS-I gene, a causative gene of Miller-Dieker lissencephaly (MDL). Another enzyme cloned is Placental leucine aminopeptidase (P-LAP)/oxytocinase, which increase in serum during pregnancy and considered to prevent a premature onset of uterine constractions by degrading oxytocine. Interestingly P-LAP was found to be identical with recently cloned insulin-regulated aminopeptidase from Glut4 vesicle. We are now investigating the biological roles of these enzymes. We are also interested in the action mechanisms of cytokines with mulitiple functions. The cytotoxic mechanism of tumor necrosis factor is now under investigation.

- 연구주제 : ① Action mechanism of cytokines with multiple functions, ② Structure and function of novel scavenger receptor, ③ Structure and function of novel proteases; placental leucine aminopeptidase/oxytocinase etc.

(7) Biophysical Chemistry Laboratory (Dr. Y. Inoue)

- 연구영역 : Metal proteins and metal enzymes have important roles in a variety of biological systems. They are involved in biological energy conversions and synthesis and degradation of essential compounds through electron transfer, binding and activation of molecular oxygen. They are also involved in formation and breakdown of nitric oxide, which is an important messenger molecule in signal transduction in cells. We are investigating function of metal proteins and enzymes, especially hemoproteins, in vivo and in vitro, and aim at understanding biological phenomena based on their molecular structure. We are also working on basic research for developing micro- sensing techniques and biological devices.
- 연구주제 : ① Structure and Function of Hemoproteins, ② Biochemical and Biophysical Analyses of the Recombinant Heme Proteins Expressed in E.coli and Yeast, ③ Mechanism of Generation and Regulation of Active Oxygen in Biological Systems

(8) Biophysics Laboratory (Dr. T. Ueki)

- 연구영역 : Biophysics Laboratory has a major and essential research subject "structural biology" in which X-ray diffraction and scattering methods are applied on biological macromolecules to understand the their function based on the atomic and molecular structures. In FY1997, the main target is to complete the RIKEN beamline 1 for structural biology study on the storage ring at the SPring-8 Facility, located at Harima Science Garden City, Hyogo. This beamline is to perform structural studies by crystallographic and small-angle scattering techniques on biological macromolecules from the brilliant and intense undulator X-rays. The laboratory has also been carrying out preparation, and crystallization and diffraction/scattering studies as a core laboratory in synchrotron radiation structural biology research group in RIKEN. The laboratory, in addition, performs physical research on lipids/ liquid crystals as model system of biological membranes. The laboratory will move to the Harima Science Garden City, Hyogo this Fall, upon completion of SPring-8 Facility, RIKEN structural biology building and RIKEN beamline 1.

- 연구주제 : ① Relationship between structures and their functions of biological macromolecules, ② Structural studies by the use of RIKEN structural biology beamline at the SPring-8, ③ Structures and properties of lipid and liquid crystals

(9) Biopolymer Physics Laboratory (Dr. Y. Doi)

- 연구영역 : Electrical and optical properties of functional polymers such as photoconductive, nonlinear optical and ferroelectric polymers are studied from the viewpoint of molecular bindings and higher order structures. In addition to the fundamental understanding of these materials, applications to information processing/storage and energy conversion, are an important target of the research. For the development of biocompatible materials, the mechanism of blood coagulation is studied from the viewpoint ofinteractions among blood, vascular components and polymers.

- 연구주제 : ① Organic Thin Films, ② Ferroelectric Polymers, ③ Blood Coagulation and Antithrombogenic Polymers, ④ Rheology, ⑤ Image Processing

(10) Cellular and Molecular Biology Laboratory (Dr. T. Shibata)

- 연구영역 : The understanding of mechanisms for the regulation of genetic recombination will provide us a powerful tool for genetic analysis and for safe gene-therapies. For the understanding, we are trying to identify proteins involved in this process and studying their functions at the molecular level. Owing structural and functional conservation in proteins involved in genetic recombination and the related DNA metabolism, we selected yeasts and Drosophila as major model systems. In addition, we are looking for novel roles of genetic recombination in vivo. We just made a small break-through in a study on mitochondrial genetic recombination which has been supposed to play roles in aging and health of animals; i.e., first identification of a gene (MHR1 of yeast, Saccharomyces cerevisiae) for mitochondrial genetic recombination and finding an essential role of the gene in the maintenance of the respiration function.
- 연구주제 : ① Molecular mechanisms and genetic regulation of homologous genetic recombination, ② Roles of genetic recombination in mitochondrial genome stability and development in eukaryotes

(11) Cellular Physiology Laboratory (Dr. F. Hanaoka)

- 연구영역 : The replication and the maintenance of genetic information are essential processes on which the continuity of all species depends. Our laboratory undertakes studies of the mammalian chromosome replication and repair. We have developed soluble systems that support DNA replication and repair of SV40 mini-chromosomes. Using these cell-free systems as models, we are investigating the cis-acting elements and the trans-acting factors which modify the efficiency of chromosome replication and factors which are essential for the repair mechanisms of DNA lesions. Somatic cell genetics is a powerful tool for elucidating the molecular mechanisms of regulation of the cell cycle. In these studies, a number of temperature-sensitive cell cycle mutants of mouse FM3A cells have been analyzed. Attempts are being made to isolate cDNAs which complement the temperature-sensitive defects of these mutants.
- 연구주제 : ① Mechanisms of Chromosome Replication, ② Cell Cycle Regulation, ③ Studies on DNA Lesions, Repair and Mutagenesis

(12) Cellular Signaling Laboratory (Dr. S. Yokoyama)

- 연구영역 : i) Development of new methodologies of structural biology such as amino acid-selective and site-specific incorporation of unnatural amino acids or stable-isotope labeled amino acids into proteins, and multidimensional NMR spectroscopy of large proteins and nucleic acids. ii) Mechanisms of cellular signal transduction in mammalian cells, particularly from viewpoints of tertiary structures of proteins involved in signaling pathways from cell membrane to nucleus.
- 연구주제 : ① Stable Isotope-labeling Multidimensional NMR Spectroscopic Studies on Proteins, ② Cell-free Protein Production, ③ Mechanisms of Signal Transduction Involving the Ras Protein

(13) Chemical Dynamics Laboratory (Dr. Y. Inoue)

- 연구영역 : We are working on the dynamic processes of chemical reactions with the use of physico-chemical methods. The dynamic processes of our concern are photoreactions, ionizing radiation-induced reactions, thermal reactions, and electrochemical reactions. Since radicals and excited states are involved as key intermediates in these processes, studies of the reactive intermediates are the important subject in physical chemistry for the full elucidation of chemical reactions. The detection and identification of these intermediates are made using a variety of spectroscopic methods. we are now focusing our research on photochemistry and radiation chemistry. The photo-induced electron transfer and photochemistry of metal complexes are the major subjects in our photochemical studies to establish the model system for photosynthesis, aiming at the storage and conversion of solar energy into chemical energy. Fundamental research on radical reactions for application in organic synthesis is also underway. In radiation chemistry, we are investigating emission from gases or solids observed after excitation by accelerated heavy ion beams for understanding of unique processes occurring by high energy excitation of matters.
- 연구주제 : ① Studies on Chemical Dynamics of Photoreactions, ② Primary-Stage Interaction of Ionizing Radiation with Matter

(14) Computational Science Laboratory (Dr. T. Ebisuzaki)

- 연구영역 : The objective is the high performance computing of large-scale simulations with supercomputers, massively-parallel computers. and special purpose computers.
- 연구주제 : ① Large Scale Numerical Simulations with the Vector-Parallel Super-Computer, VPP-500., ② Development of Special-Purpose Computers, ③ Development of Highly Parallel Alogrithms.

(15) Cosmic Radiation Laboratory (Dr. Y. Yano)

- 연구영역 : Main research area is the high energy astrophysics in which peculiar astrophysical objects and phenomena are investigated through observations of X-rays, g-rays and high energy particles. For this purpose, artificial satellites are mainly used to carry the required radiation detectors. In this respect, the laboratory cooperates with institutes related to space development and science.
- 연구주제 : ① High Energy Transient Experiment, ② Observational research of X-ray sources, ③ Particle Astrophysics, ④ Monitoring Observation of Cosmic Rays, ⑤ Development of Radiation Detectors

(16) Cyclotron Laboratory (Dr. Y. Yano)

- 연구영역 : The research subject widely covers the experimental and theoretical study of heavy-ion nuclear physics. Special emphasis is put on R & D work for upgrading the accelerator performance. A conceptual study for projecting a future accelerator facility is also one of the main themes.
- 연구주제 : ① Accelerator Physics, ② Experimental and Theoretical Study of Nuclear Physics, ③ Applications

(17) Genome Science Laboratory (Dr. Y. Hayashizaki)

- 연구영역 : Since 1992, we have been working in the field of the development of new technologies based on the concept of "Genome Scanning" and the application to various medical and biological fields. Especially, restriction landmark genomic scanning (RLGS) was originally developed by this group, which employs direct labeling of genomic DNA and high-resolutional two dimensional electrophoresis. Our working field also includes the application of RLGS to searching and discovering new genes systematically. The purpose of the research at our laboratory is not limitted to genome scanning technolgies and we also aimed at the development of any sort of new technologies for high-speed genome analysis and its application.
- 연구주제 : ① Development of High Speed Technology for Genome Analysis, ② Search for Functional Gene Using RLGS-based Technique

(18) Information Science Laboratory (Dr. Y. Yano)

- 연구영역 : This laboratory aims at understanding the neural mechanisms of higher brain functions, such as recognition, memory, and motor planning, based on system level studies. Currently, we are concentrated on studies with the non-invasive measurement of human brain activities with MRI system, and the single-cell recordings from the temporal and frontal association cortices of behaving animals.

- 연구주제 : ① Research of Information Processing in the Brain

(19) Inorganic Chemical Laboratory (Dr. R. Kato)

- 연구영역 : In our laboratory, physical and chemical properties of atoms and molecules both in the gas phase and condensed phase are studied by using (i) electromagnetic radiations such as laser, ┘-ray and X-ray (ii) ion and electron beams. We are applying laser spectroscopy to the study of exotic microscopic systems such as atoms and molecules in superfluid helium, high Rydberg atoms and molecules, van der Waals complexes, and ions in an RF-ion trap. X-ray, ┘-ray and radioactive tracer produced in the accelerator are used for the elemental and chemical analysis and the study of new materials and interfaces.
- 연구주제 : ① Laser Spectroscopy of Excited Atoms and Molecules, ② Material Analysis by ┘-ray, X-ray, Charged Particles and Radioactive Tracers

(20) Laser Technology Laboratory (Dr. K. Midorikawa)

- 연구영역 : Development of ultrashort high-intensity laser technology and its application to generation of coherent soft x-ray are main subjects. Nobel nonlinear phenomena based on interaction of ultrashort high intensity laser pulses with matter are also investigated. In addition, applications of ultrahshort laser and short wavelength laser pulses to material processing are studied.
- 연구주제 : ① Ultrashort High-Intensity Laser Techology, ② Coherent Soft-X-ray Genetaion, ③ Laser Material Processing, ④ X-Ray Optics by Atomic Layer Deposition

(21) Linear Accelerator Laboratory (Dr. I. Tanihata)

- 연구영역 : Several fields of interest using accelerated heavy ions and radioactive nuclear beams are studied in the laboratory. They are; i) Studies of structure of nuclei and its application to astrophysics; ii)Studies on atomic clusters; and; iii) Development of linear accelerator technology.
- 연구주제 : ① Structure of Nuclei Far from the Stability, ② Nuclear Astrophysics, ③ Cluster Formation after the Heavy-Ion Collisions, ④ Construction of ECR Heavy-Ion Source and development of frequency variable RFQ linac.

(22) Magnetic Materials Laboratory (Dr. K. Katsumata)

- 연구영역 : Condensed matter Physics. Experimental studies of magnetic properties of matter are conducted using various kinds of unique techniques such as electron spin resonance at high frequencies, high magnetic fields and nuclear probes. Neutron scattering, synchrotron X-Ray and muon spin relaxation experiments are also performed in collaboration with laboratories in Japan and other countries.

- 연구주제 : ① Experimental Studies of Magnetic Phase Transitions, ② Studies of Magnetic Materials by Means of X-ray and g-ray Spectroscopes, ③ Magnetic Materials Research

(23) Materials Fabrication Laboratory (Dr. A. Makinouchi)

- 연구영역 : Development of new processing technologies, such as forming, cutting, grinding and polishing, for variety of materials is main objective of our research activity. In order to develop innovative processing methods and related simulation software systems, the mechanics and physics of material deformation and fracture are studied.

- 연구주제 : ① Development of New Process Technologies, ② Mechanical and numerical modeling of elasto-plastic solids, ③ Development of computer-aided-design (CAE) software systems

(24) Microbial Toxicology Laboratory (Dr. I. Yamaguchi)

- 연구영역 : The principal objective of the Laboratory is to find the better means of controlling plant diseases for the final goal to meet the human welfare. Studies are focused on the biochemistry of pathogenic microbes and host plants, the pharmacological mechanisms of new controlling agents, and the fundamentals of metabolic fate of chemicals in the environment
- 연구주제 : ① Studies on Regulation of Genes in Plant-Pathogen Interaction, ② Studies on Action Mechanisms of Fungicides and Metabolic Fate of Xenobiotics, ③ Studies on Phytopathological Bioassay Systems for Prospective Fungicides and on Bioremediation.

(25) Microbiology Laboratory (Dr. T. Kudo)

- 연구영역 : Research is concentrated on "microbial diversity and evolution". The intellectual focus of our laboratory is microbiology, with specific emphasis on 1) understanding adaptation to the extreme environments, 2) molecular evolution of aromatic compound-degrading bacteria, and 3) diversity and interaction of microorganisms in natural and managed habitats.
- 연구주제 : ① Microbial and Molecular Studies on Microbes under Extreme Conditions, ② Diversity and Evolution of Xenobiotics Degrading Bacteria, ③ Termites Ecosystem and Molecular Symbiosis

(26) Microwave Physics Laboratory (Dr. K. Katsumata)

- 연구영역 : Our major concerns are basic and applied researches of various fundamental processes induced by the interaction between coherent electromagnetic radiation (from infrared to x-rays) and matter. In the low energy region from infrared to ultraviolet, various lasers are available as coherent light sources. We are developing several novel measurement, characterization and control techniques for realizing higher energy resolution, sensitivity, and efficiency. These are utilized for the reaseach of the quantum-state-selective atomic/molecular processes and their applications such as : Theoretical and experimental research of nonlinear phenomena induced by lasers; Development of novel laser-spectroscopic techniques for investigations of atomic/molecular relaxation processes; Surface state characterization and its dynamics using nonlinear optics; High resolution photoemission spectroscopy of surface states and excited states of adsorbed molecules. Although the coherent light source in the x-ray region is now under development as the 3rd/4th generation synchrotron light sources, we are developing crystal diffraction optics and optical elements for the utilization of coherent x-rays. Theoretical study of the fundamental interaction process between coherent x-rays and ordered/disordered materials; Instrumentation for the use of the coherent x-rays from high energy storage rings; Development of novel x-ray interferometers.

