Brite-Euram Programme Approves 218 Materials Projects

The European Commission (EC) received about 1,180 submissions involving 8,800 participants in response to its recent call for proposals within the Brite-Euram Programme, which funds research in industrial and materials technologies throughout Europe. The proposals requested a total of 2.5 billion ECUs (approximately 3 billion U.S. dollars), almost eight times higher than the amount of funding available (400 million ECUs). Consequently, only 218 projects (just under 19%) were approved to receive financial support. The projects to be funded were in areas including production technologies, materials and technologies for product innovation, aeronautics technologies, and general technologies for surface transport means.

An estimated 7,200 research groups were involved in the 962 unsuccessful applications. For the first time, the EC commented on the evaluation process in a recently produced report. As might be expected, many proposals have been rejected because of low innovative content, no clear demonstration of benefits, or economic arguments that lacked credibility. However, some proposals were rejected because they contained disjointed workplans, overestimations of costs, lack of definition of objectives, or little conformity with the targeted actions described in the work program.

The United Kingdom presents several special workshops throughout Europe on "How to Satisfy the Commission Criteria and Prepare a Winning Proposal." The Institute of European Trade and Technology (IETT) in collaboration with the U.K. Department of Trade and Industry (DTI) organized one such meeting for February in London. For contact information about the workshops, call Mary Marshall at 44-171-628-9770.

CORDIS and ARCADE Databases Available for European Research Groups

The European Commission (EC) is now operating two databases which can be used by European Research Groups to find partners for research projects to be funded by the EC. The databases, CORDIS and ARCADE, are freely available throughout the member states for on-line access.

CORDIS contains details of existing and completed projects and programs, publications, and contacts. Organizations in a particular area of interest can be traced, even if they have not registered, if they have been active in previous programs or have published in the area. CORDIS is available through the internet (Telnet echo.lu) and the Worldwide Web (http://www.cordis.lu/) when using browser software. It can also be purchased as a series of CD-ROMs, issued quarterly, for about 300 ECUs ($250 U.S. dollars), by phoning 352-34498-1240 or e-mailing helpdesk@cordis.lu.

ARCADE is operated through directorate DG-XII, who coordinate the Industrial and Materials Technologies (IMT) Programmes. ARCADE is still undergoing development, having been conceived as a two-way communication system, although the search facilities are well-established. Expressions of interest can be sent on-line or by fax on special forms available by phoning 32-2-295-0745. This system is more geared toward potential participants in new programs than is CORDIS, which is primarily concerned with project results.

SiO_2/Si Superlattices Photoluminesce Due to Quantum Confinement

Scientists at the National Research Council in Ottawa, Canada fabricated tiny stacks of alternating Si and SiO_2 films that emit visible light through photoluminescence. The researchers were able to change the wavelength of the light by varying the thickness of the Si layers. Z.H. Lu, D.J. Lockwood, and J.-M. Baribeau reported their findings in the November 16, 1995 issue of *Nature*.

The researchers grew the SiO_2/Si superlattices at room temperature on phosphorus-doped n-type (100) Si wafers by molecular beam epitaxy (MBE). They deposited Si films of various thicknesses on the wafer surface. They then grew a SiO_2 film ~1 nm thick *ex situ* by a rate-limited uv/ozone oxidation process, repeating the entire procedure to make a six-period SiO_2/Si superlattice.

Knowing that changes in the electronic energy bandgap can occur at both the conduction band minimum (CBM) and valence band maximum (VBM), the researchers used soft x-ray Si $L_{2,3}$ edge absorption spectroscopy to probe the shift in the CBM. They discovered that the $L_{2,3}$ absorption edge increases in energy with decreasing Si film thickness, caused by the shift in the CBM.

When measuring the room-temperature photoluminscence (PL) properties of the superlattices, the researchers found a PL peak at wavelengths across the visible range from superlattices with Si film thicknesses ≤ 3 nm. The researchers concluded that "quantum confinement governs the Si energy band structure and is the fundamental source of the bright Si luminescence." By varying the Si film thickness, scientists can control the wavelength of the emitted light. They could not detect PL signals from superlattices with Si film thickness >3 nm. The researchers attributed this phenonmenon to a dramatic reduction in the quantum confinement effects.

