NATIONAL SCIENCE FOUNDATION CENTERS

NSF supports a variety of centers programs that contribute to the Foundation's mission and vision. Centers exploit opportunities in science, engineering, and technology in which the complexity of the research problem or the resources needed to solve the problem require the advantages of scope, scale, duration, equipment, facilities, and students. Centers are the principal means by which NSF fosters interdisciplinary research.

NSF Centers Funding

(Dollars in Millions)

	Program Initiation	FY 2006 Number of Centers	FY 2006 Actual	FY 2007 Request	FY 2008 Request	Change over FY 2007 Amount	Change over FY 2007 Percent
Centers for Analysis & Synthesis	1995	2	$6.40	$6.46	$11.46	$5.00	77.4%
Chemical Bonding Centers	1998	6	1.50	3.00	9.00	6.00	200.0%
Earthquake Engineering Research Centers	1988	3	6.00	-	-	-	N/A
Engineering Research Centers	1985	19	60.18	62.79	52.86	-9.93	-15.8%
Materials Research Science & Engineering Centers	1994	29	53.50	55.70	59.20	3.50	6.3%
Nanoscale Science & Engineering Centers	2001	16	40.04	37.35	42.35	5.00	13.4%
Science & Technology Centers	1987	17	62.58	67.48	66.20	-1.28	-1.9%
Science of Learning Centers	2003	6	20.66	27.00	27.00	-	-
		98	$250.86	$259.78	$268.07	$8.29	3.2%

Totals may not add due to rounding.

CENTERS DESCRIPTIONS

Centers for Analysis and Synthesis (BIO)

The Centers for Analysis and Synthesis are designed to continue development of new tools and standards for management of biological information and meta-information, support data analysis capabilities with broad utility across the biological sciences, host workshops bringing together scientists from a variety of disciplines, and begin to host and curate databases. The centers have a critical role in organizing and synthesizing biological knowledge that is useful to researchers, policy makers, government agencies, educators, and society.

The National Center for Ecological Analysis and Synthesis (NCEAS) at the University of California at Santa Barbara promotes integrative studies of complex ecological questions and serves as a locus for the synthesis of large data sets.

The National Evolutionary Synthesis Center (NESCent) is a collaborative effort by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill to foster a greater conceptual synthesis in biological evolution by bringing together researchers and educators, extant data, and information technology resources.

A Plant Science Cyberinfrastructure Collaborative will be established in FY 2008 to create intellectual synergy among biologists, computer and information scientists, mathematicians, engineers, and others to drive discovery and enable new conceptual advances through integrative, computational approaches.

Chemical Bonding Centers (MPS)
The Chemical Bonding Centers (CBCs) are designed to support major, long-term "big questions" in basic chemical research. Problems to be addressed are high-risk but with potentially high scientific and societal impact. CBCs are expected to be agile, responding to scientific opportunities as they arise, and to take advantage of cyberinfrastructure. These centers provide diverse ways for groups of researchers in the chemical sciences to work collaboratively on challenging problems of fundamental and strategic importance. These problems include the activation of strong bonds as a means to decrease energy requirements in chemical processing, the design of self-replicating biological molecules with the capability of evolving enhanced function, and the rational synthesis of "smart materials." Selected centers are fabricating molecular machines that are powered by chemical bond formation, investigating the efficient storage of solar energy in synthetic molecules, and probing the inner workings of molecular events with unprecedented spatial and temporal resolution.

The CBC program is being built year-by-year, with an incremental approach to support for outstanding proposals. Phase I awards support preliminary proposals. Phase II awards fund full-scale center implementation. In FY 2008, phase I awardees from FY 2005 are expected to compete for phase II funding. In addition, a new phase I competition is being held in FY 2007.

Earthquake Engineering Research Centers (ENG)
Earthquake Engineering Research Centers focus on reducing earthquake losses, integrating research and education, and developing partnerships with industry and public agencies responsible for earthquake hazard mitigation. Funding for these centers concluded as planned in FY 2006.