- 연구주제 : ① Coherent Nonlinear Optics and Its Applications, ② High Resolution, High Sensitivity Laser, ③ Coherent X-Ray Optics

(27) Molecular Cell Science Laboratory (Dr. H. Amanuma)

- 연구영역 : The laboratory undertakes studies on the regulation of cell growth, differentiation, cell division, and specific functions by retroviruses, cytokines an d retinoids. It also conducts studies on the development of retrovirus vectors.
- 연구주제 : ① Friend virus, ② Studies on cytokine receptor-mediated signal transduction, ③ Regulatory mechanism of cell divison and cell cycle, ④ Molecular and cellular mechanism of blood cell maturation and differenti ation, ⑤ Gene regulation in neural cells, ⑥ Leukemia induction by bovine leukemia virus and human T-cell leukemia virus-1, ⑦ Pathogenesis by HIV-1, ⑧ Development of retrovirus vectors, ⑨ Studies on the regulation of cellular functions by retinoids (vitamin A)

(28) Molecular Entomology and Baculovirology Laboratory (Dr. I. Yamaguchi)

- 연구영역 : The laboratory focuses on molecular biological studies of insects and insect viruses. Insects, which comprize 70% of all animal species, are usef ul systems to study molecular biology at the cellular and organismal levels. Insect viruses, especially baculoviruses, are insect specific and are important in molecular biology, for example as expression vectors. We have been developing and improving baculovirus expression vector systems and we currently focus on molecular interactions between baculoviruses and hosts.
- 연구주제 : ① Molecular mechanisms of baculovirus replication in insect cells, ② Developmental and behavioral studies of insects at the molecular level, ③ Isolation and

characterization of insect hormones and their receptors, ④ Signal transduction of neuropeptide hormones, ⑤ Molecular interactions between insect viruses and their hosts, ⑥ Development of baculovirus expression vectors using insect cells

(29) Molecular Genetics Laboratory (Dr. S. Ishii)

- 연구영역 : The transcriptional control is a key step for development, stress response, and various deseases of human being. The transduction of signal initiated by the binding of the growth factor to its receptor resutls in the generateion of second messenger changes which must, of course, be interpreted inside the cell to produce an effect. Transcriptiona factors are the final players which located in this signal transduction pathway. This is the area which is the focus of work in the Laboratory of Molecular Genetics. Ever since its establishment in 1989, this labratory has directed its research activities towards (i) the understanding of the molecular mechanisms by which nuclear oncogene products or tumor suppressor proteins regulate cellular proliferation, and (ii) the identification and characterization of the novel transcription factors which are involved in cellular growth control. Much of the work is, of course, centered on the elucidation of molecular mechanisms for the fundamental biological control processes that are involved in normal development and growth which are relevant to cancer studies. Through the use of molecular biology and biochemistry techniques, we are investigating the details of several control processes at the subcellular level, through approaches using cell culture and, in some cases, employing whole animal systems.
- 연구주제 : ① Nuclear Oncogene Products and Supressor Oncogene Product as a Transcriptinal Regulator, ② Induction of Gene Expression by Extracellularstimuli, ③ Genetic Analysis of Transcriptional Regulators by using Drosophila

(30) Molecular Membrane Biology Laboratory (Dr. A. Nakano)

- 연구영역 : In eukaryotic cells, vesicular transport is essential for dynamic membrane traffic between organelles. Our laboratory focuses on the roles of vesicular trafficking in the secretory pathway and aims at elucidating the molecular mechanisms of vesicle budding and fusion and unveiling the secrets of molecular recognition and sorting during these processes. We are also concerned with the fact that the secretory processes are important for determination of cell polarity, directions of cell division and elongation, and will pursue how they contribute to the morphogenesis of tissues and organs. As experimental systems, we use the budding yeast Saccharomyces cerevisiae for detailed molecular and genetic analyses, and higher plants tobacco and Arabidopsis for expansion to multicellular systems. Every kind of methodology, including genetics (classic genetics, molecular genetics, reverse genetics, conditional-dominant somatic cell genetics, etc.), molecular biology (cloning), biochemistry (purification and characterization of gene products and reconstitution of transport reactions) and morphology (light and electron microscopy), is being employed.

- 연구주제 : ① Functions of Small GTPases in the Secretory Pathway -- Sar/Arf and Rab/Ypt Families, ② Molecular Mechanisms of the Formation of Transport Vesicles from the Endoplasmic Reticulum (ER), ③ Protein Sorting within the ER, ④ Vesicle Recycling between the ER and the Golgi Apparatus and the Molecular Sorting during Recycling, ⑤ Molecular Mechanisms of Retrograde Transport from the Golgi Apparatus to the ER, ⑥ Isolation of Plant Secretory Genes and Their Functional Analysis Using Yeast, ⑦ Genetic Analysis of Secretory Processes in Higher Plants

(31) Molecular Oncology Laboratory (Dr. T. Sato)

- 연구영역 : This laboratory aims at the elucidation of molecular mechanism of cancerization of cells by oncogenes, tumor suppressor genes and retroviral genes and of embryonal development and cell differentiation. Allelic deletion of genes has been induced in mice using homologous recombination in embryonal stem cells to investigate recessively functioning genes in vivo.
- 연구주제 : ① Physiological Function of Oncogenes, ② Physiological Function of Tumor Suppressor Gene, ③ Investigation of Other Genes in Signal Transduction, ④ Leukemogenesis by Retroviruses, ⑤ Differentiation of Embryonal Stem (ES) Cells, ⑥ Development of Embryonal Technologies.

(32) Molecular Photochemistry Laboratory (Dr. H. Hayashi)

- 연구영역 : This laboratory's studies concentrate on the elucidation of the electronic structures of molecules and molecular systems and that of the dynamic behavior of excited molecules and reaction intermediates. There is an emphasis on understanding how magnetic fields affect the dynamic behavior of those species, such as chemical reactions and energy transfers.
- 연구주제 : ① Magnetic Field Effects on Chemical Reactions in Condensed Phases, ② Primary Processes of Photochemical Reactions in Condensed Phases, ③ Dynamic Behavior of Unstable Species in Gas Phases and Their Magnetic Field Effects

(33) Muon Science Laboratory (Dr. K. Nagamine)

- 연구영역 : Muon Science Laboratory applies beams of accelerator producing muons and ions including unstable nuclei to a variety of studies on (1) electronic and crystalline structures of metals and other condensed matters, (2) microscopic magnetic structure and its dynamics in synthesized metals and oxide superconductors, (3) location of impurities in metals, (4) diffusion properties of light interstitials in metals and (5) secondary electron and photon emission phenomena from metals by radiation impact. Also, various types of muon science research including muon catalyzed fusion are studied.
- 연구주제 : ① Construction of a new muon facility at ISIS/RAL and development of new muon science program., ② Studies on fundamental understandings and application capability

of muon catalyzed fusion., ③ Condensed matter studies with muon spin rotation, relaxation and resonance methods., ④ Studies on secondary electron emission from metal surfaces by fast heavy ion bombardment., ⑤ Studies on impurity states in metal by a channeling method with light and fast heavy ion beams., ⑥ Production and application to condensed matter studies of slow radioactive nuclei and unstable particles such as muons by using high-energy heavy-ion beam at the RIKEN Ring Cyclotron.

(34) Nuclear Chemistry Laboratory (Dr. K. Asahi)

- 연구영역 : Unique properties of raidioactive isotopes are utilized in obtaining useful information on chemistry of inorganic substances and materials, geological and environmental systems, and bio-trace elements. Production of multitracers and group tracers by RIKEN Ring Cycloron (RRC) is developed and the tracers are applied to studies of basic chemistry, environmental chemistry, and bioinorganic chemistry. Main topics are the effect of acid rain on adsorption equilibrium of trace elements in soil, the effect of alcohol on the metabolism of trace elements in animals and so on. Three types of in-beam Moessbauer spectroscopy are being established. Excited 57Fe nuclei produced by (d,p) reaction and Coulomb excitation are used in the study of dynamics of iron atoms in solids. The radioactive beam of 57Mn from RIPS of RRC is also utilized for in-beam Moessbauer spectroscopy. Chronological studies using 87Rb-87Sr and 147Sm-143Nd as well as chemical analyses are performed in order to investigate the genesis and history of ureilites, unique differentiated meteorites including diamond and giving information concerning the chemical evolution processes in the early history of solar system. Chemical and isotopic studies are performed on the water samples collected in Taklamakan Desert, N.W. China.
- 연구주제 : ① evelopment and Application of the Multitracer Technique, ② Application of Hyperfine-Interaction Techniques to Chemistry, ③ Studies on Planetary Materials and Their Evolution Processes

(35) Optical Engineering Laboratory (Dr. I. Yamaguchi)

- 연구영역 : Main orientation of the research is the application of physical properties of light waves to measurement, information processing, and control. Uses of laser diode, nonlinear optical materials, optical fibers, and electronic detection and digital processing of images are investigated for improvement, acceleration, and versatility of interferometry, holography, speckle metrology, microscopy, real time image processing, and laser trapping.
- 연구주제 : ① Interferometry, ② Speckle Metrology, ③ Real Time Image Processing and Holography, ④ New Microscopy, ⑤ Optical Trapping, ⑥ Optical Fiber Sensors

(36) Organometallic Chemistry Laboratory (Dr. Y. Wakatsuki)

- 연구영역 : Organometallic chemistry is based on direct interaction between a metal atom and carbon atoms of organic molecules. Organometallic compounds are expected to possess a variety of rich chemical and physical properties since characters of metal atoms are widely different as they scatter in periodic table while organic molecules to be bound to metals are also variable in kinds and binding modes. We have been investigating organometallic complexes in many aspects : synthesis, structure-reactivity relationship, electronic analysis by theoretical calculations, etc. Based on the information thus obtained, we design electronically and/or sterically controlled metal-sites to realize highly efficient (catalytic) reactions or to utilize specific properties. Mainly, we are interested in many (from early to late) transition metals including lanthanide metals. We have been also investigating homo- and hetero-metal cluster compounds aiming to construct a novel reaction site which is effected by neighboring metal atoms.

- 연구주제 : ① Ruthenium catalyzed transformations of alkynes and alkenes and their mechanisms., ② Polymerization of olefins catalyzed by lanthanide and group 4 metal complexes., ③ Cluster chemistry relevant to fixation of air polluting gas molecules.

(37) Plasma Physics Laboratory (Dr. T. Katayama)

- 연구영역 : This laboratory studies accelerator physics and plasma physics including fundamental research, diagnostics and applications.
- 연구주제 : ① Accelerator Physics and its Technology, ② Fundamental Studies of Plasma Physics and Plasma Processing, ③ Applications

(38) Plant Molecular Biology Laboratory (Dr. K. Shinozaki)

- 연구영역 : Plants have unique systems for signal transduction and gene expression during development which are different from those of animal systems, such as totipotency, plant-hormone-mediated regulation, responses against various environmental stresses and light regulation of gene expression. The Laboratory of Plant Molecular Biology studies gene structure and regulation of gene expression in higher plants. They are interested in plant nuclear genes involved in stress response and signal transduction. This laboratory uses {갰it Arabidopsis thaliana}, called "plant Drosophila" (a model plant in molecular biology), as a plant material. Ever since its establishment in 1989, this laboratory has directed its research activities towards (i) control of gene expression by plant hormones and environmental stresses, (ii) functional analysis of plant genes involved in signal transduction, (iii) mapping of expressed genes on Arabidopsis genome and positional cloning of mutant genes, and (iv) genetical analysis of signal transduction pathways in osmotic stress response of gene expression in yeast.
- 연구주제 : ① Functional analysis of plant genes induced by drought stress, ② Identification of cis-acting elements involved in drought-stress response in plant gene expression, ③ Plant myb-related gene involved in drought response, ④ Identification of plant protein kinase family by molecular cloning, ⑤ Role of MAP kinase family in signal transduction pathways of plants, ⑥ Analyses of expressed genes on Arabidopsis geneome

(39) Polymer Chemistry Laboratory (Dr. Y. Doi)

- 연구영역 : The study is concentrated on the both microbial and chemical syntheses of biodegradable polymers which are environment friendly new-polymeric materials. The objective of the study is to understand the nature and mechanism of biological polymerization and to design new polymer compounds with biodegradable and biocompatible properties. In addition, the structure and properties of enzymes for biosynthesis and hydrolysis of biopolymers have been studied
- 연구주제 : ① Biosynthesis and Genetic Engineering of Polyesters, ② Structure and Properties of Depolymerases Enzymes, ③ Structure and Properties of Crystalline Polymers, ④ Synthesis and Material Design of Biodegradable Polymers

(40) Regulation of Plant Functions Laboratory (Dr. S. Yoshida)

- 연구영역 : Unique functions of plants are investigated on the basis of molecular physiology. Regulation of chloroplast functions is a clear target to think about molecular interaction between a substrate and a certain functional protein, and it is tightly linked with response of plant to environmental stresses. Chloroplast mutants arising from amino acid changes at the target site of inhibitors, has encouraged us in application of the new approaches to other plant physiology. Plants operate specific systems for embryogenesis which are affected by various exogenous molecules. We found several interesting compounds for probing gene expression in these systems. Understanding processes of plant cell growth and differentiation requires suitable mutants in order to analyze regulating genes for the sites of molecular probes. Thus effective methods for plant-mutation are investigated by the use of RIKEN's own technique
- 연구주제 : ① Regulatory Mechanisms of Plant Functions, ② Survey of New Plant Functions

(41) Radiation Laboratory (Dr. M. Ishihara)