Two Intersecting Laser Beams Generate 3D Movable Structures

O. Lehmann and M. Stuke from Max-Planck-Institut für Biophysikalische Chemie have used laser-assisted chemical vapor deposition to create complex movable structures. The structures are driven by thermal-expansion forces that are caused by selective laser beam heating. The researchers fabricated three-dimensional microstructures consisting of aluminum oxide and aluminum by laser-induced direct-write deposition from the gas phase. The one-step nature of this process enables rapid prototyping of micromechanical devices. The researchers said that the absorption wavelength of laser light is large in weakly absorbing materials such as alumina, resulting in uniform temperature distribution that leads to nondirectional material deposition from the gas phase around the laser spot. At the intersection of laser spots, the absorbed energy leads to a rise in temperature, causing deposition from the gas phase. "If the sample is moved slowly in any direction with a speed comparable to the growth rate of alumina, a structure with a complex shape can be directly written into free space," said the researchers in the December 8, 1995 issue of *Science*.

The researchers built 3D structures on substrates mounted inside a reaction chamber. They varied the laser power between 0.2 and 20 mW. They pumped an aluminum precursor trimethylamine alane through the chamber, which they maintained at a total pressure of ~1.6 mbar. Rods designed to expand and apply force on other structure parts were coated with aluminum to assist in uniform temperature distribution. According to the researchers, "When two parallel vertical aluminum-coated rods connected at the top are alternately laser-heated, the thermal strain leads to disconnection of the rod bases from the substrate," enabling the manufacture of freely movable structure parts.

The researchers used their laser-driven process to build a set of microtweezers and a micromotor with a maximum travel of 100 μm.

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Nanochannel Glass Replica Membranes Fabricated

Researchers at the Naval Research Laboratory (NRL) are studying the fabrication and applications of low-aspect-ratio patterned metallic membranes, prepared by thin-film deposition, using nanochannel glass wafers as substrates.

Douglas Pearson, one of the principal investigators from NRL's Optical Sciences Division, explained that nanochannel glass (NCG) replica membranes are thin films containing patterned arrays of uniform voids, with aspect ratios of typically 2:1 or less. The void diameters are as small as 40 nm, and the packing densities are greater than 3×10^9 voids/cm^2. The membranes, prepared from tungsten, molybdenum, platinum, gold, and palladium, are used as shadow masks in substrate patterning processes that require low-aspect ratio masks.

The process for preparing NCG replica membranes allows large numbers of membranes to be produced simultaneously, yields void features below 50 nm without the use of serial lithographic techniques such as electron-beam lithography, and provides flexibility in choice of materials used.

Ronald Tonucci, also a principal investigator from the Optical Sciences Division, said that the nanochannel glass from which the replica membranes are derived is applicable as an ion-implantation mask, as a host material for the growth of high-aspect-ratio metallic and semiconductor wires, or as a simple high-resolution filter.

The researchers are currently using NCG replica membranes as shadow masks to study substrate patterning by reactive ion etching and materials deposition. Tonucci said, "The use of these membranes provides the capability of producing millions of submicron features on a substrate in a single process step."

Chemical Sensor Mimicks Olfactory System

By modeling the olfactory system to identify a single odor out of a million, David Walt and John S. Kauer from Tufts University created a fiber optic and computer device that identifies many substances by smell.

To detect one chemical, a hair-thin glass fiber is tipped with chemical A, a combination of a polymer and a dye, which is known to react with chemical B. The fiber is exposed to the substance to be tested. A light beam travels down the fiber, hits chemical A then bounces back. A computer analyzes the light for changes in color and intensity that would occur if chemical A encountered chemical B.