Engineering Research Centers (ENG)
NSF's Engineering Research Centers (ERCs) are proven cauldrons of innovation, bridging the energy and intellectual curiosity of universities with the real-world applications of industry-focused research. These centers also are uniquely successful in educating a technology-enabled workforce with hands-on, real-world experience. These characteristics create an environment that catalyzes the development of marketable technologies to generate wealth and address engineering grand challenges, many of which intersect with the Administration's American Competitiveness Initiative. This is particularly evident in ERCs that address hydrogen as an alternative fuel, biomedical healthcare innovations, and multimedia information systems.

ERCs succeed in these areas because they provide the intellectual foundation for industry collaboration with faculty and students to resolve long-range challenges, continue the steady advances in technology, speed their transition to the marketplace, and train graduates who are effective in applying them in industry. ERCs are also devoted to the integration of research and education by creating collaborative environments for learning and research, and producing curricula and course materials for bioengineering, manufacturing, electronic packaging, and particle science and technology, among others. In addition, all ERCs have active programs to stimulate interest in engineering among pre-college students and their teachers; several have sites at local museums to educate the general public about engineering and technology.

Materials Research Science and Engineering Centers (MPS)
Materials Research Science and Engineering Centers (MRSECs) support interdisciplinary materials research addressing fundamental problems of intellectual and strategic importance that are critical for American competitiveness and the development of future technologies. The MRSECs also support shared experimental facilities, place strong emphasis on the integration of research and education at all levels, and provide seed support to stimulate emerging areas of materials research. The MRSECs feature

cutting-edge materials research in areas such as polymers, biomimetic, and biomolecular materials, magnetic and ferroelectric materials, nanoscale materials, electronic and photonic materials, structural materials, and organic systems and colloids. The MRSECs have strong links to industry and other sectors, enabling the development of marketable technologies that depend on new classes of materials and the discovery, control, and innovative exploitation of materials phenomena. Areas of potential technological impact include computers and communications, transportation, energy storage, structural engineering, health, and medicine. MRSECs also foster research and educational partnerships among academic institutions in the U.S. as well as international partnerships.

Open competitions for NSF support are held triennially. The 2005 MRSEC competition yielded two new centers devoted to biotechnology and interfaces in semiconductor materials, respectively. The phase out that began in FY 2006 of three centers will be completed in FY 2007.

Nanoscale Science and Engineering Centers (multi-directorate)
Nanotechnology, which addresses technology on the smallest of scales, is projected to be one of the largest drivers of technological innovation for at least the next decade and beyond. This potential was recognized in the National Nanotechnology Initiative and more recently in the American Competitiveness Initiative, particularly in the burgeoning area of nanomanufacturing. Research at the nanoscale through NSF-funded Nanoscale Science and Engineering Centers aims to advance the development of the ultra-small technology that will transform electronics, materials, medicine, environmental science and many other fields. Each center has a long-term vision for research. Together they provide coherence and a long-term outlook to U.S. nanotechnology research and education. Support will be provided for education and outreach programs from K-12 to the graduate level, designed to develop a highly skilled workforce, advance pre-college training, and further public understanding of nanoscale science and engineering. The centers have strong partnerships with industry, national laboratories, and international centers of excellence, which puts in place the necessary elements to bring discoveries in the laboratory to real-world, marketable innovations and technologies. There are 16 NSECs, including one Network on Nanotechnology in Society. Four NSECs on nanomanufacturing will establish the National Nanomanufacturing Network in FY 2007.

Science and Technology Centers (multi-directorate)
The Science and Technology Centers (STCs) program advances discovery and innovation in science and engineering through the integration of cutting-edge research, excellence in education, targeted knowledge transfer, and the development of a diverse workforce while broadly advancing the goals and objectives of the American Competitiveness Initiative (ACI). The STC research portfolio is very broad. Examples of continuing investment include areas of cyber-security, advanced sensors and embedded networked sensing, revolutionary materials for information technology, advanced nano/microfabrication capabilities, new materials and technologies for monitoring water resources and water quality, medical devices, and, modeling and simulation of complex earth environments for improving their sustainability and weather/climate prediction. STCs engage the Nation's intellectual talent, robustly drawn from its full human diversity through partnerships between academia, industry, national laboratories, and government. These partnerships ensure timely transfer of knowledge and technology from the laboratory to appropriate industries, the application of patents derived from the work of the STCs, the launching of spin-off companies, and creation of job opportunities. In addition, STCs have impressive records of research training of undergraduate students, graduate students, postdoctoral fellows, established researchers, and educators as well as contributions to K-12 education, industry, and other sectors.