- 연구영역 : The research activities cover two major fields; i.e., nuclear physics and radiation science. The former subject is pursued using high-energy heavy ion beams at RIKEN Ring Cyclotron. Particular emphasis is placed in developing a variety of radioactive beams to study exotic states of nuclei and also to excavate new domains of application to astrophysics and solid state physics. Research on radiation science involves development of detectors, study on biological effects and nuclear data-bank activities.
- 연구주제 : ① Nuclear Physics, ② Radiation Science

(42) Semiconductors Laboratory (Dr. Y. Aoyagi)

- 연구영역 : In this laboratory, new fabrication techniques for quantum structures of dot(s), wire(s), and well(s) are developed and the optical and electrical properties of quantum structures and the application are studied. New beam technologies and the application are also studied

- 연구주제 : ① Development of new fabrication techniques of quantum structures, ② Electrical and Optical Properties of Quantum Well, Wire and Dot and the Device Application, ③ Development of New Beam Technology and the Application

(43) Surface and Interface Laboratory (Dr. M. Aono)

- 연구영역 : Fundamental research aimed at understanding physical and chemical properties of solid surfaces and interfaces and its application to the creation of novel materials. For these purposes, several novel methods have been developed. Atom manipulation is one of the most important research subjects.
- 연구주제 : ① Physical and Chemical Properties of Solid Surfaces and Interfaces, ② Atomic-Level Material Processing, ③ Microscopic Studies of Friction and Lubrication

(44) Surface Chemistry Laboratory (Dr. M. Kawai)

- 연구영역 : The laboratory studies chemical processes on semiconductor surfaces, metal surfaces and oxide surfaces. Recently, special attention has been focussed on fundamental studies of oxide surfaces related to cuprate superconducting materials, fabricated by layer-by-layer film formation.
- 연구주제 : ① Fundamental Studies of Chemical Processes on Solid Surfaces, ② Layer Controlled Synthesis of Thin Oxide Films

(45) Synchrotrons Radiation Center(SPring-8 Project)(Dr. H. Kamitsubo)

- 연구영역 : RIKEN has been constructing a third-generation synchrotron radiation facility, SPring-8 (Super Photon ring-8GeV), at Harima Science Garden City, Hyogo, in collaboration with Japan Atomic Energy Research Institute (JAERI). In FY 1996, the injector system of linac and booster synchrotron has been completed and the storage ring has been in commissioning after security inspection "in-advance" on radiation shield since March 11. In the evening of March 25, we observed electrons stored in the storage ring at the current of 0.05 mA for 10 hours. The first synchrotron radiation was also observed at the view port of the front end channel on beamline BL02B1. RIKEN has been constructing 10 public beamlines in collaboration with JAERI. In parallel to the commissioning of the storage ring, these beamlines, especially two pilot beamlines, will be in commissioning status. The RIKEN structural beamline I has been completed, waiting for the start of commissioning after two pilot beamlines. These beamlines will be in public use this October. The proposal of scientific program has been called, and after the evaluation by Proposal Review Committee of Japan Synchrotron Radiation Research Institute, about 70 % were accepted for utilization of the beamlines in the first six months.
- 연구주제 : ① Design and development of high brilliance X-ray storage ring, ② Development of accelerator physics, ③ Development of scientific program with high brilliance synchrotron radiation

(46) Synthetic Cellular Chemistry Laboratory (Dr. Y. Ito)

- 연구영역 : To understand the cell-cell interaction on molecular level, we are persueing organic sythetic studies on cell-surface glycoconjugates. In particular, targets for our synthetic challenge are taken from cell mebrane associated glycoproteins and their ligands as well as from extracellular matrix glycosaminoglycans and proteoglycans. Synthetic projects are directed towards developement of new synthetic routes, new reactions and new strategies. Collaborative project to elucidate relationship between structure and function of glycoconjugates are also of our keen interest.
- 연구주제 : ① Reconstruction of Functional Domains of Glycoconjugates, ② Development of New Strategies for Glycan Synthesis, ③ Computer Chemistry of Glycoconjugate

(47) Synthetic Organic Chemistry Laboratory (Dr. T. N

- 연구영역 : The laboratory studies new methodologies and efficient strategies for the synthesis of biologically active natural products with complex structures. Based on these newly developed methods, stereoselective total synthesis and the determination of the stereostructure of natural products, and development of new bioactive compounds are being carried out.
- 연구주제 : ① Development of New Synthetic Methods and Strategies, ② Determination of the Stereostructure of Natural Products, ③ Total Synthesis of Complex Natural Products, ④ Design and Synthesis of New Bioactive Compounds Head

2. Basic Science Research and Others

(1) BASIC SCIENCE RESEARCH

- 연구주제 : ① Laser Science, ② Photosynthetic Science. ③ Research on New Reaction Fields for Chemical Reaction, ④ Research on Microclusters, ⑤ Atomic-Scale Sciengineering, ⑥ MR Science Reserch

(2) RESEARCH CONCERNING THE PEACEFUL USE OF ATOMIC ENERGY

- 연구주제 : ① Heavy-Ion Science, ② Studies for the Breakthroughs on Molecular Laser Isotope Separation, ③ Nuclear Base Technology

(3) RESEARCH ON SYNCHROTRON RADITION

- 연구주제 : ① Research and Development on RIKEN Beamline

(4) DEVELOPMENT OF FUNDAMENTAL TECHNOLOGIES

- 연구주제 : ① Development of Rapid Prototyping System

(5) RESEARCH ON LIFE SCINECE

- 연구주제 : ① Biodesign Research Program, ② Functional Analsis of the Nervous Systems, ③ Molecular Ggenetics of Immune Systems, ④ Research on Gene Science and Technology, ⑤ Human Genome Project

3. Frontier Research Program

◦ 연구분야 및 담당 연구실은 다음과 같음.

(1) Supra-Biomolecular System Research

① Integrative Glycobiology
- Glyco-Chain Expression Lab.
- Glyco-Chain Function Lab.

② Sphingolipid Biology
- Sphingolipid Expression Lab.
- Sphingolipid Function Lab.

(2) Spatio-Temporal Function Materials Research

① Pattern-Rhythm Function
- Local Spatio-Temporal Function Lab.,
- Dissipative-Hierarchy Structures Lab.

② Nano-Organized Materials
- Exciton Engineering Lab.
- Topochemical Design Lab.

(3) Photodynamics Research Center, Sendai((Photodynamics Research Program)

- Tera-Photonics Lab.
- Photophysics Lab.
- Organometallic Photodynamics Lab.
- Photo-Biology Lab.
- Surface-Photodynamics Lab.

(4) Bio-Mimetic Control Research Center, Nagoya((Bio-Mimetic Control Research Program)

- Neural Circuits Lab.
- Genes of Motor Systems Lab.
- Bio-Mimetic Sensory Systems Lab.
- Bio-Mimetic Control Systems Lab.

[부록 4] 프라운호퍼 연과과제 개요

1. 연구분야

프라운호퍼의 중점 연구분야는 ① Materials technology, component behaviour, ② Production technology, manufacturing engineering, ③ Information and communications technology, ④ Microelectronics, microsystems technology, ⑤ Sensor systems, testing technology, ⑥ Process technology, ⑦ Energy and building technology, environmental and health research, ⑧ Technical and economic studies, information transfer 등 8개 분야이다.

2. 연구소별 연구주제

각 연구소별로 현재 진행중인 연구주제를 살펴보면 다음과 같다.

(1) Applied Solid State Physics(IAF)

① High Frequency Devices and Circuits : Design, simulation (CAD), and test of integrated circuits based on the III-V compound semiconductors GaAs and InP.

② III/V-Technology : Manufacturing of integrated circuits on the basis of GaAs and InP HFETs. Development of manufactoring processes.

③ Epitaxy : Molecular beam epitaxy (MBE) and metalorganic vapour phase epitaxy (MOVPE) for the deposition of III-V heterostructures.

④ Optoelectronic Devices : Development and manufacturing of novel electronic and optoelectronic III-V devices.

⑤ Infrared Technology : Development of infrared detectors based on semiconductor quantum-well structures. Deposition of large-area diamond layers by plasma CVD.

⑥ Optoelectronic Materials : Study of fundamental properties of III-V heterostructures and heterostructure devices.

⑦ Analysis and Reliability : Material and epilayer analyses; reliability and lifetime testing of devices and circuits.

(2) Applied Optics and Precision Engineering(IOF)

① Optical Coatings : Development of optical technologies (high-precision electron beam techniques, plasma-enhanced technologies, sputtering, coatings on plastics); optical thin film elements (uv-resistant mirrors, ultra-narrow bandfilters, polarizers); characterization of optical surfaces and thin films

② Optical Measurement Technology : Non-contact 3D-shape; measurement. interferometers (phase-shift shearing interferometer, white light); surface measuring systems (stray light measurement, profilometry, atomic force microscopy, confocal microscopy); evaluation of optical and non-optical surfaces (topographical and roughness evaluation, corrosion effects on optical surfaces); design of optical systems

③ Microoptics / Integrated Optics : Design, modeling and simulation of components and subsystems; passive and active components for microsystems and communication technology (elements in plastics, glass, and silica); optical characterization for microoptical components and waveguides; miniaturized and micro-optomechanical systems
④ Precision Engineering : Simulation and design of optical-mechanical systems : prototype development; precision systems : air bearings and precision balancing, wafer holder with electrostatic chucks; automated microassembly : precision adhesive application, handling and microfeeding; know-how in medical and space technologies

(3) Applied Polymer Research(IAP)

① Synthetic Polymers : Technology of synthesis and optimization of processes, amino resins, retard delivering systems, microencapsulation, environmentally friendly plastics, water soluble polymers, flocculating agents, water purification, polymeric surfactants, optimization of melt polycondenzation processes, polymer dispersions, communication polymers. modification of polymers, surface modification, plasma technology, characterization of polymer surfaces, chemical analyses
② Polysaccharides : Regioselective derivatization of cellulose and starch, adsorber, enzymatical and chemical modification of starch, molecular and rheological characterization of starch polysaccharides, materials based on starch.
③ Applied Polymer Physics : Formation of structure in shaping, precipitation and cristallization processes; structure characterization, thin polymer layers (non-linear optical, piezo- and pyroelectrical, light emitting), starch films, mechanical testing, optical characterization

(4) Industrial Engineering(IAO)

① Competence Centers : Technology Information Systems / Rapid Product Development / Software-Technology / Virtual Reality / Knowledge Transfer
② Competence Centers : Process Service Economy / R&D Management / Human Engineering / Human Resource Management / Production Management / Software Management
③ Branches : Financial Service Providers / Printing and Publishing Industry / Public Service Providers / Production Companies / Public Health / Software-Production
④ Products : Business Process Intranet / Component Ware / Service Portfolios / Production Information Systems / Information Engineering / Innovation Management / Interactive Products / Customer Management / Training Concepts / Logistic Information Systems / Multimedia Business Management / Networks and Services / New Business Development / New Work Development / Product Design

(5) Atmospheric Environmental Research(IFU)

① Biogenic VOC Emissions : Quantification of the emission of volatile organic compounds (VOCs) by plants; studies of the contribution of VOCs to the formation of photo-smog;

biochemical process studies and application of the results e.g. for the biotechnological production of selected VOC

② Exchange of trace substances between soil and the atmosphere : Study of the impact of enhanced pollutant deposition on the exchange of trace substances between atmosphere and soil of semi-natural and agricultural eco-systems; contributions to global climate change

③ Anthropogenic Emission of Pollutants : Quantification of the emission of pollutants from point and area sources using remote sensing methods; development of techniques for the remote measurement of these emission rates; emission control measurements; preparation of environmental risk assessments

④ Regional Air Pollution : Study of atmospheric transport and (photo)-chemical transformation of pollutants; field measurement using mobile and stationary experimental platforms and airplanes; study of processes governing pollutant degradation; determination of local and regional distributions of air pollutants employing mobile measurement platforms (vans or airplanes)

⑤ Solar UV-B Radiation : Determination of the temporal change in solar UV-B irradiation using spectrally highresolving instruments; measurement of the UV-B radiation flux in the troposphere and investigation of its impact on vegetation; reference laboratory for UV measurements

⑥ Numerical Simulations : Development and improvement of numerical models for simulating regional climate as well as formation, transport, and distribution of air pollutants; preparation of expertises in the sectors climate change and air pollution and for the definition of emission abatement measures

⑦ Distribution, Transport, and Trends of atmospheric Trace Constituents : Measurement and remote sensing of vertical distribution, transport, and trends of greenhouse gases and gases relevant to the formation and degradation of atmospheric ozone (measurement stations on the Zugspitze, Bavaria, and at the Cape of Good Hope, South Africa)

⑧ Development of Analytical Instruments and Operational Software : Development of analytical instruments and software for measurement of trace substances; development of ground-based remote sensing methods; combination of individual components to form operational environmental measurement systems

⑨ Quality Assessment and Quality Control : Designing of QA plans; execution of system and performance audits for monitoring networks and measurement programmes; consulting for data quality improvement; training and educational programmes in QA/QC

(6) Building Physiks(IBP)

① Building Acoustics : Airborne and impact sound insulation of component parts, sound absorption, elastic properties of materials, sound insulation of walls and shieldings, silent water supply installations, sanitary facilities and installation systems, structure-borne sound-insulating pipe fixing and wrappings, testing and development of building components (all qualification and quality tests according to DIN 4109); Vibration measurements, insulation of unwanted vibration. Protection against noise immissions from sports fields and leisure-time facilities, traffic noise, low frequency noise, structure-borne sound propagation. Emission and immission measurements (measuring point according to ㎣ 26/28 BlmSchG). Expert planning and testing on acoustic design in construction engineering and in immission protection, calculations of sound propagation within factory halls, building complexes, industrial plants and urban development, development of measuring methods, calculation and prediction programs.

② Room Acoustics, Technical Acoustics : Acoustic design of lecture halls for speech and music. Computer simulation and model measurements of complex architectural design for theatres and concert halls. Planning and design of acoustically sophisticated working spaces and leisure-time facilities. Development of alternative non-fibrous sound absorbers for the lining of anechoic chambers, shieldings and cabins. Noise reduction for machines and plants through measures at source and in propagation media. Calculation, design and testing of passive, reactive and active sound silencers for special requirements as regards durability and contamination resistance. Development of measuring methods and components for sound attenuation and insulation for frequencies lower than 100 Hz. Examination of the sound absorption coefficient at normal sound incidence for low frequencies and large specimens.