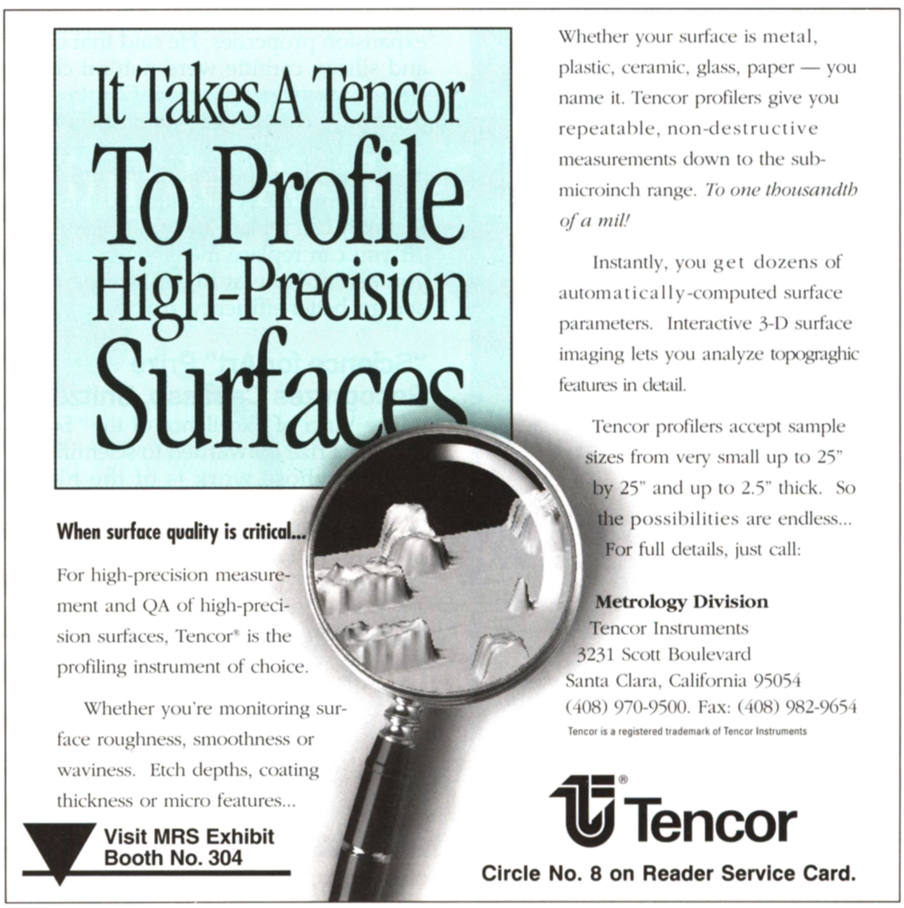
Walt said that the fiber-optic sensors he created previously could deal with only one chemical at a time. This updated device uses 10 probes to record responses to up to a million substances. In building a sensing system, Kauer said, "there would be an array of sensors where each sensor is cross-reactive—each one responds to some degree to some compounds and to some degrees to others—to create patterns across the array."

Rohatgi Received UWM Distinguished Public Service Award

Pradeep Rohatgi, Ford/Briggs and Stratton Professor in Materials in the College of Engineering and Applied Science at the University of Wisconsin—Milwaukee (UWM), has been named recipient of the 1995 Distinguished Public Service Award at UWM. Rohatgi was honored for his outstanding service to students, industry, and the community.

Specific accomplishments cited for the award include: (1) organizing world class materials research at UWM, some of which addresses environmental problems by reducing lead in drinking water, creating advanced materials from industrial and agricultural waste, and creating materials to reduce pollution from automobiles; (2) developing joint research programs between UWM and institutions in Europe, Asia, Australia, and Africa and training students worldwide in developing socially relevant new materials; (3) advising students and the Students of India Association in multicultural activities; (4) building strong links with industry, especially in Wisconsin, through relevant research, highly rated courses through UWM Outreach and Continuing Education Extension and televised instruction programs, and the organization of seminars, tours, and training for industry representatives at UWM; and (5) helping numerous industries, especially in Wisconsin, solve technical problems and write proposals for federal and state funding, including the Great Lakes Composite Consortium.