Science of Learning Centers (multi-directorate)
In FY 2008, NSF will support the fourth of five initial years of funding for three Centers awarded in the program's first competition, and will continue supporting three centers initiated in FY 2006 after a second competition. The young portfolio of SLCs represents synergistic, exciting research efforts that address important questions central to our understanding of learning and its societal implications. Topics include: Influence of interplay between informal and formal environments on learning processes; combination of modeling and experimental studies of brain and behavior toward understanding of real-time autonomous learning; use of learning technologies to study robust learning in classrooms; the processes involved in learning visual languages, and their applications for language processing; the influence of timing and temporal dynamics on learning; and processes underlying spatial intelligence and learning.

Continuing in FY 2008, NSF will focus on the growth and development of individual centers (and potential merit-based renewal of the first cohort of centers) and the development of infrastructure and support to coordinate activities among SLCs and other NSF centers. These will include capacity building for research communities involved in science of learning through new partnerships and collaborations that benefit, and can benefit, from SLCs. Such opportunities, open to researchers both in- and outside centers (including international partnerships), augment program strategies aimed at engaging outside researchers in SLC efforts and more fully leverage investments already made in SLCs as national resources available to other researchers. In addition, activities at the SLCs stimulate and involve participation of underrepresented minorities in research at the frontiers of science, and facilitate knowledge transfer and dissemination to the research communities, industry, and the general public.

FY 2006 Estimates for Centers Participation
(Dollars in Millions)

	Number of Participating Institutions	Number of Partners	Total FY 2006 NSF Support	Total Leveraged Support	Number of Participants
Centers for Analysis & Synthesis	4	20	$6	$2	736
Chemical Bonding Centers	60	13	$2	$3	358
Earthquake Engineering Research Centers	49	74	$6	$13	1,004
Engineering Research Centers	228	425	$60	$89	10,803
Materials Research Science & Engineering Centers	108	335	$54	$44	5,323
Nanoscale Science & Engineering Centers	137	274	$40	$17	7,170
Science & Technology Centers	173	313	$63	$33	2,522
Science of Learning Centers	20	11	$21	$8	366

No. of Participating Institutions: all acadmeic institutions that participate in activities at the centers.

No. of Partners: the total nubmer of non-academic participants, including industry, states, and other fed agencies at the centers.

Total Leveraged Support: funding for centers from sources other than NSF.

No. of Participants: the total number of people who use center facilities, not just persons directly support by NSF.

