## Researchers Develop Semiconductor Laser that Produces Low-Divergence Beam

Scientists at the University of Rochester, in collaboration with scientists from IBM and the National Nanofabrication Facility (NNF) at Cornell University, have designed and built a semiconductor laser that produces a low-divergence circular beam of light. Previously, a semiconductor laser produced only oblong-shaped beams. The Rochester beam diverges less than one-half of one degree, compared to 30 degrees for the typical commercial semiconductor laser.

The typical beam of light from the semiconductor lasers used for sending telecommunications signals is egg-shaped and broadens very quickly; when it is squeezed into a circular optical fiber, sometimes only 30 percent of the light successfully transmits into the fiber. The rest is shunted away or filtered out as engineers use layers of optics to focus the oval into a circle, with some light lost at each layer. "The shape of the typical laser beam limits how much light you can get into the fiber," said Dennis Hall, professor at the University's Institute of Optics and principal investigator.

The 150-micron-wide device designed at Rochester is a surface-emitting laser made of gallium arsenide. The novel part is a concentric circle grating made up of 600 grooves etched into the semiconductor surface. As the laser light fans out from the center of the grating toward the grooves, the waves are deflected by the grating's ridges and interfere with each other, producing a coherent laser beam which is emitted from its surface. A small portion of the light escapes out the sides of the grating, a feature which may be useful in developing arrays of such lasers, Hall noted. "People have wanted to obtain a circular beam from a semiconductor laser for a long time, but they didn't think it could be done," says Hall. Such a laser could be used in a variety of settings, in particular, for applications such as telecommunications and optical recording.

The laser was designed at Rochester and several have been built using electron beam lithography facilities at IBM and at the NNF at Cornell. Other researchers, most notably at Northern Telecom in Canada, are also working on lasers utilizing concentric circle gratings, but have not yet demonstrated a circular beam.

Hall and his colleagues have written about their work in *Applied Physics Letters* and the *Journal of Vacuum Science and Technology* and have presented it at several optics conferences. Hall's colleagues include former graduate student Turan Erdogan (now with Bell Labs), engineer Oliver King, and associate professor Gary Wicks; Erik Anderson of the IBM T.J. Watson Research Center in Yorktown Heights; and M.J. Rooks of the National Nanofabrication Facility at Cornell.

## W. Lincoln Hawkins Undergraduate Research Fellowship Established

George Campbell Jr., president of the National Action Council for Minorities in Engineering (NACME), announced in February the establishment of the W. Lincoln Hawkins Undergraduate Research Fellowship. The award honors Hawkins, a pioneering chemist and the first African American scientist at AT&T Bell Labs, where he was employed for 34 years. He retired in 1976 and became a consultant to the company on educational and employment opportunities for minorities. He died last year, at 81.

A recipient of the 1992 National Medal of Technology, Hawkins held 18 U.S. and 129 foreign patents related to the conservation and reclamation of materials used in communications equipment. Hawkins was a member of the NACME board and its executive committee.

The fellowship fund is designed to encourage outstanding African American, Hispanic, and American Indian chemical engineering students through one-on-one faculty mentoring, early research experience, and the opportunity for exposure to leading-edge technologies.

The fellowship will be advised by a five-member committee representing the Hawkins family, industry, the National Academy of Engineering, the American Chemical Society, and NACME.

NACME's goal is a $600,000 endowment, with the first fellowship to be awarded in the 1993-94 academic year. Contributions to the fund may be mailed to: The W. Lincoln Hawkins Fund, c/o NACME, 3 West 35th Street, Third Floor, New York, NY 10001-2281.





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## Semiconductor Uses Fullerenes

Mitsubishi Electric Corporation in Japan has used fullerenes ($C_{60}$) to create a new type of semiconductor material. It is hoped that this material will enable the production of semiconductor substrates with improved resistance to radiation and heat and with greater transparency, as well as with a higher degree of integration of memory functions than that of the conventional silicon-based materials. Further, Mitsubishi Electric believes that it has now become possible to produce semiconductor devices that can more efficiently receive and emit light over a wider range of wavelengths. Thin films of $C_{60}$ absorb light from about 200 to 700 nm. $C_{60}$ shows fluorescence between 650 and 750 nm and phosphorescence between 780 and 950 nm, but Satoru Isoda, group manager of the Molecular Electronics Department at Mitsubishi, hopes to improve light-emitting properties by controlling electronic states through ion implantation.