Rohatgi is the originator of appropriate and environmentally friendly advanced materials. His advice on technology and policy has been sought by professional



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and technical organizations worldwide, national governments, and international organizations including the World Bank and the United Nations.

A native of India, Rohatgi received his BS degree in metallurgical engineering from Banarus Hindu University in 1961, and his PhD degree from the Massachusetts Institute of Technology in 1964.

"Laminated Matrix" Composites Improve Strength and Toughness to Expand Uses For High-Temperature Parts

By applying alternating thin layers of matrix materials to traditional reinforcement structures, researchers at the Georgia Institute of Technology have developed a type of material system they believe will be tougher and stronger than conventional fiber-reinforced composites.

Two conventional techniques exist for making mechanically tough composites. The first uses fiber reinforcement within matrix materials such as ceramics or metals, while the other relies on building up multiple bonded layers of different materials such as copper and aluminum.

"We have combined those two approaches," said W. Jack Lackey, a research scientist at the Georgia Tech Research Institute (GTRI). The researchers make a fibrous preform by stacking layers of cloth, then infiltrate a matrix into the preform one layer at a time. They infiltrate with one material until they form a layer of it around each fiber, then infiltrate with another material, then switch back to the first. They continue iterating until they have put down as many as 50 layers.

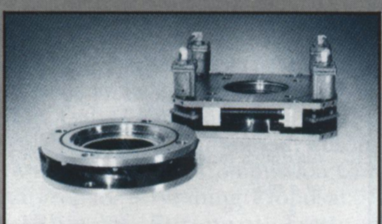
The researchers used forced-flow thermal-gradient chemical vapor infiltration to apply layers ranging in thickness from 0.02 to 0.5 μm. The layers were formed by alternating the precursor gases flowing into the chemical vapor infiltration reactor.

The work initially focused on infiltrating a carbon fiber preform with alternate layers of carbon and silicon carbide matrix. The process is expected to be applicable to silicon-carbide or aluminum-oxide fibers, as well as to metallic, polymeric, or ceramic matrix materials.

Lackey said that the matrix materials that bind the reinforcement fibers together and fill in the space between them must be chosen to be chemically compatible and closely matched in their thermal expansion properties. He said that carbon and silicon carbide were natural choices since they were easy to infiltrate into a preform and were compatible chemically.

"People are struggling to improve the mechanical properties of ceramics and ceramic-matrix composites to the point that they can replace metals," Lackey said. "If you can replace metals with ceramics, you can operate at higher temperatures and get better efficiency in a heat engine."

Vacuum Pump Vibration Isolator



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"Science for Art" Prize Recognizes Capasso, Snitzer

The Vinci of Excellence of the "Science for Art" Prize is awarded to scientific candidates whose work is of the highest international level. Federico Capasso of AT&T Bell Laboratories and Elias Snitzer of Rutgers University are among the recipients. The "Science for Art" prize, created in 1988, annually rewards artists and scientific researchers worldwide for the impact of their discoveries on artistic or aesthetic creation.

For his work in atomic engineering of new photonic devices and materials, Capasso received the Vinci of Excellence. For 15 years he has explored many aspects of the active interaction of light and matter by combining the capabilities of bandgap engineering and molecular beam epitaxy (MBE) to design and build optical devices and optoelectronic/nonlinear optical materials.

Capasso invented and demonstrated an infrared semiconductor laser (quantum cascade laser). The laser's wavelength, unlike other lasers, is not determined by the chemistry of the material, but by the layer thicknesses and as such can be tailored over a broad range using the same combination of materials. Capasso also designed semiconductor lattices which exhibit new photoconductive, photovoltaic, and photorefractive phenomena and coupled quantum well "pseudo molecules" with nonlinear optical properties.

Snitzer was recognized for his work in glass lasers and fiber optics. He has been in the forefront of technologies relating to light transmission and interaction of light with matter. He studied the propagation of light in small diameter fibers either for light wave telecommunications, or in the rod and cones of the retina.