③ Heat Technology (Stuttgart and Berlin Project Group) : Design, practical measuring and determination of low-energy, low-entropy and zero heating-energy houses and settlements. Calculation and realization of energetic redevelopment concepts for existing buildings. Development and investigation of heating, ventilation, solar, hybrid, storage and energy-supply systems for practical use in buildings. Setting up and development of total energy balances (including ecological balance share) of buildings and heat supply systems. Analyses and determination of the energy potential in new and existing buildings. Calculation and measurement of streams of air in rooms and large halls (atria). Assessment of the temperature behaviour of buildings in summer. Calculation and measuring of lighting and daylighting provision for buildings. Assessment of mould fungus growth. Development and updating of computer-aided planning instruments.

④ New Building Materials and Building Components (Gips-Schule-Department) : Product developments for new building materials, component parts and building systems (prototype development as well as support with patent application and market introduction). Examinations for licensing authorities, feasibility studies, aptitude and quality tests of building materials, components (for example masonry, windows, doors etc.). Heating and chimney systems, determination and calculation of heat and energy transmission and conductivity by experiment. Investigations as regards the recycling compatibility of waste and residual materials for building materials and their production processes. Development of methods, e.g. for ecological balances.

⑤ Holzkirchen Branch Institute : Outdoor Testing Site / Moisture Technology, Energy Systems / Hygrothermics / Indoor Climate

(7) Strength of Structures under Operational Conditions(LBF)

① Component-Related Material Behavior : Strength hypotheses and life prediction; optimization and fatigue life proof of components; evaluation of defects and fracture mechanics; metallography and fractography; sintered steels; cast materials; forged materials; aluminum alloys; ceramics; metal-matrix composites; fiber reinforced materials; welded joints; shaft-hub-assemblies; hheat and surface treatments exhaust systems; high-temperature loading; corrosion.

② Stress Analysis and Strength Evaluation : Experimental stress analyses; load assuption; derivation of design spectra; fracture behaviour of safety components; multiaxial fatigue life proof; generation of control signals for multiaxial tests; durability approval of joints (shrinkfits, fasteners, weldings); system behaviour and kinematic of complex assemblies under service loadings; durability approval of elastomer components; strength hypotheses; optimization of design and manufactoring processes of components; fretting corrosion of joint components and contact fatigue; wear; surface treatment; coated components.

③ Load Mechanics and Numerical Simulation : Development of sensors for the determination of operational loads; determination, analysis, and simulation of operational stresses; experimental stress analysis; determination of operational loads, stresses, strains, and deformations; statistical description and synthesis of operational loads; generation and shortening of control signals; generation of standardized load sequences; numerical stress analysis (finite-elements) and shape optimization; numerical simulation of surface treatment methods for fatigue strength increase; material and strength behaviour of elastomer components; material and strength behaviour of thin sheet structures; determination and evaluation of residual stresses; optimization of vibration response; modal analysis; systems identification; expert systems on fatigue strength; concepts for numerical life predictions; reliability; computers and nets.

(8) Biomedical Engineering(IBMT)

① Sensor systems / microsystems Microsystems : Sensor systems / Biosystems

② Ultrasound-systems : Ultrasound-systems technology / Ultrasound applications / Software systems and communications technology / Test sensor systems

③ Healthcare telematics : Networking of service providers in health care; portable electronically stored medical records, their integration into information systems at hospitals and doctors' practices, home-care units, equipment in medical communications networks; medical standards (DICOM 3.0, HL7, XDT, ICD10, etc); geronto sensor systems; telematic systems for patients, elderly and disabled persons living at home; homecare and teleservice

④ Magnetic resonance : Biomedical research (NMR, FT-IR) / Materials research (NMR, FT-IR, AFM) / NMR-technology

⑤ Sensor production technology : Development of production technology for ultrasonic sensors; production technology for low-cost ultrasonic single-element transducers for use in solid, liquid, and gaseous media; high-frequency (20-50 MHz) ultrasonic single-element transducers for medical technology and industrial testing; hydrophones for acoustic measurements; development and manufacturing technologies for ultrasonic for high-temperature applications; production technology for one-dimensional and two-dimensional transducer arrays for medical and technical applications; manufacture of piezo-composite materials (standard and full-custom specification); pilot and series production of ultrasonic sensor and microsystems, especially for industrial applications (process sensor systems); development of production technology for thin-film/thick-film sensors; development of production technology for low-cost solid-state gas sensors; development of layout and connection technologies for producing hybrid microsystems; development and production of implantable micro-electrodes.

(9) Chemical Technology(ICT)

① Energetic Materials : Analysis, synthesis and development of energetic materials; Processing of energetic components, preproducts and binders; Formulation, development and characterization of solid rocket and gun propellants; gas inflators and high explosives for military and commercial application; Reutilization and disposal strategies of energetics; Particle technology; exhaust gas characterization; reaction kinetics and mechanisms; supercritical-fluid technology (SCF)

② Energetic Systems : Combustion processes and reaction kinetics of chemical energetic materials, energetic compounds and polymers; high-pressure combustion; safety technology; gas explosions; interior ballistics; detonation; gas generator systems, e.g., for airbags, seat belt retensioner fire extinguisher, explosion supression; fast optical diagnostics for analysis of combustion processes and polymer identification; high temperature materials

③ Polymer Energieering : Polymer processing, e.g., injection moulding, extrusion, pressing, compounding, assembly in tool, plasma treatment, ion implantation, product development, simultaneous engineering (CAE, CAQ, FEM), rapid prototyping, rapid tooling, material development and modification; tooling technology for polymer processing

④ Environmental Engineering : Recovery of plastics and residues, waste disposal, soil and groundwater decontamination, supercritical fluid technology, environmental analysis, environmental simulation of materials and products, airbag qualification, strategies for closed loop economy, life cycle engineering, recycling of composites, design for recycling, transportation and packaging design

⑤ Applied Electrochemistry : Rechargeable high-energy batteries, development of chemical sensors for (trace-)gases and liquids, waste- and drinking-water analysis, conducting and electrochromic polymers

(10) Electron and Plasma Technology(FEP)

① Thermal Processing

② Nonthermal Processing

③ Coating Metal Strips
④ Coating Glass
⑤ Coating Plastics
⑥ Coatings Components
⑦ Characterization
⑧ Division Systems/Administration

(11) Experimental Software Engineering(IESE)

① Requirements Engineering : Methods and tools for the elicitation, analysis and specification of software requirements : object-oriented modeling (UML), object-oriented methods (OMT, Fusion), use cases and scenarios, requirements documentation standards, software cost reduction requirements technique (SCR)

② Software Design Methods : Tools and technologies for transforming requirements into executable systems; object-oriented languages (Java, C++), architectures, patterns, distributed objects and components (CORBA, DCOM), object-oriented design, Cleanroom method

③ Inspections and Testing : Techniques for the avoidance and detection of software defects; inspection activities, reading techniques, perspective based reading, inspection of object-oriented artifacts, testing methods, testability, statistical reliability certification, testing of object-oriented artifacts

④ Product Line Engineering : Methods to scope a product line (PL) and derive its economic value (net present value), perform PL analysis and modeling, derive, evaluate and validate the PL architecture, evolve and manage PL over time, select and manage contractors

⑤ Reengineering : Methods to perform architecture recovery towards ADLs or in-use notations, system redocumentation, and system evolution : integration of one or multiple existing systems, perhaps with additional requirements, into a new reusable architecture for better adaptability

⑥ Distributed Reference Architectures : Methods to develop, evaluate and field reference software architecture (DSA) in distributed environments. A DSA embodies a flexible, evolvable design that supports a family of applications operating within a networked environment. The methods include distributed object-oriented frameworks, transformation, etc.

⑦ Cost and Quality Engineering : Measurement-based, statistical modeling of software development processes; monitoring, evaluation, and prediction of software quality, cost, productivity, and related risks

⑧ Process Engineering and Improvement : Software development process elicitation, modeling, and analysis; prescriptive process modeling, electronic process guidance; identification and evaluation of software process weaknesses and strengths; reliability and validity of process assessments; process improvement

⑨ Quality and Process Support Environments : Tool support for the design and implementation of measurement programs, goal-oriented data collection and analysis, the analysis and assessment of software development processes

⑩ Systematic Learning And Improvement : Built up of effective organizational structures, procedures, and tools for organizational learning in the software development area; tailoring and introduction of knowledge asset evaluation, of knowledge acquisition, storage, dissemination, and management; set-up of goal-oriented, measurement-based quality improvement programs

⑪ Information Technology Security : Security analysis of software components, architectures, and entire software systems; identification of vulnerabilities and threats; evaluation of effectiveness of employed safeguards; advice towards improvement of security

⑫ Company-Specific Education and Training Programs : Development of professional education and training curricula; accredited education and training courses; education and training supplementing technology transfer; distance learning and computer-based training; open seminars and education measures, also in cooperation with third parties

⑬ Consulting for Small and Medium Sized Enterprises : Management of the 'Software Technology Initiative' (STI); consulting in base practices of Software Engineering; quality management and preparation for certification

(12) Factory Operation and Automation(IFF)

① Enterprise Strategy and Structures : Enterprise strategy, market-oriented enterprise structuring, enterprise management, enterprise cooperations

② Industrial Building and Factory Engineering : Industrial building, layout design, visual simulation, virtual reality, demand-oriented information technology-concepts

③ Technological Innovation Management : Innovation design, vitalization, technology development, communication design

④ Product and Process Planning : Marketing concepts, product development and optimization, rapid-prototyping technologies, process development and management

⑤ Basics for Factory Operation and Organization of Factory Processes : Enterprise modeling, new methods of factory operations, factory analysis and assessment, business process-oriented organization planning, education and qualification

⑥ Production Systems Planning : Enterprise analysis, planning and management of variants, real planning, multimedia presentation

⑦ Factory Planning and Logistics : Factory and plant planning, logistics for production and service processes, enterprise modeling, tool-development

⑧ Planning and Visualization Techniques : Virtual reality, simulation and optimization, multimedia

⑨ Maintenance and Service Management : Organization and re-design of maintenance functions, customer-oriented design of service management, supporting systems for planning and operation

⑩ Quality Management : Integrated management systems, knowledge management, cooperation management, service management, innovation and reliability management

⑪ Factory Ecology : Ecology-oriented informatics, ecology-oriented management systems, techniques for the disposal of waste, ecology technique

⑫ Robotics and Manipulator Systems : Industrial robot systems, mobile robots in service, intelligent manipulation systems
⑬ Process Control Systems : Control engineering, 2D- 3D- image processing, control station techniques and telediagnosis

(13) Applied Materials Research(IFAM)

① Powder Technology : Forming of powdered metals; thermal compression in the manufacture of ultra-dense sintered materials; metal-powder injection moulding; metallic foams; ultra-fine metal powders; Rapid Prototyping; construction of special equipment; sintering technology
② Powder Metallurgy : Powder-metallurgical materials and components; high-temperature working materials; fibre metallurgy; gradient materials; metal-matrix composites; metallic filter systems, sintering theory
③ Foundry Technology : Aluminium/magnesium pressure diecasting; thixocasting; cast-mould prototyping; prototyping of pressure die casts
④ Computer Modelling and Simulation : FEM simulation for powder compression, form-filling, hardening and component optimization; implementation of material laws; tele-engineering
⑤ Bonding Technology/Adhesives : Principles of adhesion; development and characterization of polymers; network polymers; chemical and physical analysis
⑥ Function-Integrated Component Manufacture : Material and component testing; composite-fibre components; lightweight construction; resilience and stress-resistance analysis; computer-aided calculation; finite-element simulation
⑦ Production Technology : Evaluation of low-heat bonding technologies; hybrid technologies; optimization of bonding process operations; preventative quality management; manufacture of prototypes
⑧ Plasma and Surface Technology : Plasma polymerization; plasma purification; plasma activation; fluorization; silicatization; ionic treatment; surface analysis
⑨ Microassembly : Electrically and optically conducting connections; dosage of minimal volumes; properties of polymers in thin films; development of special polymers
⑩ Technology Management : DVS-certified training of bonding engineers and technicians; consultancy and studies; recycling; material-flow management; eco-audits; value analysis; health, work safety and environmental protection
⑪ Polymer Composites : Structural and functional polymers; characterization of polymers; bonding and coating materials; laminating and casting resins; recycling

(14) Fraunhofer-Management-Gesellschaft mbH(FhM)

① Programme Development and Evaluation
② Technology and Information Services
③ Biotechnology, Medicine and Chemistry

④ Information and Communication Technology
⑤ Implementation, Administration and Realisation of Projects, Environmental Technology
⑥ Administrative Management Services
⑦ Project Development, Technology Centres,
⑧ Marketing Services
⑨ Further Education
⑩ International Organisations

(15) Computer Graphics Research(IGD)

① Document Imaging : Document processing and document communication integration of prepress, press and post press (CIP3); document concepts; page description languages; screening methods; electronic documents; hyper- /multimedia systems; converters / exchange formats; cross-media publishing, computer generated holography
② Industrial Applications : Concurrent engineering; CSCW in product development; product modeling; product data technology (STEP standard development); virtual prototyping; CAD / CIM interfaces; feature modeling, semantic modelling; 3D-user interfaces for modeling systems, cooperative CAD; Virtual Engineering
③ Animation and Image Communication : Tools for animation applications; modeling systems (geometry, colour, texture); animation systems and special effects; simulation applications; application- and user adaptive realtime - visual simulation; image database; world wide web; VRML and respective application; image communication systems; office of the future
④ Visualization and Virtual Reality : Visualization systems for scientific-technical data; visualization of weather forecast data; visualization of financial data; expert centre for visualization systems; virtual reality; development of VR-systems; VR applications in the field of architecture, car industry and civil engineering, digital mock-ups, landscape redevelopment projects, medicine (surgical training and OP-planning), shipbuilding, molecule design, edutainment, marketing; road shows; VR technology laboratory equipped with CAVE, feedback devices, full-motion platform; augmented reality, applications for architecture, car industry and medicine (OP-support)
⑤ Graphical Information Systems : Geo information systems (GIS); facitlity management systems (CAFM, FMS); open distributed information systems (ODIS); geo information management (GIM); interactive graphic user interfaces; visualization; internet/intranet applications; AI applications; 3D information systems
⑥ Cooperative Hypermedia Systems : Cooperative hypermedia (CHM) : integrated cooperative work, hyperstructured documents and multimedia; CHM systems : services for CHM document processing; CHM applications : definition of multimedia data processing in distributed homogeneous environments
⑦ Cognitive Computing / Medical Imaging : Integrated system solutions in hardware and softwar e : 2-D and 3-D graphics and multimedia systems; 2-D and 3-D image processing; medical imaging; volume rendering; telemedicine; ISDN applications; multimedia user interfaces