Mitsubishi Electric used the ionized cluster beam (ICB) method (deposition of material on a substrate by forming a cluster of atoms/molecules, ionizing the cluster, and then accelerating it) to improve fullerene's crystallinity. The formation of fullerene thin films using this method improves the long-range order and enables controlled crystal orientation. Ion implantation can also be used to add dopants to a fullerene thin film, enabling the characteristics of the resulting semiconductor to be accurately controlled.

The ICB method allows high-speed thin-film formation at a rate of several nanometers per minute, compared to less than one nanometer per minute by conventional methods. It is also possible to control the crystallinity, including the orientation of the crystals, with thicknesses of up to several hundred nanometers, as compared to approximately 50 nanometers using conventional methods. Mitsubishi researchers have developed a way to incorporate boron and phosphorous, which are used as p- and b-type dopants for silicon, into the fullerene thin films under a variety of conditions. The conductivity changes over a range of more than eight orders of magnitude (from less than $10^{-7}$ to 10 siemens/cm). The galvanomagnetic properties strongly suggest that n- and p-type semiconductors were created as a result of the phosphorus and boron doping. Accurate identification of the dopant's polarity is now under investigation.

F.S. Myers

## Program Targets Diamond Film Growth Using Plasma Torch, CVD

Westinghouse Electric Corporation and the SGS Tool Company, Monroe Falls, Ohio, have launched a $5.2 million effort to develop an efficient, high-volume technology for producing diamond films using the Westinghouse plasma torch with the chemical vapor deposition process.

The National Institute of Standards and Technology (NIST) recently revealed plans to provide $2.4 million in funding support over the program's three years. For the first year, now underway, NIST has made a commitment of more than $1 million.

Project managers said that a successful scale-up would cut the cost of diamond coatings from today's $30 to less than $5 a carat.

The project's primary target is a coating for carbide tools that would extend their useful life; uses that depend on diamond's other properties are also possible—for example, as an electrical insulating material in electronic packaging, as a transparent material for aircraft windows and missile domes, and as a low-friction, corrosion-resistant semiconductor.

With assistance from the University of Minnesota's Department of Mechanical Engineering, plasma torches will be supplied by the Westinghouse Science & Technology Center, where the experimental diamond production system will be installed and operated under the direction of Westinghouse's plasma systems manager, Shyam V. Dighe.

## National Educators' Workshop Seeks Materials Experiments

The Materials Education Council, an agency of the U.S. Materials Science and Engineering Community, has published a call for experiments for its annual National Educators' Workshop:Update (NEW:Update) in November. This year, NEW:Update will emphasize new and evolving topics in engineering materials, science, and technology, and will focus on gathering well-designed experiments and demonstrations for use in materials lab courses to aid in teaching about new and modified materials.

To meet this goal, the organizers need assistance from industrial, governmental, or academic materials engineers, technicians, scientists, and educators who can submit abstracts of their own experiments or demonstrations for distribution at NEW: Update 93, to be held November 3–5, 1993, at the National Aeronautics and Space Administration in Hampton, Virginia. The long-range objective is to reproduce a solid collection of experiments and demonstrations in a *Manual of Experiments* for educators, available through coordination of the Materials Education Council of the United States and the appropriate technical societies.

Educators interested in receiving registration materials for NEW:Update 93 should send their name and address to: National Educators' Workshop:Update 93, Dr. James A. Jacobs, School of Technology, Norfolk State University, 2401 Corprew Ave., Norfolk, VA 23504; telephone (804) 683-8109 or -8712; FAX (804) 683-8215.

For those interested in providing experiments, abstracts are due **June 1, 1993**.