He invented the neodymium and erbium glass lasers and many other specialized laser devices. The erbium laser amplifier has had a major impact on fiber optic telecommunications since it relieves the systems designer of a concern for the "light budget." Snitzer demonstrated the fiber glass amplifier. Inexpensive and readily integrated, his amplifier is capable of boosting the signal by a factor of 10,000.

Each scientist named "Vinci of Excellence" received, along with a diploma, a brass dodecahedron trophy based on an original drawing of Leonardo da Vinci.

SBIR Update

Lone Peak Engineering (LPE) (Draper, Utah) received a Phase I SBIR award to rapidly prototype functional metal components. LPE will use a proprietary process originally developed for engineered ceramic materials to rapidly prepare 316L stainless steel prototype parts.

Advanced Refractory Technologies (ART) (Buffalo, New York) was awarded Phase II SBIR funding from the Department of Defense to develop materials for pulse power batteries. The award amounts to $600,000 for a two-year study.

Materials Resources International (MRI) (Blue Bell, Pennsylvania) received a two-year, Phase II SBIR award of $600,000 from the Department of Defense. MRI will use the award to develop engineered tungsten alloys and composite components for use in armaments.

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Laser Induces Fluorescent Cooling

Researchers from Los Alamos National Laboratory developed a laser-induced cooling technique. Since atomic motion causes heat, a laser beam pumped into an object can be adjusted to extract the heat, creating a cooling effect. "Successful fluorescent cooling requires that a negligible fraction of the decays from the excited- to the ground-state groups occur through nonradiative, heat-generating processes," the researchers explained in the October 12, 1995 issue of *Nature.* Using the results of two types of experiments, the researchers concluded that they might be able to develop a solid-state cryocooler by pumping a fluorescent cooling material with a high-efficiency diode laser.

In one type of experiment, a titanium-sapphire laser was beamed into a sample of heavy-metal-fluoride glass (ZBLANP) doped with trivalent ytterbium (Yb^{3+}) ions. A helium-neon laser probe was beamed through the sample in the opposite direction. Measuring the angular deflections of the probe beam (photothermal-deflection), the researchers found a 180° phase difference between the two waveforms, indicating that "the positive temperature gradient observed at 980 nm becomes a negative temperature gradient at 1,010 nm," and this is cooled at 1,010 nm.

In the second type of experiment, again a titanium-sapphire laser beam was used to pump the sample, which was placed in a vacuum chamber onto two vertical thin glass slides that thermally insulated the sample from the chamber. A reference sample was placed near the test sample, but outside the pump-beam path, to account for changes in the sample temperature arising from temperature drifts of the chamber. The temperature was monitored using an InSb infrared camera, which can resolve temperature differences of 0.02 K. Temperature differences of 0.3 K were detected, confirming cooling of the pumped sample.