⑧ Security Technology for Graphics and Communication Systems : Cryptography for confidentiality, liability, integrity, and authentification; access control; chipcard applications; biometric identification procedures; copyright protection; accounting and billing; access control in broadcasting services (video on demand, pay TV)

⑨ Computer Supported Cooperative Work (CSCW) : Groupware, multimedia communication, cooperative work in distributed virtual environments, agent technologies, visual end user programming for software agents, Internet audio, Internet telephony, Internet live broadcasting, spatial audio for distributed virtual environments, communication in global nets (ISDN, ATM, IP-Internet / Intranet)

⑩ Multi-media Communication : Exchange of multi-media documentation; multi-media authorship systems; multi-media presentations on CD ROM; hyper/multi-media systems; distributed information systems; multi-media information systems; World Wide Web (HTML, Java, VRML); network technologies (ISDN, Internet, TCP/IT, SLIP, PPP, ATM); CSCW (T.120); conference systems; video conferencing

⑪ Visualization and Interactive Technologies : Visualization of environmental data in defined area; architecture and CBT; innovative interaction technologies : multi-media user interfaces, biosensors, VR metaphors; imaging : 3-D image reconstruction; content-based searching in image databases

⑫ Mobile Multi-media Technologies : Wireless LAN/WAN technologies; mobile terminal equipment; mobile information structures and software architectures, remote programing; mobile-communications strategies; mobile office; distributed multi-media systems; on-site collection and analysis of environmental data; travel information systems

(16) Interfacial Engineering and Biotechnology(IGB)

① Surface Technology and Interfacial Engineering : Process development for non-polluting methods for surface treatment; cleaning and coating by means of plasma processes serving the improvement of the technical and biotechnical performance of materials and devices; characterization of surfaces and coatings; on-line tensiometer

② Membrane Separation and Process Engineering : Development of membranes and membrane processes for product separation and downstream processing, for purification of air and water, and for recycling of chemicals and solvents. Development and production of organic and inorganic membranes and membrane-modules for technical and biotechnical applications; construction and operation of laboratory and technical scale filtration plants (micro-, ultra-, and nanofiltration); electrodialysis, membrane electrolysis; gas separation, pervaporation, pertraction; membrane contactors; design, simulation, and calculation of membrane processes

③ Environmental Bioengineering / Waste and Waste Water Treatment : Process development for the biotechnical conversion and utilization of residues and waste materials from agricultural and food industries and municipalities; production of chemicals (propionic acid, lactic acid) and energy (ethanol, hydrogen, biogas) from organic waste materials; sludge treatment; water purification; modeling, simulation, and calculation of processes; development of bioreactors; testing of bioreactor components with respect to sterility

④ Soil and Water Bioremediation and Biotransformation : Development of biological systems for the degradation of environmentally hazardous compounds and for the conversion of problematic substances into useful raw materials; biological degradation processes for the treatment of hazardous wastes, and for the purification of soil, water and air (process development)

⑤ Enzymes and Biocatalysis : Screening for new biocatalysts; optimization of enzymes by site-directed and evolutive mutagenesis; contract research and process development for the production of native and recombinant enzymes (S1) in pilot scale (100-l-bioreactor; certification in preparation); enzymes and antibodies for diagnostics (test strips, bio-sensors)

⑥ Biopharmaceutical Proteins : Development of new recombinant enzymes and therapeutic proteins, such as interferons of the first, second and third generation; Novel recombinant agents for pharmaceutical products, such as cytozymes and nucleoproteins

⑦ Genome Analysis, Protein Screening Methods and Proteomics : High efficiency methods for genome analysis and gene diagnosis; automation of DNA isolation and purification; automation of gene sequencing and cloning; screening for and identification of new signal chains and targets interesting for pharmacological applications

⑧ Cell and Tissue Cultures : Animal and human cell cultures, esp. three-dimensional cell structures (cornea, skin, mucous membranes, blister) for the testing of active agents, drugs, and cosmetics, as well as for substitution of animal tests and for transplantations

⑨ Special Analytical Services : Biochemical, chemical, and physico-chemical analyses of food, gas, fluids, and environmental samples

(17) Wood Research, Wilhelm-Klauditz-Institut(WKI)

① Process Engineering Wood / Wood Materials : Production automation; drying of bulk materials; fitness for use; weathering simulation; test tailoring; testing of structural elements; geometric, mechanical, thermal, caloric measurements (measuring and testing); optical, radiometric and acoustical metrology

② Wood Materials : Materials research, materials development, optimization of the properties of wooden materials and other regenerative raw materials, and of organic and anorganic binding agents; raw materials and materials testing; splinter and fibre materials, plywood; recycling of secondary materials, questions of ecology

③ Chemical Engineering and Environmental Research : Emission sources; air pollution control; firing plants; recycling; resource recovery; adhesives; wood chemistry; pulp technology; waste wood; secondary materials

④ Surface Technology and Wood Protection Techniques : Surface refinement; furniture surfaces; powder varnishes; building lacquers; weathering; varnish-chemical analyses; wood properties; damage analyses; wood protection

⑤ Materials Testing

(18) Information and Dataprocessing(IITB)

① Production control systems : Object-oriented monitoring and control of production; object-oriented project-evaluation systems for applications involving control technology; archiving and assessment of production and product data using standard tools; knowledge-based layout of plant equipment and formulation of tenders; formula-based control of production and plant; knowledge-based formula composition; model-supported service assistance systems; start-up and maintenance of operation; life-cycle modelling of plant installation with (STEP) representation standards; graphic modelling and project-evaluation systems; application-oriented generation of diagnosis systems; model-based systems for production monitoring and control, quality control, design and layout of control technology (simulation : real time, dynamic); on-line and on-board diagnosis in and for distributed systems; intelligent maintenance systems with O-O databases; multimedia-based process control technology (include. VR) incorporating OLE platforms and component-ware; production monitoring for management and adminstration

② Production optimization : Controllers and regulators : tools for design of regulators, fuzzy regulators, knowledge-based systems; multi-sensor measurement systems; measurement system design and development for special measurement tasks (measurement of cavities, reel-off position of photographic film, amongst others); optimization of business processes; simulation of business processes; services : configuration and optimization of work-flow systems; control tools for means of production; planning charts; integration of operations in planning; measurement technology, control and regulation systems (new and further development of sensors working on special principles and of different types for process engineering and manufacturing technology; fuzzy and neural-based regulators and controllers); intelligent inspection systems for monitoring and task planning; optimization of processes and sequential operations; modelling of hazardous disruptions as a packaged service

③ Telematic systems : Distributed production; automation in buildings; management systems; electro-magnetic compatibility (R&D, test systems and services); system-conformity testing; distributed real-time applications; testing services; performance analysis of bus-controlled DP systems; electronic office; intra-net systems for industry and the service sector; telecare systems for the handicapped and people under nursing care; WWW services; network management systems, management assistants; configuration and engineering tools for field-bus systems

④ Real-time image processing systems : Operational real-time systems for quality control (grey-scale visual surface-inspection systems; grey-scale visual inspection systems for film-packed tablets and pills; visual colour-identification system for sorting of bulk materials); clarification and design of processes for automated visual inspection; development of programs and electronic assemblies for image analysis systems; colour-capable visual systems for 3-D recognition of surface flaws; colour-capable visual inspection systems for film-pack tablets and pills; enhanced visual colour-identification system for sorting of bulk materials

⑤ Recognition and diagnostic systems : Methods and tools for automated aerial and satellite image interpretation and for visual-based inspection in quality control and in medical engineering; security-monitoring inside and outside of buildings; signal-based diagnosis in the car, rail transport, telecommunications and machine tool industry; completed versions of existing products; content-based search methods for image databases; video and multi-sensor security systems for monitoring the inside and outside of buildings

⑥ Interaction systems : Methods and tools for approaching ergonomic problems, rapid prototyping of interaction concepts; user interfaces and menu generators; interaction concepts for assistance systems in image evaluation; interactive systems for image evaluation and description; information structuring systems; usability lab and experimental systems; complete and enhanced versions of existing products; interaction concepts for support systems used by car drivers, city information services and multi-modal transport networks; teaching and training systems, multimedia handbooks; workflow simulation in control technology and in distributed image evaluation systems

⑦ Multi-modal transport systems : Traffic support systems; driver-support sytems for road vehicles; traffic information systems; sensors for traffic management systems; cause and effect analysis of traffic management systems (simulation, etc.); (multimodal) transport systems networks; intermodal transport management : technologies; traffic control system s : traffic flow regulation, direction and guidance systems, route planning systems, operation management systems (commuter services, rail, other); transport telematics : passenger guidance and information systems, Personal Traveller Assistant (PTA), fare collection and charging; vehicle guidance and automation : autonomous guide-rail vehicle systems and the control, regulation and safety of transportion equipment incl. diagnosis and operational measurement technology

⑧ Utility supplies and waste disposal systems : Planning and management of inter-regional energy supply systems : electricity, gas systems; control and planning of water supply, regulation and control in buildings; control of biotechnological processes : control of oxygen concentration in sewage plants; electricity : control and evaluation of power lines; planning and control of water supplies : ground water extraction, model-based optimization of pipeline reconstruction; regulation and control in households and large buildings; control of biotechnological processes : adaptive regulation of several process types, non-linear regulation of biomass; Support systems for formula planning and regional waste-water disposal; sewage plant automation; leakage recognition and localization; pipeline monitoring, management of district heating systems concentrations

⑨ Cognition systems : Methods and algorithms for automatic evaluation of images and image sequences; robot guidance with visual systems for automatic disassembly of scrap vehicles; model-based and automatic extraction of traffic scenes from video image sequences; traffic diagnosis based on stationary or dynamic camera position and automatic extraction of traffic scenes; traffic optimization; integration of distributed image evaluation systems for real-time applications over public broadband

⑩ Infrastructure and services : Planning, configuration, operation and maintenace of long-distance transport networks; planning, configuration, operation and maintenace of local workstation and PC networks incl. cabling; manufacture of mechanical components and electronic equipment, expansion of switching units; conduct of trials and measurement campaigns; organization and conduct of training events; set-up and support of documentation databases

(19) Information Center for Regional Planning and Building Construction(IRB)

① ARCONIS Information Consulting : Individual services, database investigations, market analyses, further enquiries, mediation of literature

② Fraunhofer IRB Publishers : Specialist books, specialist journals, specialist bibliographies; research reports; CD-ROM-databases and disk services; publications from institutes of the Fraunhofer-Gesellschaft

③ SDC : Setting and printing center

(20) Integrated Circuits(IIS)

① Integrated Circuit Design Analog Systems : RF-ICs; Sensor signal processing; Analog-to-Digital-Converters; Complex Mixed Signal ICs; Smart Sensors in standard technologies (optical, magnetical, current); ASIC prototypes and small volumes

② Integrated Circuit Design Digital Systems : Specification and development of digital integrated circuits for technologies from commercial vendors; high complexity circuits for applications with special purpose processors; digital signal processing; telecommunications

③ Audio and Multimedia : Coding of audio and video signals; music transmission via ISDN; measurement technology for audio signals; signal processing for multimedia applications; international standardisation (MPEG, AES, DAVIC)

④ RF and Microwave : Simulation and development of RF systems from prototype to product, design of integrated RF circuits; wireless data transmission systems for telemetry and remote sensor reading, design and linearization of power amplifiers, radio coverage measurements and system verification in field trials, simulation and design of antennas for mobile communication

⑤ Electronic Systems - Quality Assurance Facilities : Image processing systems for quality assurance; pattern recognition; texture analysis

⑥ Electronic Systems - Electronic Imaging : High-speed cameras; industrial cameras; development of camera electronics; image data compression; industrial object recognition; security systems; automatic configuration of image processing systems; color image processing; surface inspection; biometric systems; high speed data processing

⑦ Automation of Circuit and System Design : Multi-level / mixed-mode simulation; modelling; CAD tool adaptation; methods and algorithms for high-level and logic synthesis; rapid prototyping; test-pattern generation and formal verification of circuit and system designs; system and ASIC design; equipment for digital audio broadcasting

⑧ Fraunhofer Project Group for Wireless Telecommunication and Multimedia Technology ADTM - Communications : Mobile communications; wireless networks; system design for digital broadcast systems; real time implementation

⑨ Fraunhofer Project Group for Wireless Telecommunication and Multimedia Technology ADTM - Studio : Coding of audio and video signals; tools for multimedia productions; DSP-based Codecs (MPEG Layer-3; MPEG-2 AAC, MPEG-4 Audio, H.263); systems for image and audio transmissions

⑩ Fraunhofer Project Group for Wireless Telecommunication and Multimedia Technology ADTM - Terminal Devices : Data terminals and interfaces for digital broadcasting; data service applications; data server technology; human interface concepts; devices and systems for audience and test market research; low power circuit design and systems; multistandard terminals; security and conditional access; electronic commerce

⑪ Fraunhofer Development Center X - Ray Technology : X-ray image processing systems for quality assurance; X-ray evaluation systems with a ultra-microfocus source; automatic 2D and 3D inspection of printed circuit boards; X-ray cameras; digitizing of X-ray films; X-ray installations; high resolution 2D and 3D computer tomography; Compton backscattering tomography, computer laminography

⑫ Technology Simulation : Development of simulation models for process steps such as ion implantation, diffusion, oxidation and layer deposition; development of process simulaticsoftware; development of models for equipment simulation; support for the optimization of technological processes and equipment through the use of process, device and equipment simulation

⑬ Semiconductor Manufacturing Equipment and Materials : Development of equipment and components; optimization of production processes and automation; testing and optimization of materials for semiconductor manufacture; examination of process compatibility of equipment, media and materials; development of in-situ and on-line measurement and control methods; examinations of the contamination of equipment and materials; yield-affecting interactions; media supply systems; safety aspects; throughput analyses; prequalification of equipment