Centers Supported by NSF in FY 2006

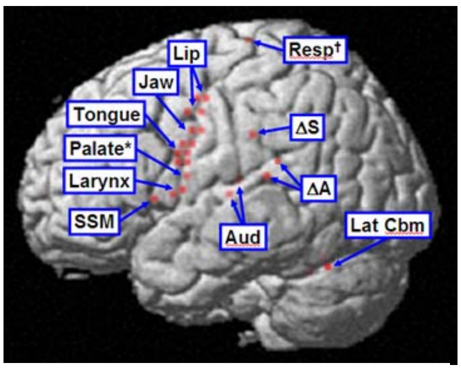
Center	Institution	State
Centers for Analysis and Synthesis		
National Center for Ecological Analysis and Synthesis (NCEAS)	U of California-Santa Barbara	CA
National Evolutionary Synthesis Center (NESCent)	Duke, NC State, U of N. Carolina	NC
Chemical Bonding Centers		
Activation and Transformation of Strong Bonds	U of Washington	WA
Center for Molecular Cybernetics	Columbia	NY
Chemical Design of Materials	U of California-Santa Barbara	CA
Chemistry at the Space-Time Limit: Time Resolved Nonlinear Spectroscopy of Elementary Chemical Events	U of California-Irvine	CA
Darwinian Chemical Systems	Mass. General Hospital	MA
Powering the Planet: A Chemical Bonding Center for the Direct Conversion of Sunlight into Chemical Fuel	California Institute of Technology	CA
Earthquake Engineering Research Centers		
Mid-America Earthquake Center	U of Illinois-Champaign-Urbana	IL
Multidisciplinary Center for Earthquake Engineering Research	State U of NY-Buffalo	NY
Pacific Earthquake Engineering Research Center	U of California-Berkeley	CA
Engineering Research Centers		
Advanced Engineering Fibers and Films	Clemson	SC
Bioengineering Educational Technology	Vanderbilt	TN
Biomimetic Microelectronic Systems	U of Southern California	CA
Collaborative Adaptive Sensing of the Atmosphere	U of Mass-Amherst	MA
Compact and Efficient Fluid Power	U of Minnesota	MN
Computer-Integrated Surgical Systems and Technologies	Johns Hopkins	MD
Engineered Biomaterials	U of Washington	WA
Engineering of Living Tissue	Georgia Institute of Technology	GA
Environmentally Beneficial Catalysis	U of Kansas	KS
Extreme Ultraviolet Science and Technology	Colorado State	CO
Integrated Media Systems	U of Southern California	CA
Mid-IR Tech for Health and the Environment	Princeton	NJ
Power Electronic Systems	Virginia Tech	VA
Quality of Life Technology	Carnegie Mellon/U of Pittsburg	PA
Reconfigurable Machining Systems	U of Michigan	MI
Structured Organic Composites	Rutgers	NJ
Subsurface Sensing and Imaging Systems	Northeastern	MA
Synthetic Biology	U of California-Berkeley	VA
Wireless Integrated MicroSystems	U of Michigan	MI
Materials Research Science and Engineering Centers		
Center for Complex Materials	Princeton	NJ
Center for Materials for Information Science	U of Alabama	AL
Center for Materials Research	Cornell	NY
Center for Materials Science and Engineering	Mass Institute of Technology	MA
Center for Micro- and Nanomechanics of Materials	Brown	RI
Center for Multifunctional Nanoscale Materials Structures	Northwestern	IL
Center for Nanomagnetic Structures	U of Nebraska	NE
Center for Nanoscale Science	Pennsylvania State	PA
Center for Nanoscopic Materials Design	U of Virginia	VA
Center for Nanostructured Interfaces	U of Wisconsin	WI
Center for Nanostructured Materials	Columbia	NY
Center for Polymer Science and Engineering	U of Massachusetts	MA
Center for Polymer Interfaces and Macromolecular Assemblies	Stanford, UC-Davis, IBM	CA