## Xerox Develops Method for Single-Layer Polymers to Emit Full Color Spectrum

A new, simpler way to emit the full spectrum of colored light from a single layer of commercially available nonmetallic polymers was announced by two scientists, Gordon Johnson and Kathleen McGrane, of the Webster Research Center of Xerox Corporation. In a paper Johnson presented at the 1993 Symposium on Electronic Imaging: Science & Technology, the scientists stated that red, yellow, green, blue, and white light have been emitted from the commercially available polymer, Poly (N-vinyl carbazole), by adding off-the-shelf compounds to it and running a current through the material. In addition, the shade and intensity of the light can be easily fine-tuned, in most cases, by changing the amounts and types of additives.

Currently, light emissions from organic polymers generally use more exotic materials that require laborious polymer synthesis and multiple layers of molecular or polymeric materials, the scientists said.

The light-emitting properties of certain organic polymers, when exposed to electric fields, have been known for about a decade, but have yet to be applied commercially. They are relatively inexpensive, however, can be bent and shaped, can cover large surfaces, and can be powerful enough to serve as light sources. Potential applications broadened in 1990, when scientists from the University of Kyushu, Japan, first reported the emission of blue light—the most difficult to achieve of the primary colors—permitting the creation of the full spectrum of colored light.

In the Xerox research, Poly (N-vinyl carbazole) is doped with different combinations of an aromatic diamine, an oxadiazole derivative, and a light-emitting compound. That solution is laid atop an indium-tin-oxide-coated glass substrate by spin coating, which yields a thin, uniform layer. The thinner the film, the lower the voltage required for light emission, Johnson said. Significant hurdles remain, however, including lengthening the lifetime and improving the efficiency of the devices—currently less than two percent—and improving the thickness uniformity of materials for large-area displays.

## Two Stanford Labs Merge

Two of Stanford's physics labs, the Stanford Linear Accelerator Center (SLAC) and the Stanford Synchrotron Radiation Laboratory (SSRL), merged October 1. SLAC director Burton Richter and Arthur Bienenstock, former director of SSRL and now as-





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sociate director of SLAC, agreed that by cooperating, they would be able to take advantage of scientific and technological opportunities that were more difficult to take advantage of independently. SSRL is now a division of SLAC, bringing the total number of employees at the Department of Energy research laboratory to around 1,400 and the total budget up to around $153 million.

SSRL's 600 investigators get synchrotron radiation from the accelerator's storage ring to study, for example, chemical catalysts, the structures of proteins, and new ways of fabricating advanced electronic chips. SLAC is a high-energy physics laboratory, smashing electrons and positrons together to study the nature of matter at subatomic levels.

Three principal reasons for the merger were simplified operating and budgetary procedures by the Department of Energy, perceived benefits to both facilities by a closer association, and retention of SLAC's status as a world-class facility. The first fruit of the collaboration is a plan to design and build a free-electron laser that will use hard x-rays to make holograms of such things as crystals or biological samples.

## National Academy of Engineering Elects 73 Members and Eight Foreign Associates

The National Academy of Engineering has elected 73 engineers to membership in the Academy and eight as foreign associates, bringing the total U.S. membership to 1,684 and the number of foreign associates to 142.

Election to the Academy is among the highest professional distinctions accorded an engineer. Academy membership honors those who have made "important contributions to engineering theory and practice, including significant contributions to the literature of engineering theory and practice," and those who have demonstrated "unusual accomplishment in new and developing fields of technology."

MRS members newly elected to the Academy are listed:

**Jerome B. Cohen,** dean of engineering and applied science, Northwestern University, for contributions to x-ray diffraction of materials, including residual stress, and atomic arrangements in alloys, ceramics, and catalysts.

**Jerome J. Cuomo,** senior manager, Advanced Materials Laboratory, IBM T.J. Watson Research Center, for contributions to ion beam and plasma processing of thin film materials.

**Charles B. Duke,** senior research fellow, Xerox Corp., for providing the theoretical foundations for developments in xerography.