⑭ Technology : Surface technology, thin-film technology, processes for thin dielectric layers, ion beam techniques; contamination and trace impurity analyses, CMOS-technology, short-loop MOS test processes, electrical characterization; circuit modification; microsystem technology, micromechanics, sensors; actoric; medical engineering; power devices

(21) Ceramic Technologies and Sintered Materials(IKTS)

① Powder Technology, Development of Processes and Prototypical Components : Powder processing; casting and pressing, thermal treatment / sintering, design of components, machining

② Structural Ceramics / Cermets : Oxide ceramics; nitride ceramics; carbide ceramics;

composite ceramics; cermets / hard alloys; nanostructured materials

③ Functional Ceramics : Dieelectrics; ferroelectrics; piezoelectrics; conductive oxides and glass; thick layer and thin film pastes; functional pastes; micro systems technology

④ Characterization of Materials and Processes : Granulometry; surface measurement; thermoanalysis; dilatometry; ceramography; structural analysis; fractography; mechanical testing in the field of ambient and high temperature; data bases / expert systems; thermophysical properties; environmental technique

(22) High-Speed Dynamics, Ernst-Mach-Institut(EMI)

① Propulsion Processes : Interior and transition and exterior ballistics, ignition and combustion processes in solid and fluid propellants; combustion processes in motor engines; fuel injection processes

② Impact Physics : Terminal ballistic research and technology; investigation of structural behaviour and failure under crash loading conditions; crash testing of vehicle components; dynamic material behaviour ; penetration and perforation processes in materials at collision velocities between 10 and 10.000 m/s; simulation of meteorite and space debris impacts on spacecraft components

③ Safety Technology : Safety analyses for buildings and facilities; safety aspects of explosive storage; protection of buildings against blast load, blast testing of security glass and concrete; information systems

④ Numerical Simulation : Development and application of numerical methods for the study of transient processes; numerical simulation of shock propagation in gaseous, liquid and solid media; development of models for the study of material response to highly dynamic loading

⑤ Fluid Dynamics : Experimental simulation of blast propagation in chamber systems at model scale; shock and blast wave propagation in gaseous, fluid and solid media; blast simulation; blast loading of objects

⑥ Detonics and Protection : Experimental investigations for the development of protection systems based on new materials; new defence systems; detonation and deflagration processes; explosive deformation of materials

⑦ High-Speed Diagnostics : Optical visualization of high-speed processes; high-speed optical photography up to 100 million pictures per second; shadow and schlieren techniques; laser stroboscopy; flash X-ray techniques; development of high-intensity pulsed light sources; velocity measurement techniques

⑧ System studies and analysis : System studies in ballistics; system design for terminal ballistic protection and interior ballistics

(23) Laser Technology(ILT)

① Gas lasers : development of gas lasers; development and adaptation of transistorized power supplies; testing and customized modification of lasers; advice for official acceptance of lasers according to the actual regulations; development of laser components for infrared and UV lasers, e.g. laser beam diagnostic devices; testing and modification of components

② Solid state and diode lasers : development of solid state-lasers; development of components for frequency conversion; mounting and connecting techniques for diode laser assembling; development of diode laser modules for direct industrial and medical applications; development, testing and modification of laser components; process development for laser welding of plastics

③ Laser measuring and testing technology : development, construction and testing of laser measurement and testing equipment; laser coordinate measurement machines; chemical analysis of materials; non-destructive test procedures; analysis of vibrations; interferometric measurement techniques

④ Plasma technology : power supplies and excitation systems for plasma technology; low and high pressure plasmas for cleaning processes; plasma based X-ray sources and X-ray technology; short time measurement techniques

⑤ Cutting and joining : high speed processing; thick section processing; cutting and joining of special materials; removal (drilling, caving, perforating, graving); 3-D-applications; welding with additional material; hybrid techniques; design of processing nozzles and optics; sensor based process control; computer supported simulation and optimization of processes; multimedia qualification and information systems

⑥ Surface treatment : transformation hardening; remelting, cladding, alloying and dispersing; bending of metals; cleaning and modification of surfaces; rapid prototyping for production of metallic parts

⑦ Microtechnology : laser micro soldering and micro welding; laser supported bending and adjustment; precision cutting and drilling of metals, ceramics, semiconductors and diamonds; micro structuring with excimer and Nd:YAG-lasers; micro punching and stamping; marking; laser CVD and PVD, laser-galvanizing

⑧ System technology : pilot plants; integration of laser technology into manufacturing systems; development of sensors and control systems; small-lot applications; concept and design of plants; control of machines and logging of the operational data; data bases for storing process data; education and training

(24) Material Flow and Logistics(IML)

① Quality Management and Organisation Systems : Quality management and software; preparation of companies for certification; training; goods economy systems; process visualisation; 3-D animations

② Planning and material Flow Systems : Material flow planning; warehouse and order-picking systems; optimization of material flow systems (transport, warehouse, order-picking); generation of packaging patterns

③ Control Technology : Development of modular control systems; control of components and systems; customer-specific electronic applications, production automation, sensors, information and data modelling

④ Development and Construction : Warehouse, transshipment and transport systems; handling and order-picking systems; automatic parking systems, automatically guided transport systems; construction and putting into practice of prototypes and pilot systems up to the operational application

⑤ Enterprise Planning : Strategic and structural planning; planning and evaluation of business processes; process chain modelling; process cost calculation; new planning, removal planning; reegineering; commissioning planning; putting into practice; project management

⑥ Enterprise Modelling : Simulation as planning tool; reduction of throughput times; validation of material flow plannings; evaluation of business processes; cooperation management; Supply Chain Management; teachware

⑦ Software and Systems : Development of information, control and communication systems; DP-consulting and integration of software systems into the operational practice; multimedia applications; software; engineering; enterprise informatics

⑧ Waste Disposal : Waste disposal logistics for service providers and industry; redistribution; ①dismantling, materials flow management; closed loop materials economy in the building industry; environmental management; economic and ecologic evaluation; closed loop materials economy; supply and waste disposal systems; concepts for the local Agenda 21

⑨ Traffic Logistics : Traffic networks; planning of distribution, tours and car fleets; design of transport chains; telematics and transshipment systems; regional traffic concepts; planning of harbours; concepts of rail-bound goods traffic; maintenance systems; shipment tracking

⑩ Packaging and Trade : Development, planning and tests of packagings; one-way and reusable packaging systems; building and securing of unit loads; stock management; multimedia packaging handbooks, packaging laboratory; eco-balances; efficiency analysis and calculation of process costs; identification technology; trade strategies; ECR; instore logistics and design of points of sale

⑪ Project Center Frankfurt Airport : Demand and capacity analysis; optimization of logistic processses and procedures; planning and development of transshipment and handling systems for aircrafts; air freight and luggage

(25) Microelectronic Circuits and Systems(IMS)

① Devices and Technology : Microsensor technology; micro structure technology; micromechanics; wafer bonding; Chemical Mechanical Polishing

② Computer Aided Engineering (CAE) : CAD-Development

③ Analog / Digital Circuits : Mixed Signal and Opto ASICs, High Frequency Circuits, Analog FPGA's

④ Signal Processing and Systems Design : Synthesizable Cores : CAN; 16CXX; DES; I^2C, RSA; C50; EIB; PCMCIA-Cards

⑤ Devices and Technology : CMOS Technology; Fabrication of prototypes and series of ASICs and microsystems with integrated sensors and actuators; SOI circuits on SIMOX Substrates; power and smart power devices

⑥ Computer Aided Engineering (CAE) : CAD support for design, simulation and verification of ASICs and microsystems

⑦ Analog / Digital Circuits : Controller cores; RISC processors; microcontrollers; microprocessor systems; design of analog / digital circuits; high temperature circuits; smart power circuits

⑧ Signal Processing and Systems Design : CMOS image sensors (1D, 2D); Smart Cameras; sensor readout electronics; signal processors; image processing

⑨ Systems and Applications : Bus coupled distributed microelectronic systems; smart home; transponder systems; telecommunications; hardware / software codesign; requirements engineering; rapid prototyping

(26) Technological Trend Analysis(INT)

① Technology Monitoring and Foresight : Technology monitoring, trends, forecasting, assessment

② Information Services : International research programs and institutions; databases; internet; literature; methodologies

③ Electromagnetic Effects : Propagation and coupling of electromagnetic fields; electromagnetic compatibility (EMC); protection and hardening against EM effects; electrodynamics; microwave measurements laboratory; EM simulation on scaled down models

④ Radiation Effects in Electronics and Optoelectronics : Optical fibres; fibre optic data transfer and sensor systems; integrated optics; semiconductor components and devices; Co-60-gamma sources; 14 MeV neutron generators; flash X-ray facility; proton irradiation facility

⑤ Nuclear Detection Techniques : Measurement of environmental radioactivity; verification and identification of nuclear material by nondestructive methods; transportable system for detection of radioactive nuclear material; neutron spectroscopy; radiation protection

⑥ Physical Aspects of Security Policy : Electromagnetic and nuclear threat; physical aspects of arms control and proliferation

(27) Patent Center for German Research(PST)

① Patent Department : Intellectual property law; licence law; employees' inventor law; central management of all patent activities of the Fraunhofer-Gesellschaft, covering the estimation of the patentability of an invention, elaboration and filing of patent applications, protection of granted patents from infringement, etc.; patent database search

② Promotion of Inventions : Search for qualified and industrially applicable inventions, in particular, from universities, research institutions, small businesses as well as from private individuals; assessment of innovative technologies; financial support of inventions; allocation of interest-free loans

③ Licencing : Technology marketing, technology licencing nationally as well as internationally, cooperation partner of the Technology-Alliance; international cooperations; market analysis; negotiation of licence agreements; patent strategy consulting, technology consulting

④ Patent and Licensing Agency for the Human Genome Project, PLA : Biotechnology transfer between science and industr : to support the protection of Intellectual Property arising from the German Human Genome Project; to offer biotechnological innovations from universities and academic institutions to members of the Forderverein (sponsoring industrial body) for commercial use.

(28) Physical Measurement Techniques(IPM)

① Optical Spectroscopy : Spectrometer systems for quantitative chemical gas analyses : emission measurement technology, rapid exhaust gas analyses, saturation and trace moisture measurement; photometer for aerosol measurement; white light interferometer for layer thickness gauging; laser exposure systems

② Optical Production Measurement Technology : Contactless optical and electrical measurement techniques : distance measurement, surface inspection, defect identificaton, profile measurement, three-dimensional shape measurement, location detection, quality assurance

③ Microsensors and Integrated Optics : Integrated optical sensors and modulators in lithiumniobate and glass; electro-acoustically controlled modem converter; assembly and connection technology for fibre-chip coupling; waveguide on silicon; short production runs of custom-designed components

(29) Production Systems and Design Techology(IPK)

① Control technology (robotics and CNC technology) : Robot and plant control technology; PC-based control systems; new control processes (force, yield characteristics); mobile systems and service robotics; planning and simulation systems; robotics applications; realistic implementation of robots and their programing; measurement and calibration; process models and simulation; CNC controls; operating and programming systems; technology-specific applications; CNC grinding and polishing; control technology; process reliability and mechanical engineering diagnosis; safety technology and EU guidelines in mechanical engineering; use of the Internet in automation technology

② Engineering technology : Geometrical processing; engineering systems management; system ergonomics; methodology for CAD systems; CAD integration; simultaneous engineering; feature processing; integrated product and process modelling; simulation; rapid prototyping; STEP developments; integrated QM methods; modelling systems; digital mock-up; computer-aided industrial design; product data management; EDM; PDM; virtual reality; production planning; CSCW - applications

③ Systems Planning : Production planning; production logistics; integration strategies; factory management; production control and factory organization; order processing; disposition; system integration; software engineering; benchmarking; knowledge management

④ Process Technology : Automated image analysis for the inspection of surfaces in production technology, for applications in security and transport technology, as well as for applications in the service sector; biometrical sensor technology; communication platforms for manufacturing automation; engineering of special machinery and controls; remote diagnosis and service systems; multi-media information systems; telematic services and applications for traffic data aquisition and for traffic and mobility management; communication services for cooperative work

⑤ Quality Management : Introduction of quality management systems; process management; methods of quality management, total quality management (concept formation, advice and support along with the introduction); planning, steering and controlling of various products; optical production measurement technology; Production-technological education; education with regard to quality and environment; decentralized learning; work organization; maintenance management; marketing process planning; regional marketing

(30) Manufacuring Engineering and Automation(IPA)

① Organization Development
② Enterprise Logistics
③ Enterprise Development
④ Production Management
⑤ Robot Systems
⑥ Assembly Systems
⑦ Industrial Engineering
⑧ Microproduction
⑨ Quality Management
⑩ Information Processing
⑪ Surface Engineering
⑫ Coating Technology

(31) Production Technology(IPT)

① Process Technology : Refinement of conventional production processes (high power cutting, precision processing, 5-axes milling); processing with radiation energy (laserassisted surface treatment, laser cutting, water jet cutting, ion implantation); development of new technologies (rapid prototyping and tooling, laser aided processes, quick point grinding); treating of new materials in production technology (high-performance ceramics, composite materials, semiconductor and glass materials); development of computer-aided process management and design (CAD / CAM application for free-form area production, technology software), die and mold making (design building, injection molding, die casting) ultra precision and microengeneering, product development and optimization

② Production Machines : Development, design, and measurement technical examination of precision machines with regard to their performance capacities and operational accuracy; integration of high-energy lasers in production machines; manufacturing plants for fibre composite components; development and erection of machines for microcomponent production as well as handling and mounting systems for microtechnology, special machines

③ Measurement and Quality Technology : Optical metrology for product geometry : 1D, 2D and 3D-metrology; cunsulting, sensor- and measurement system development, integration in production process; quality- and development management systems; optimisation of product and process; TQM (esp. TQM-based cooperation of enterprises); information systems for quality management

④ Planning and Organization : Technology planning : manufacturing planning, planning of advanced manufacturing technologies, technology development strategies, technology audit, strategic planning : core processes and core technologies, production integrated environmental protection, economic, ecological and technological optimization of production, analysis of technology potential, product planning : development of new product ideas, development of new product concepts, product optimization, market strategies for innovative products, innovation management, design for life cycle, life cycle costing, controlling of warranty- and good will cost