Engineering Foundation Announces 1995/96 Grants Supporting Research

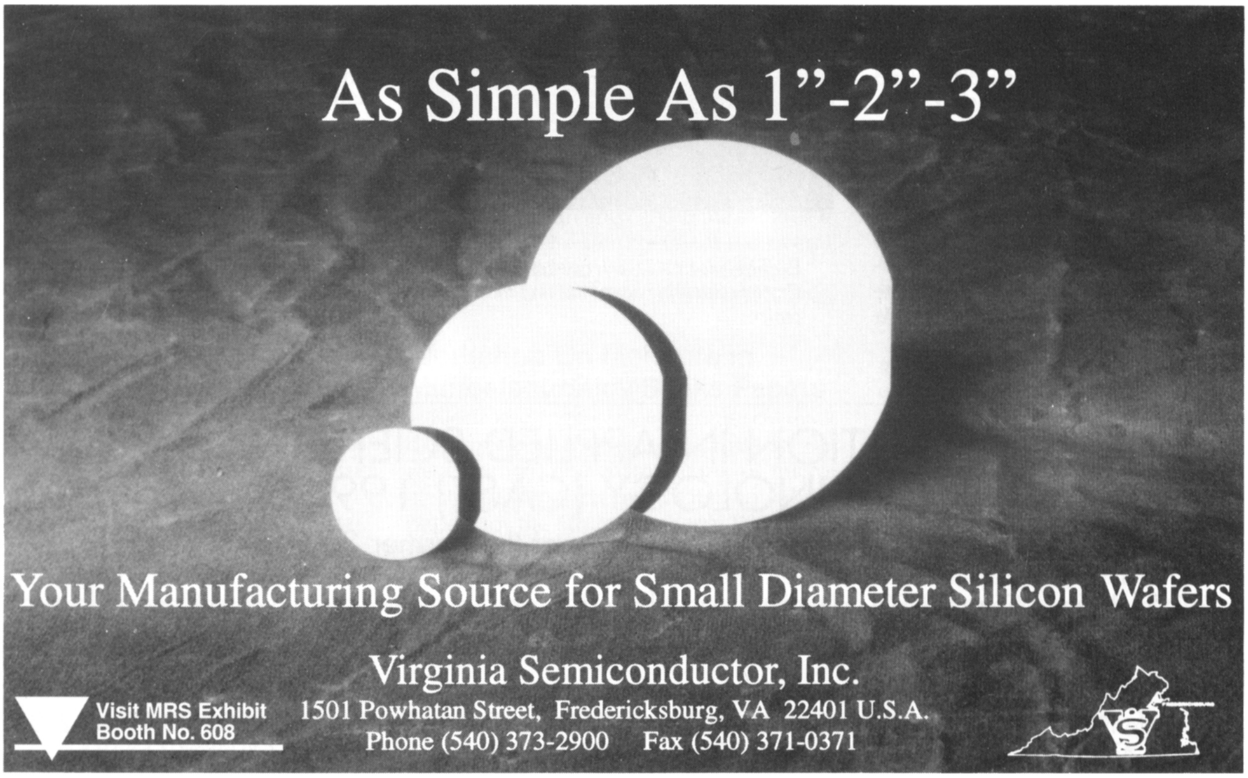
The Engineering Foundation has provided seed funding to catalyze research in three areas of which the Foundation finds insufficient attention. One grant was awarded to Steve Granick at the Univer-

Julian Szekely of the Department of Materials Science and Engineering at the Massachusetts Institute of Technology (MIT) died from a long-term illness in December.

Szekely was a pioneer of applying heat flow, fluid flow, mass transfer, and electromagnetic theory to materials processing. His research interests were in materials processing, industrial ecology, and international technology transfer.

Before joining MIT, Szekely taught at Imperial College in London and the State University of New York at Buffalo. He received his Bsc, PhD, and Dsc degrees in chemical engineering from Imperial College.

Szekely was editor of the March 1995 issue of *Journal of Materials Research (JMR)* focusing on green materials and processes, and guest editor of the January 1994 issue of *MRS Bulletin*, on the theme of mathematical modeling of materials processing. He served as a Principal Editor for *JMR.* R.A. Laudise, Editor-in-Chief of *JMR*, said, "Julian was an inspirational teacher, a world renowned researcher, and an ardent environmentalist."



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sity of Illinois—Urbana for "Polymer Peptide Interactions for Biocompatibility Applications," Michael Mundschau at Bowling Green State University for "Study of Magnetic Materials with Photoelectron Emission Microscopy," and the Civil Engineering Research Foundation for "Benchmarking and Enhancing Best Practices in the Engineering and Construction Sector." Twelve grants have been given to support research, and for precollegiate programs, career-oriented information, and engineering roundtable and conferences.