Center for Polymers at Engineered Interfaces	SUNY-Stony Brook, CUNY, Polytech	NY
Center for Research on Interface Structures and Phenomena	Yale	CT
Center for Response-Driven Polymeric Films	U of Southern Mississippi	MS
Center for Science and Engineering of Materials	California Institute of Tech	CA
Center for Semiconductor Physics in Nanostructures	U of Oklahoma, U of Arkansas	OK, AR
Center for Thermal Spray Research	SUNY-Stony Brook	NY
Ferroelectric Liquid Crystals Materials Research Center	U of Colorado-Boulder	CO
Genetically Engineered Materials Science and Engineering Center	U of Washington	WA
Laboratory for Research on the Structure of Matter	U of Pennsylvania	PA
Materials Research Center	U of Chicago	IL
Materials Research Center	Harvard	MA
Materials Research Science and Engineering Center	U of California-Santa Barbara	CA
Materials Research Science and Engineering Center	U of Maryland	MD
Materials Research Science and Engineering Center	U of Minnesota	MN
Materials Research Science and Engineering Center	Carnegie Mellon	PA
Materials Research Science and Engineering Center	Johns Hopkins	MD
Nanoscale Science and Engineering Centers		
Affordable Nanoengineering of Polymer Biomedical Devices	Ohio State	OH
Center for Integrated and Scalable Nanomanufacturing	U of California-Los Angeles	CA
Directed Assembly of Nanostructures	Rensselaer Polytechnic Institute	NY
Electronic Transport in Molecular Nanostructures	Columbia	NY
High Rate Nanomanufacturing	Northeastern, U of New Hampshire, U of Mass-Lowell	MA
Integrated Nanomechanical Systems	U of Calif-Berkeley, Cal Tech, Stanford, U of California-Merced	CA
Integrated Nanopatterning and Detection Technologies	Northwestern	IL
Molecular Function at the Nano/Bio Interface	U of Pennsylvania	PA
Nanoscale Systems in Information Technologies	Cornell	NY
Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems	U of Illinois-Champaign-Urbana	IL
Nanoscience in Biological and Environmental Engineering	Rice	TX
Probing the Nanoscale	Stanford, IBM	CA
Science of Nanoscale Systems and their Device Applications	Harvard	MA
Templated Synthesis and Assembly at the Nanoscale	U of Wisconsin-Madison	WI
Nanotechnology in Society Network	Ariz St, U of California-Berkeley, U of Southern Calif, Harvard	AZ, CA, MA
Network for Hierarchical Nanomanufacturing	U of Massachusetts-Amherst	MA
Science and Technology Centers		
Adaptive Optics	U of California-Santa Cruz	CA
Advanced Materials for Water Purification	U of Illinois	IL
Behavioral Neuroscience	Georgia State	GA
Biophotonics Science and Technology	U of California-Davis	CA
Coastal Margin Observation and Prediction	Oregon Health and Science U	OR
Earth Surface Dynamics	U of Minnesota	MN
Embedded Networked Sensing	U of California-Los Angeles	CA
Environmentally Responsible Solvents and Processes	U of North Carolina	NC
Integrated Space Weather Modeling	Boston U	MA
Layered Polymeric Systems	Case Western Reserve U	OH
Materials and Devices for Information Technology Research	U of Washington	WA
Microbial Oceanography: Research and Education	U of Hawaii	HI
Multi-Scale Modeling of Atmospheric Processes	Colorado State U	CO
Nanobiotechnology	Cornell	NY
Remote Sensing of Ice Sheets	U of Kansas	KS

Sustainability of Semi-Arid Hydrology and Riparian Areas	U of Arizona	AZ
Ubiquitous Secure Technology	U of California-Berkeley	CA
Science of Learning Centers		
CELEST - A Center for Learning in Education, Science, & Tech.	Boston U	MA
The LIFE Center - Learning in Formal and Informal Environments	U of Washington	WA
Pittsburgh Science of Learning Center - Studying Robust Learning with Learning Experiments in Real Classrooms	Carnegie Mellon	PA
VL2: Visual Language and Visual Learning	Gallaudet	DC
SILC: Spatial Intelligence and Learning Center	Temple	PA
The Temporal Dynamics of Learning	U of California-San Diego	CA

Recent Research Highlights

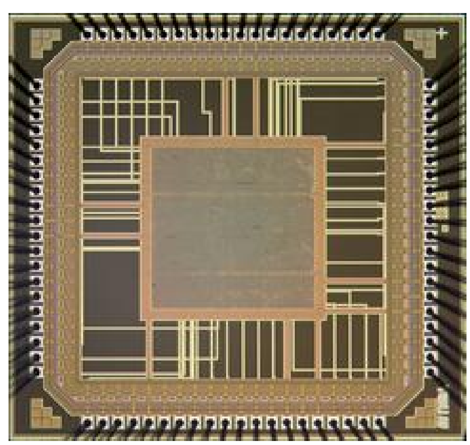
► **Babbling Computer May Help Teach Kids To Speak:** Scientists at the Center of Excellence for Learning in Education, Science, and Technology, an NSF-funded Science of Learning Center hosted by Boston University, are developing a computer model of speech production. The model identifies computations performed by the brain to produce tongue movements that make speech sounds. Like an infant, the model uses a babbling phase to learn how to speak. After babbling, the model learns to produce new speech sounds it "hears" from a human speaker, much as an infant learns to produce new words by imitating parents. The components of the model correspond to precisely defined regions of the brain. By illuminating the neural computations responsible for speech, as well as the ways in they malfunction, the model can help guide the design of therapies for individuals with speech disorders such as stuttering. The model's focus on speech learning also provides insights into the best ways to teach speech to children and learners of a second language. (SBE/SLC).