**Robert L. Fleischer,** research professor, earth and environmental sciences, Rensselaer Polytechnic Institute, for contributions to the development and diverse applications of high-temperature materials, solid solution hardening, and etched particle track detectors.

**David W. Johnson Jr.,** head, metallurgy and ceramic research, AT&T Bell Laboratories, for the discovery of new compositions and processing techniques and their transfer to manufacture.

**William B. Russel,** professor and chairman, department of chemical engineering, Princeton University, for research on the influence of polymers on the phase behavior, coagulation, and rheology of colloidal dispersions.

## Three Transuranic Elements Named

Three new chemical elements discovered in the 1980s have been named. Because a need for clarification on their initial discoverers has been satisfied, these transuraniums with the atomic numbers 107, 108, and 109, are now called nielsbohrium, hassium, and meitnerium, respectively.

Niels-bohrium, named after the Danish physicist, was produced for the first time in 1981. Hassium, first produced in 1984, was named after the German state Hesse, called Hassia in Latin. Meitnerium, named after Lise Meitner, a contributor to the discovery of uranium fission, was initially produced in 1982. The discovery of these elements by the Society for Heavy-Ion Research in Darmstadt was awarded priority by the international Transfermium Working Group.

The elements were created by bombarding heavy nuclei with other charged heavy nuclei in a heavy ion accelerator so that the nuclei fused, forming a new element, even if only for a fraction of a second.

*From* The German Research Service, Special Science Reports ***VIII*** *(12) (1992).*

## Alfred University Professors Receive DOE Grant to Study Formation of Ultra-Fine Ceramic Particles

Gregory Stangle, assistant professor of ceramic engineering at the New York State College of Ceramics at Alfred University, along with Vasantha Amarakoon, associate professor of ceramic and electrical engi-



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neering, and Walter Schulze, professor of ceramic and electrical engineering, have received a $607,000 grant from the Division of Advanced Energy Projects, a part of the Office of Basic Energy Service of the federal Department of Energy, to develop a process to generate ultra-fine ceramic particles.

Their goal is to develop a process that starts with salts, which are added to an organic fuel, and then heated quickly. The material, they hope, will literally blow itself apart, with the resulting "shrapnel"—ultra-fine ceramic particles—providing the building blocks for some of the most advanced ceramic materials.

Many ceramics, which are inorganic, nonmetallic materials, start with powders, which are then shaped and fired into the finished product. Ceramics have a lot of desirable properties that could be improved by using ultra-fine particles. Ceramic grains typically range in size from one to 500 microns. The smaller the grain size, the greater the improvement in certain desirable properties, including the ability to be electrical superconductors, says Stangle.

By using their new technique, the Alfred researchers hope to produce starting powders that are from 1–100 nm. During the three-year project, they hope to be able to go from the starting powder to a final product.

## DOE Announces Grant for Clark Atlanta University Graduate Research Center

The Department of Energy (DOE) will provide an $8 million grant to complete construction of the graduate research facility at Clark Atlanta University. The research center will strengthen the role that Clark Atlanta University plays in addressing the underrepresentation of minorities in all fields, especially science and engineering.

The grant is part of DOE's efforts to restore the environment at DOE sites and facilities throughout the United States, as outlined in the Five-Year Plan for Environmental Restoration and Waste Management. The research center will enable faculty and students to focus research, technology development, and related manpower training on the field of environmental restoration and waste management.

The Clark Atlanta Research Center has been designed to support four of DOE's critical technological areas:

- environmental technology and waste management;
- materials science and technology;
- biotechnology; and
- computational sciences.

## Phule Made Whiteford Fellow at Pitt

Pradeep P. Phule, an assistant professor of materials science and engineering at the University of Pittsburgh, has been appointed as the William Kepler Whiteford Faculty Fellow at the University. The fellowship was given in recognition of Phule's teaching and research abilities in the area of synthesis and processing of advanced materials. Phule, a founder-member of the Greater Pittsburgh Section of MRS, is also the faculty advisor for the MRS student chapter at the University of Pittsburgh. □





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