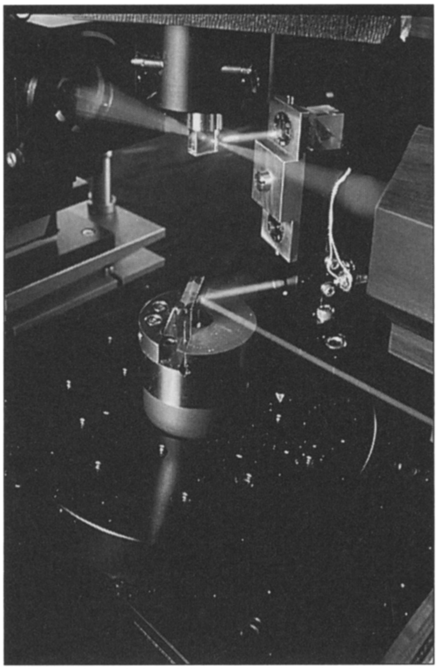
Approximately $250,000 a year is available for Exploratory Research Grants, Advancement of Engineering Grants, and the Engineering Journalism Award. While the deadline for preliminary proposals for 1996/97 grants has passed, the tentative deadline for 1997/98 grants is October 1, 1996. For more information, contact The Engineering Foundation, United Engineering Trustees, Inc., 345 East 47th Street (Suite 303), New York, NY 10017; 212-705-7835; fax 212-705-7441; e-mail engfnd@aol.com; worldwide web http://www.engfnd.org/engfnd.

HDSS Program Begins Holographic Storage Development

A joint university/industry/government consortium has begun to develop holographic data storage systems that can hold more than 12 times the information of the largest magnetic hard disk drives and maintain high data input and output rates.

Holographic data storage uses lasers to store information as "pages" of electronic patterns within the volume of special optical materials. The Holographic Data Storage System (HDSS) program was formed to develop several key components and to integrate them into separate write-once and rewritable systems that demonstrate its potential of a capacity of 1 trillion bits or more and a data-throughput rate of at least 1 billion bits a second.

The HDSS program complements the Photorefractive Information Storage Materials (PRISM) program. The PRISM project is developing optically sensitive materials optimized for storing holograms and developing an understanding of the various tradeoffs that must be made between mutually exclusive performance parameters. HDSS takes the next step of developing the other hardware technologies needed for practical holographic data storage systems and integrating them into demonstration systems.



PRISM holographic materials test stand. Crystal containing holograms is at the top center.

FMS National Materials Advancement Award Goes to Bridenbaugh

The Federation of Materials Societies presented the National Materials Advancement Award to Peter R. Bridenbaugh, Executive Vice President and Chief Technical Officer of Alcoa. The award recognizes individuals who have demonstrated outstanding capabilities in advancing the effective and economic use of materials and the multidisciplinary field of materials science and engineering generally, and who contribute to the application of the materials profession to national problems and policy.

Bridenbaugh serves on advisory boards for many educational institutions including Carnegie-Mellon University, The Pennsylvania State University, Stanford University, Massachusetts Institute of Technology, University of Virginia, Lehigh University, and Northwestern University. He is a member of the board of directors for Precision Castparts Corporation, the Penn State Research Foundation, and the Alcoa Foundation.

1995 Dannie Heineman Prize Awarded to Eigler

Göttingen Academy of Sciences and Humanities in Göttingen, Germany awarded the 1995 Dannie Heineman Prize to Don Eigler, the first scientist to position individual atoms. The prize, worth over $35,000, is awarded biennially for distinguished scientific achievements in natural science.

Eigler, an IBM Fellow at the Almaden Research Center, pioneered the use of the scanning tunneling microscope (STM) to move atoms and study atomic surfaces at their most basic level. He used the STM to create a single atom "switch" and to place atoms in rings, creating "quantum corrals" that enable scientists to study the nature of electron waves on metal surfaces. □

COOPERATION IN APPLIED SCIENCE AND TECHNOLOGY (CAST) 1996

with the Newly Independent States of the Former Soviet Union

The National Research Council (NRC) invites applications from U.S. scientists and engineers to host colleagues from the Newly Independent States (NIS) of the former Soviet Union for joint research in applied scientific fields.

Application deadline: March 1, 1996.

For more information, contact the National Research Council, Office for Central Europe and Eurasia (FO-2014), 2101 Constitution Ave., NW, Washington, DC 20418; 202-334-3680; fax 202-334-2614; e-mail OCEE@NAS.EDU; http://www.nas.edu.

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