The locations of the model's components on the left hemisphere of the cerebral cortex and cerebellum. *Credit: Frank Guenther, Boston University.*

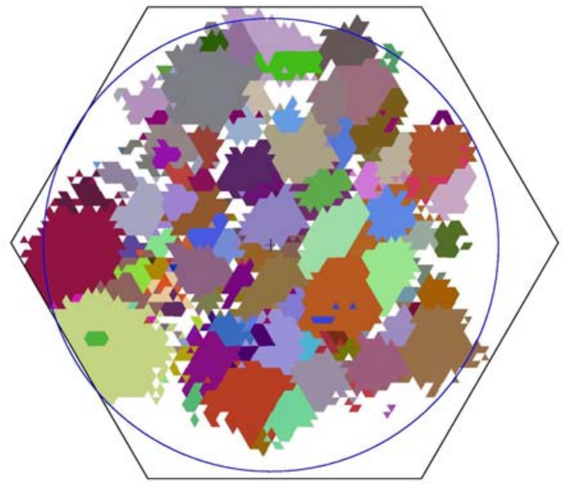
► **A Powerful Platform for Implantable Prosthetic Devices:** Work by researchers at the Engineering Research Center for Biomimetic MicroElectronic systems may enable a broad range of implantable prosthetic devices. The center, headquartered at the University of Southern California, is developing new platforms for devices that restore vision, revive paralyzed limbs, and overcome some kinds of cognitive impairments. The new implantable devices would integrate seamlessly with the human body – replacing missing or damaged neuronal function. The enabling technologies range from wireless power and data systems to hermetically sealed packaging and low-power, bio-based, integrated circuits.

The center has developed a state-of-the art, mixed-signal, very large scale integration (VLSI) chip. The chip has more than 100,000 transistors and combines both digital and analog circuits to mimic biological function. The highly flexible platform is ideal for new implantable prosthetic devices that could revolutionize treatment for many serious disabilities. (ENG/ERC).


A novel mixed-signal system on a chip, which is a platform for implantable prosthetic devices. *Credit: Center for Biomimetic MicroElectronic Systems.*

► **X-Ray Vision for Materials:** Researchers at Carnegie Mellon University, together with scientists at the Advanced Photon Source, have developed a non-destructive method to visualize the arrangement and orientation of individual crystals within a solid material. High energy X-rays from a synchrotron light source penetrate the material and interact with the crystals in their path. The pattern of transmitted X-rays that emerges from the material is then analyzed by custom software to determine the internal structure of the material.

Because the complete X-ray/crystal interaction is modeled, this technique yields far more data than is contained in conventional radiograms. This new tool allows scientists to see within opaque materials with unprecedented detail and, therefore, allows the visualization of a wide range of previously hidden processes, such as crack formation in structural materials. (MPS/MRSEC).

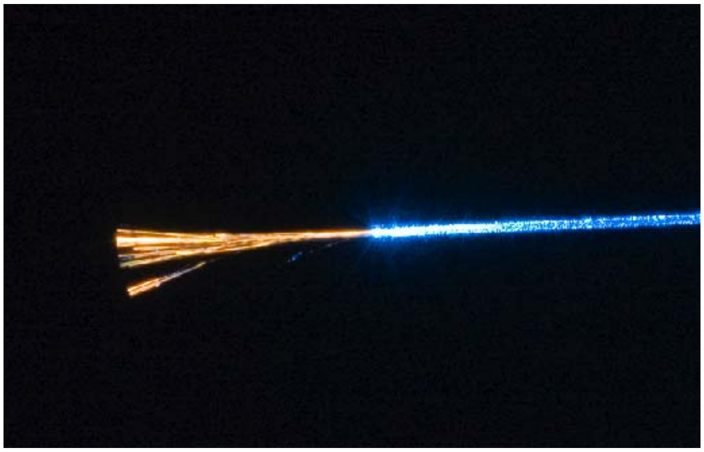


A two-dimensional slice of the microstructure inside of an aluminum wire, 1 mm in diameter (the blue circle). Each color corresponds to a different crystal orientation. *Credit: R.M. Suter, MRSEC, Carnegie Mellon University.*