(32) Thin Films and Surface Engineering(IST)

① Industrial Processes and Coating Applications : Coating by vapor or vacuum deposition; tribology; corrosion prevention; surface refinement and finish; optimization of the wetting; surface cleaning; application-related tests; prototype and short production runs, Transfer Center

② New Coating Systems : Development of new coating systems with a broad range of applications (diamond, cubic boric nitride) or customized properties (decorative coloured coatings, coatings for passive electrical components, dielectric coatings, optical coatings); electroplating; characterization of mechanical, electrical and optical coating properties

③ Characterization of Coatings : Coating analyses; surface analyses; microanalyses; grid probe microscopy; electron microscopy; X-ray structural analysis; Raman spectroscopy; optical spectroscopy; analyses service; development and application of measuring and test methods; quality assurance

(33) Silicate Research(ISC)

① Glass : glass development and glass technology; glass corrosion; glass recycling and environmental technology; special mechanical engineering for the glass industry; sol-gel-glasses damage analysis; environmental monitoring by glass sensors; new conservation materials; innovative restoration techniques

② Machinery Engineering : Special aparatus development; computer-controlled calibration units; exact dispersing instruments

③ Ceramics : Chemistry of ceramic precursors - Powder synthesis, aerogels, spinnable sols, chemically bonded ceramics, membranes, reflecting and anti-reflecting films / Ceramic fibre technology - Reinforcing and functional fibres, fiber composites, interface materials / Ceramic functional components - Functional ceramic componentes with optical, electrical, dielectric, magnetic, electromechanical and catalytic properties; nanostructered composites, e.g. metal/ceramic; smart materials

④ ORMOCERRs : Microsystem Technology – Structuring; passivation; solid state ionics Dr. Michael Popall / Bulk materials – Medical, biological applications; composites; molding / Coatings – Abrasion / corrosion resistant; barrier layers; decoration, sensors; photonics

⑤ Technological Center for Surface Refined Products (T_O_P) : Integral technological solutions for coating systems up to industial implementation; technologies for ORMOCER and inorganic coatings; consulting service for industry, training, quality management and promotion of technology transfer

⑥ Analysis : Center for Analytical Services (CAS) – chemical analysis, microstructure, electron microscopy / Rheology and Suspensions – characterization of powders and suspensions / Optimization of Sintering Processes – computer simulation; optimization procedures; RCS

(34) Silicon Techonology(ISIT)

① IC Technology : Silicon Process Technology / Development and testing of single processes, process modules and complete processes for all relevant fields of the semiconductor technology; development of process modules for sub-0,5 ㎛ CMOS.; development and fabrication of power devices (PowerMOS, IGBTs, HV diods); testing of semiconductor equipment; development of CMP processes (chemical-mechanical polishing).

② Applied Plasmatechnology : Large scale source supported dry etching techniques; high rate etching and high pattern resolution; high-density plasma sources; plasma diagnosis; plasma source analysis.

③ Basic Technologies for Lithography : E-beam lithography for pattern generation; in-depth lithography with UV- and synchrotron radiation; LIGA-technology; mask repair by e-beam induced processes, microgalvanik plating, micrometallization

④ Simulation and Circuit Layout : Device physics and -theory, process simulation for all technologies used at the ISIT, device simulation for latest MOS transistor architectures, measurements for process control; software development and simulation of microlithographical - and dry etching processes; IC-design with mixed-signal-simulation, verification and layout

⑤ Microsystem Technology : Silicon micromechanical sensors, actuators, optical and structural components; micro-galvanic techniques with thick resist and UV-lithography; greytone lithography for relief-type surfaces; hybrid or monolithic integration of devices and electronics; IC-design for microsystems; finite elements simulation

⑥ Biotechnical Microsystems : Planar sensors in silicon technology and complex microprocessor controlled microanalytical systems for oxygen, ions, heavy metals, biochemical metabolites, immuno assays, nucleic acids and microorganims; deposition of thin organic layers; microfluidic systems; gene technology in microsystems; hard- and software

⑦ Multichip Module Technology : All aspects of MCM-technology : substrate preparation (MCM-L, -C, -D), chip mounting (micro-mounting, adhesive technique), joining technology (wire bonding, soldering, flip-chip) and packaging technology; included are

MCM design, electrical measurement technique on bare dice and complete modules (DC, RF up to 50 GHz), and investigations on reliability

⑧ Assembly and Packaging for Microsystems and Sensors : Development and qualification of customer specific packages; low-cost / high-rel packages for microsystems and sensors; application and classification of materials used in biomedical microsystems; packaging and thermal management for power modules; high-precision mounting technique including microapplication of adhesives

⑨ Quality and Reliability of Microelectronic Assemblies : Metallography, microstructural evaluation and material analysis; mechanics and thermomechanics; optimization by physical modeling; modeling of electronic assemblies; modeling of processes; evaluation of electronic assemblies; sample production of microelectronic assemblies and modules

⑩ Energy supply for electronic systems : Technology for the fabrication of high performance secondary batteries based on solid state ionic conductors; technologies for integration into electronis systems

(35) Software and Systems Engineering(ISST)

① Internet/intranet Technologies and Management : Design, development, implementation and operation of intranets and distributed applications. Development of distributed information services. Solutions for groupwork support. Telecooperation and video-conferencing systems. Systems and content management. System solutions for electronic publishing.

② Process management : Management of business processes (workflow management) through procedural models; evaluation of procedural models; methods and tools in computer supported cooperative work (CSCW); information logistics; consulting in the selection and introduction of workflow solutions.

③ Information management : Methods, tools and systems for the management and modelling of information; data and object management; multimedia applications such as integrated databases, and terminal and on-line systems (point-of-information / point-of-sale systems).

④ Quality Management : Introduction of ISO-9000-ready quality management. Tools for quality management measures. Assessment of software product quality.

⑤ Dependable Systems : Safety-critical embedded systems. Fault-tolerant systems. Distributed real-time systems. Concepts and methods for the construction of dependable systems.

⑥ Information Services : Development of concepts and solutions for the creation of information systems on the basis of heterogeneous stocks of data. Concepts and solutions for information sales. Integration, interoperability and management concepts for facility management software. Development of distributed multimedia applications.

⑦ Fundamentals of Software Engineering : Methods and techniques to support the development of adaptable and evolutionary software. Modeling and specification of distributed heterogeneous information systems. Standards and platforms for integration.

(36) Solare Energy Systems(ISE)

① Photovoltaic Systems and Measurement Technology : Photovoltaic applications for accessible markets; products with integrated photovoltaic power supplies; electronic components for batteries and photovoltaic systems; stand-alone photovoltaic power supplies; rural electrification in areas remote from the grid; grid-connected photovoltaic and hybrid energy supply concepts; photovoltaics in buildings; computer simulation and energy flow analyses; calibration of solar cells and photovoltaic modules

② Solar Cells - Materials and Technology : Materials research and manufacturing processes for solar cells; crystallisation processes for multicrystalline silicon; thin silicon layers from gas-phase deposition; optical processing; deposition of dielectrical layers for solar cells; epitaxy of gallium arsenide (GaAs) and gallium antimonide (GaSb); characterisation of silicon and gallium arsenide; high efficiency silicon solar cells; thin-film solar cells of crystalline silicon; concentrator solar cells; modelling of solar cell structure and solar cell parameters; characterisation of solar cells and manufacturing processes

③ Thermal and Optical Systems : Active and passive use of solar energy for buildings and systems; materials research on optically functional layers; thermal solar collectors; sorption systems for storage and cooling; solar building; transparent insulation; 퀊ntelligent?windows and facades, daylighting; computer simulation and energy flow analysis / Solar engineering - Concept development, simulatnio, implementation and analysis of buildings with solar energy systems and rational use of energy / Thermal and Optical Test Laboratory - Measurement, evaluation and transluscent wondiw and facade elements

④ Energy producing technology : Energy supply systems using chemical fuels; electrochemical, chemical and thermal energy converters; development of membrane fuel cell components and systems; hydrogen production by electrolysis and reforming of natural gas; catalytic burners for natural gas and hydrogen; safety and storage technology for hydrogen

⑤ PV-calibration lab : Characterization of solar cells, PV-modules and PV-generators

(37) Systems and Innovaton Research(ISI)

① Innovation Services and Regional Development : Innovation financing and new technology based firms; innovation services; specific aspects of technology transfer in Germany and Europe; technology and innovation-oriented regional research; innovation policy and technology transfer in Central and Eastern Europe

② Technology Analysis and Innovation Strategies : Innovation strategies and innovation management in industry; research planning; technology and innovation policy; evaluation of technology policy; technology monitoring and foresight; patent analyses and technometrics; technology impact analysis (methodology)

③ Innovations in Biotechnology : Frame conditions, prerequisites, obstacles, potentials and impacts of innovations in biotechnology; regional aspects, planning studies and questions of location; international development of biotechnology and adjacent fields (e.g., biological raw materials, food technology and medicine)

④ Innovations in Production : Analysis of production technology developments; diffusion processes and potentials; evaluation of technical and organizational alternatives; analyses of economic efficiency; technology and organization management; supporting firms in reorganization projects; technology transfer and technology promotion

⑤ Information and Communication Systems : Monitoring and analysis of technology trends, technology forecast, assessment of future applications, analysis of user demands, market potentials and strategies of manufacturers and network operators. Conception and monitoring of pilot projects, technology impact assessment, evaluation of national and international innovation promotion programs

⑥ Energy Technology and Energy Policy : Economic potentials and impacts of rational energy use and renewable energy sources; energy supply concepts for firms and municipalities; conception and evaluation of pilot projects; analyses concerning the development of energy demand; conception and assessment of measures for energy and climate policy

⑦ Environmental Technology and Environmental Economics : Options for the reduction of emissions and wastes; recycling of production residues; wastewater treatment and water resource management; substitution of environmentally harmful materials; closed cycle economics, concepts for ecological products and product uses; life cycle analysis for products and processes; analysis of emission situation and drawing up of environmental concepts; conception and evaluation of environmental policy instruments

(38) Development Group(TEG)

① Product Planning and Business Processes : ㈀ Methods-based product planning - Product analyses, definition and concepts; control / use of methods for development (QFD, FMEA); plastics technology; medical engineering; specific statutory requirements and specifications for medical engineering, use of materials in medical engineering (biocompatibility) ㈁ Management systems - Reorganisation and process optimisation; workflow; quality and environmental management systems; process and system audits; quality standards and guidelines; Q method know-how; personnel management; incentive and payment systems ㈂ Technology management and patents - Patent exploitation / marketing (patent broking, searches and circumvention); design of internal innovation process for companies; technology research and evaluations of enterprises (technology audits, portfolios and road maps), identification of new business segments ㈃ Method-based product management - Market and target-group analyses, including identification of trends; marketing concepts / strategies; marketing instruments; control / use of methods for development

② Product Development : ㈀ Concept and design special equipment - Development and setup of special devices; redesign of existing special devices; development and setup of functional specimens, quality techniques for design and development, models and prototypes ㈁ Prototypes and tests - Development and setup of test equipment and facilities, test methods; test planning and implementation; test-based product and process optimisation (redesign) ㈂ Mechatronics and control engineering - Electrical engineering; electronics; precision mechanics; control engineering; PLC; robot programming; embedded systems (HW + SW); PC (HW + SW); sensor technology; drive engineering; EMC; directives, standards and statutory requirements relating to the safety of machines and equipment; development of automatic testers ㈃ Concept and design, standard equipment and products - Analysis, conceptual design, development and industrial implementation of standard equipment / capital goods; cost, assembly and production-optimised designs (designs for standard products), optical engineering and precision mechanics, designs suitable for plastics; quality techniques for design and development, various 3D-CAD systems

③ Production Processes : ㈀ Material flow and production planning - Factory planning, material flow concepts, simulation-based planning and optimisation of production processes, simulation models; production control / shop floor control, PPC consultancy and selection, control centre /simulation interfaces ㈁ Production engineering, application of new materials - Process development and optimisation; CFC parts and equipment for heat treatment; automation technology for heat treatment, production / joining technology (welding and soldering); filter technology (cyclones and membrane filters) ㈂ Automation technology and robotics - Analyses of rationalisation potentials, machine and plant concepts for automating production / assembly processes, robotics, linking and storage technology, automatic leak detection systems, implementation of innovative testing and production facilities

④ Project Management : ㈀ Large scale projects - Management of complex tasks for interdisciplinary and cross-Institute implementation of innovative equipments and systems; statutory requirements, standards and specifications relevant to machines and plants (CE, accident prevention regulations, etc.); preparation of contract documents

⑤ Business Administration Center : Database systems; IT management; controlling systems; make-or-buy analyses; organisation development; performance measurement systems

(39) Toxicology and Aerosol Research(ITA)

① Inhalation Toxicology
② General and Reproductive Toxicology
③ Molecular Toxicology and Pharmacokinetics
④ Pulmonary Function and Pharmacology
⑤ Clinical Chemistry
⑥ In vitro Toxicology
⑦ Immuno-, Allergotoxicology
⑧ Medical Biotechnology
⑨ Chemical Risk Assessment
⑩ Controlled Clinical Inhalation Studies
⑪ Information Technology for Toxicological Pathology
⑫ Aerosoltechnology
⑬ Bio- and Environmental Analysis
⑭ Genetic Toxicology
⑮ Pathology

(40) Toxikology and Environmental Medcine(ATU)

① Analyses of Harmful Substances and Environmental Analyses : Registration of harmful substances in water, soil, air and living matter

② Genetic Toxicology and Molecular Biology : Examinations of genotoxic and tumour-promoting effects of xenobiotics

③ Immunobiology and Immunotoxicology : Registration of immunotoxic potential and research into induction of allergies

④ Environmental Medicine and Environmental Outpatient Center : Center for environmental and industrial medicine
⑤ Documentation of Xenobiotics : Data investigation and evaluation
⑥ In-vitro inhalation toxicology : Collaborative project with the Hamburg-Harburg General Hospital (Department of Thorax Surgery, Dr. Lothar Swoboda)

(41) Environmental Chemistry and Ecotoxicology(IUCT)

① Environmental Analysis and Technology : Organic and inorganic environmental analyses (industrial chemicals, hazardous substances, pesticides, biocides), inherent substance data (e.g., hydrolysis, photolysis, volatilization); analytical determination of industrial and military hazardous wastes including chemical warfare agents and explosives, human exposure protection (e.g. safety standards at work, protective clothing), fast detection methods (on-site analysis), sorption procedures for skin and respiratory protection, testing of filter materials.
② Soil and Water Protection : Determination and estimation of chemical exposure in ecosystems; investigations about mobility/distribution in/between environmental compartments, availability, degradation, metabolism, transport and accumulation; laboratory investigations and outdoor simulations in accordance with GLP; soil protection, determination of groundwater contamination; investigation of environmental contamination through waste and recycled materials
③ Environmental and Ecotoxicology : Optimization of biological sanitation procedures; remediation control; terrestrial and aquatic simulation systems; ecotoxicological assessment criteria for terrestrial and aquatic systems; development of testing methods and systems; ecotoxicological testing in accordance with guidelines; biochemical-biological test systems; biomarkers, additional or substitutional methods for directed animal tests
④ Systems for the Assessment of Substances in Environment and Technology : Concepts of strategies for the evaluation of materials, products and processes in consumer and environmental protection; risk assessment strategies; environmental models for exposure and effects evaluation; quality objectives for soil and water compartments; ecological balances; structure-activity relationships; implementation of the Dangerous Substances Regulation in companies
⑤ Hazardous Sites, Composts and Solid Wastes : Determination of contaminants in soils including military hazardous wastes; remediation procedures and their assessment : chemical, ecotoxicological, ecological analyses, method development, simulations in the laboratory, model investigations; determination of the short- and long-term hazard potential of composts and wastes with ecotoxicological and chemical analyses; landfill simulation; model investigations of composting; optimization of biofilters
⑥ Molecular Biotechnology : Generation and pathogen resistant crops and transgenic plants; molecular pharming of recombinant antibodies and proteins; development and production of therpeutics, vaccines, blood substitutes and diagnostics; improvement of the agronomic properties of crops; molecular design of crops and ornamentals; identification and production of therapheutic plant secondary metabolites; development and optimization of new enabling technologies in molecular biotechnology.