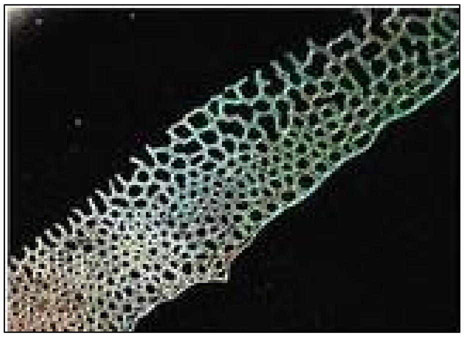
► **New Process Builds Electronics Into Optical Fiber:** Scientists from Pennsylvania State University and the University of Southampton in the United Kingdom have demonstrated a new way to combine microelectronics and optical fibers – a development that opens up potential applications in fields as diverse as medicine, computing, and remote sensing.

The researchers have discovered how to fashion a thin, flexible tube of ultra-clear glass – an optical fiber – that has a hollow core packed with microscopic wires made of a semiconductor such as germanium. The scientists then created solid-state electronic devices, including a transistor, inside the semiconductors.

"This advance is the basis for a technology that could build a large range of devices inside an optical fiber," says Penn State chemist John Badding, one of the lead authors of the report. (MPS/MRSEC).



A wire-packed glass fiber. Each of the semiconductor wires is just two micrometers in diameter – 1/20th the width of a human hair. *Credit: Neil Baril, Penn State University.*

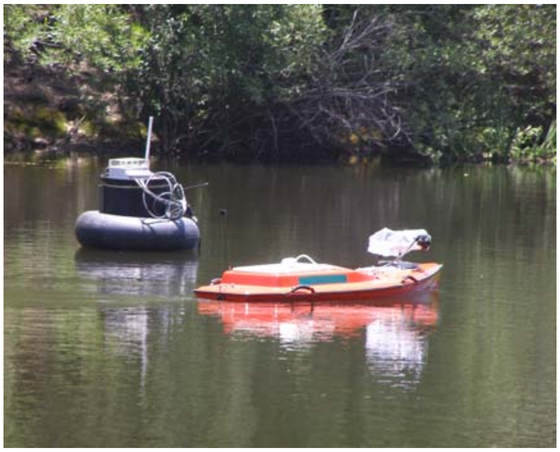


Not a snakeskin, but a magnified image of a dried polymer "ring" taken with an optical microscope. *Credit: University of Massachusetts-Amherst.*

► **VISUAL: Bridging Art and Science:** When a drop of coffee dries it leaves a ring, which contains material that was dissolved in the water. The same thing happens with a polymer that is dissolved in a solvent. Shown here is an optical microscope image of a "ring" of the dried-out polymer. The colors and shapes provide clues that help scientists understand and control the drying process. Beautiful images like this are at the core of VISUAL (*Ventures In Science Using Art Laboratory*) which is serving as a catalyst to convey science through art to the public and K-12 students. Through the University of Massachusetts Materials Research Science and Engineering Center and Vice-Provost's office, VISUAL sponsored two symposia focusing on the bridge between art and science, which serves as the centerpiece for two simultaneous art exhibitions at the Fine Arts Center on the Amherst campus and a new course on science in the arts, designed specifically for this event. With VISUAL in the lead, a reintegration of art and science is beginning that will serve as a unique educational venue for the public and students of all ages. (MPS/MRSEC).

► **Rapidly Deployable Robotic Aquatic Observing System:** A group of NSF-supported researchers have developed a technology for rapidly deploying a sensor system to monitor small water bodies such as lakes and streams. They have recently demonstrated this technology to study the formation and growth of cyanobacterial scum in a shallow lake in Southern California over a series of week-long deployments.

The technology has three physical constituents connected using a wireless network. A collection of buoys are deployed to continually monitor temperature and chlorophyll at fixed locations. A robotic shuttle supported on a cable strung across the lake is used to produce dense scans of water parameters in a vertical transect. A robotic boat is used to 'fill in' the sensing gaps across the water surface. The system functions in coordination because the statistical sampling algorithms that control the movement of the boat and the shuttle use data collected by the buoys to predict the most advantageous motion patterns for the mobile entities. (CISE/STC).



Robotic Aquatic Observing System. *Credit: Center for Embedded Networked Sensing (CENS).*