(42) Environmental, Safety and Energy Technology(UMSICHT)

① Environmentally friendly processes : particle technology; crystallization processes; carbon adsorbents; reactions/separation under specific conditions
② Water treatment : membrane separation technology; adsorption; advanced oxidation; precipitation, coagulation, flocculation; linking of process water streams
③ Cleaning and separation of gases : flue gas cleaning; gas scrubbing and adsorption; dust separation; catalytic conversion of gaseous airborne pollutants
④ Waste technology and management : waste incineration, waste-to-energy; utilization of residues; material utilization and production of secondary raw materials
⑤ Bioengineering : biotechnological syntheses; downstream processing of fermentation broths; modelling; biological treatment of waste water, waste gas and solid waste
⑥ Safety analysis and design : safety of plants and plant components; transport and storage safety; safety analysis in accordance with German regulations; thermoanalytics
⑦ Protection from fire and explosion : fire safety concepts for buildings; smoke ventilation systems in buildings; reaction of materials to fire; fire and explosion protection for technical plants; consulting for fire brigades
⑧ Design of chemical reactors : single- and multiphase systems; modelling and calculations; development/maintenance of software applications
⑨ Monitoring and control of processes : pattern recognition; protection and containment strategies based on process control systems; model-based measuring methods
⑩ Process simulation and optimization : simulation of plants and scheduling of production processes; acquisition of physical properties of substances; lay-out/evaluation of ethoxylation processes
⑪ Transient flows in pipes : investigation of water and cavitation hammers; lay-out of (hot-liquid) pipeline networks
⑫ Combustion technology : fluidized beds, gas and oil burners, entrained flow reactors, grate furnaces and other plants designed for high temperatures; secondary fuels; gasification; emissions; slags
⑬ Combined heat, cold and power : cogeneration, block-type CHP, supply concepts; thermal and steam jet refrigerating machines; cold distribution, cold supply services; strategies for reduction of carbon dioxide
⑭ Energy management : load dispatch; unit commitment and mid-term resource scheduling; optimization of CHP-operation; energy trading tools; optimization software for SCADA-systems
⑮ Energy from biomass : utilization concepts; fluidized bed gasification; electricity generation and heat recovery, combustion systems; sampling and analytics of hot gas and tar
⑯ District heating : heat generation and distribution; leakage detection; use of waste heat and solar energy; heat accumulation; network simulation, optimal supply temperatures
⑰ Use of lean gas : pit gas, bio gas, wood gas; thermal utilization concepts; burner technology, emissions
⑱ Analytics : thermoanalysis and reaction calorimetry, rheological analyses, particle size distribution; contaminants and summary parameters; characterization of products and residues; sampling and on-line analyses in technical plants; biological degradability, analyses of organic substances; isolation of mixed and pure bacteria cultures

⑲ Visualization, measurement, and simulation of flow patterns : plant components and processes; transient flow patterns
⑳ Design, set-up, and operation of pilot and demonstration plants : project management; basic and detail engineering; custom-made sampling, analytics, and test programmes; technical support; installation of process control units and of measuring equipment
① Special polymers : temperature-sensitive/hydrophilic gels, superabsorbers, thermochromates; syntheses; characterization of products, analytics; application technologies
② Technical/juridical information systems : knowledge-based and full-text information systems; internet/intranet solutions; retrieval, filing, documentation; support during licensing procedures; preparation of juridical and technical normative texts; determination of the required state of technology
③ Software development : graphical user interfaces for Windows-NT and X-Windows systems; data base technologies; client-server-solutions; software architecture

(43) Process Engineering and Packaging(IVV)

① Product safety and analytical methods : Analytical examination of packagings and articles; interactions between packagings and their contents (permeation, migration); quality assurance by physical/chemical analyses; sensory analysis; interfering odour purification; advice about the legal conformity of foodstuff packagings; trace analysis of harmful and interfering substances; safety of plastic recyclates for reuse
② Food Technology : Chocolate technology, meat technology, microbiological stabilization of foodstuffs; sterilisation of packagings; quality assurance research; analytical methods for quality assurance; analysis of the functional properties of packagings
③ Process Engineering : Seed preparation and refining processes; processes for modifying starch and protein; development of applications (food, non-food); methods for penetrative heating; selective extraction of plastics; treatment of wastes (especially industrial sludges); biodegradability
④ Materials development : Development of packagings and functional materials; film extrusion; extrusion coating; injection moulding; deep-drawing; coating technologies; high-barrier films; coating/laminating; funcionality testing/testing packagings
⑤ Systems analysis : Environmental evaluation and calculation of system costs for products (e.g. packagings, foodstuffs, electronic products); for operating units; for social-economic areas (e.g. waste economy, energy economy); method and process simulation; construction of operational environmental management systems; development of software tools; construction of user-specific material and process databases

(44) Mechanics of Materials(IWM)

① New Applications of Materials : Properties for service of technical ceramics, composites, polymers, steel and light weight alloys, materials testing and qualification, welded joints
② Safety and Availability of Components : Reactor safety, car safety, light weight structures, implants and biotechnology, material models and component simulation, life time prediction, component tests, failure analysis, defect assessment

③ Diagnostics and Assessment of Micro Systems : Design of micro systems, micro testing, microstructure analyses, assessment of technological steps of microelectronic components, in-situ test techniques, nano-engineering

④ Precision-machining, -shaping : Defect free machining of brittle materials, thermal cutting of glass, hot molding of optical components, numerical simulation of pressing and sintering of hard metals, sinter metals and ceramics

⑤ Coatings, Surface Properties : Wear and corrosion resistant coatings, submicron surfaces, assessment of surface properties, processes for surface treatment, x-ray phase-, stress- and texture-analysis, wear protection, tribology

(45) Material and Beam Technology(IWS)

① High Rate Coating : Technology and system development to deposition of thin films; coating and modification of surfaces by laser beam, arc, or chemically reactive techniques and combinations thereof; in-situ diagnostic of CVD and PVD processes; mechanical and spectroscopic surface characterization

② Material Technology : Materials-oriented development and optimization of laser tooling techniques and inductive surface heating as well as their combination (laser beam hardening, remelting, build-up welding, crack-free welding of hardenable steels with integrated inductive heating), technological optimization of laser beam tooling plants, physical and mathematical modeling of short-time heat treatment processes for feasibility studies and optimization, structural characterization by metallography and electron microscopy, characterization of materials and parts subjected to beam technology by wear and fatigue tests, characterization of thermal shock strength and thermal fatigue strength by laser, failure analysis

③ Laser Material Processing : Laser beam welding and cutting, surface heat treatment of parts, 3D-tooling with shape sensing, system development, in particular : high speed beam guiding, variable beam shaping, weld seam sensing, laser beam surface refinement with additives, development of material systems and technologies for cladding, hard metal fusion, and sub-surface alloying, development of welding fluxes (powder, tapes, pastes) based on metals, hard metals, ceramics, rapid prototyping by laser beam sintering of metal powder and laser beam build-up welding, removal of thin surface layers (technical and restoratory cleaning), precision tooling, (micro-)structuring, engraving, labelling, education and process training, development of multi-media teaching environments for laser technology

(46) Machine Tools and Forming Technology(IWU)

① Metal Forming Technologies : Process development, stage planning, tool design and manufacturing; technological trends; structurally optimized lightweight construction; sheet forming : deep drawing, stretch drawing, collar forming, bending masive forming (hot, warm, cold) : closed-die forging, wedge rolling, orbital forging, rolling of tapered sections, extrusion; extrusion forming, tube hydroforming, bending cutting : sheet, massive, extrusion; FEM-Simulation (elastic-plastic, thermal-mechanically coupled) : forming process, tool loading, part behaviour; materials technology, material properties; metallography, material testing, analysis of damage

② Metal Forming Systems : Structure development; static, dynamic, thermal analysis; multi object and FEM simulation; tube hydroforming; assebly development; mechanical and hydraulic drives; numerical characteristic; Metal forming processes (technological planning); machine linkage; manufacturing systems; plant layout; handling technology; motion simulation; workpiece and tool handling; tool wear evaluation

③ Machine and Process Information Technology : Control technology and regulation technology for machine tools; modal-supported process and machine guidance; fuzzy-classification for process control and quality assurance; control of parallel structures; automation technology; mechatronical applications in control technology; teleservice; integrated control applications

④ Tool Machines for Tool and Form Manufacturing : Subassembly development; tool machine structures; electrical drives; machine measuring technology; thermally compatible design; production measuring technology; sensor technology

⑤ Tool and Form Manufacturing Technologies : Process development in metal cutting processes : hard material machining, drying processes; laser applications; shaping production processes, laser measuring technology (geometric values, mechanical stress); digital image processing; production organization; management and quality organization, planning and control

⑥ Micro Fabrication : Microforming technology; process development; tool layout; equipment technology; tool manufacturng; tool concept; micro fabrication equipments; system desing; component dvelopment; application of microsystems in machine construction; micro measruement technology : optical measurement processes for 3D geometry determination, forming in micro areeas, mechanical loading; material properties

(47) Non-Destructive Testing(IZFP)

① Applications Center : Quality assured performance of measurement and testing by certified inspection personnel in an accredited testing laboratory and in-situ. Validation of innovative techniques in application and user-specific reliability tests. Sensor development and fabrication, manipulators and robots for automated testing

② Quality Management and Organization : Development of a quality methodology for the organization of non-destructive testing and its integration in quality managing systems, rules for organization, quality manuals, project management

③ Inspection Equipment and Systems : Development of inspection equipment and systems (hard- and software) for industrial applications; construction of prototypes, small series production; design and manufacturing of electronic boards

④ Strategic Tasks : Validation and implementation of the process models to integrate non-destructive testing into the production process and the existing quality systems. Using the experience gained for the amelioration of the models.

⑤ Process and Plant Integration : Development and application of automated non-destructive testing for detection and quantification of macroscopic material defects and for plant lifetime monitoring, i. e., the detection of critical service states, as well as integration into production processes

⑥ Materials : Development of techniques for the measurement of intrinsic material properties based on ultrasonics, electromagnetics (eddy current, dielectric, microwaves, nuclear magnetic resonance), magnetics and thermal interactions

⑦ Basics : Experimental and theoretical investigations based on materials physics; prediction of interelationships between physical and material properties or defects; development of basics to new non-destructive testing

⑧ Strategic Tasks : Understanding and development of process models by interdisciplinary cooperation in order to integrate non-destructive testing in on-line closed loop measuring, monitoring and controlling systems

⑨ Branch Lab Acoustical Diagnosis and Quality Assurance : Passive and active ultrasonics, sound propagation mechanisms, sound-source-identification, stress measurements by neutron diffraction, microstructure characterization by small angle neutron scattering, radio tracer technique

⑩ X-Ray Technology X-ray technique; x-ray image processing; radiography with micro- and nanofocus X-ray tubes; 2D- and 3D- automatic X-ray inspection system for printed circuit boards; high speed X-ray line scan camera; film digitalisation; 2D- and 3D-Computed Tomography; Compton Back Scattering; Computed Laminography

(48) Reliability and Microintegration(IZM)

① Mechanical reliability in micro technology : Mechanical/thermal simulation; X-ray measurement technology; laser measurement technology; fracture electronics; micro-production technologies; micro-packaging strategies

② Multi-chip modules : Basic design of multi-chip modules; electrical simulation and thermal analysis; multi-chip module technologies (MCM-D); 3-D integration technologies; thin film technologies, CSP at water level; water bumping

③ Chip connection technology : Flip chip technology; chip on flex and TAB, chip on glass; chip and wire bonds; plastic packaging; assembly of opto-electronics components; CSP at chip leel; mechatronic

④ Reliability of electronic component assemblies and connection technology : Layer deposition; bonding technologies; Qualification and Test Center for Electronic Assemblies; joining technologies for electrical applications; joining technologies for optical applications

⑤ Environmental Engineering : Analysis and assessment; environmentally compatible product design; ecological and commercial aspects of processes; product and material recycling; Demonstration Center Closed Loops for Products

⑥ Polymeric Materials and Composites : Synthesis and processing, chemical and physiochemical characterization, thermophysical and mechanical characterization, composite technology

주 의

1. 이 보고서는 과학기술부에서 시행한 정책연구사업의 연구보고서 입니다.
2. 이 보고서 내용을 발표할 때에는 반드시 과학기술부에서 시행한 정책연구사업의 연구결과임을 밝혀야 합니다.
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