Tuller Receives Humboldt Research Award

Harry L. Tuller, Department of Materials Science and Engineering at the Massachusetts Institute of Technology and Sumitomo Electric Industries Professor, has been awarded the Humboldt Research Award. Given in recognition of the scientist's accomplishments in both research and teaching, this award allows international scholars to perform advanced research at various German Institutes. As the program promotes scientific cooperation between Germany and the country of the recipient, Tuller will be visiting the Max-Planck-Institut for Solid State Research in Stuttgart. He will pursue investigations concerning nanostructured electroceramics.

Maunsell Structural Plastics Presented with Institute of Materials Polymer Award

The Institute of Materials presented the Prince Philip Award for Polymers in the Service of Mankind on November 13, 1996 to Maunsell Structural Plastics, Ltd., part of the international Maunsell group of consulting engineers. The Award recognizes Maunsell's work in the development of the Advanced Composite Construction System, a lightweight, high-strength, durable, modular construction system for buildings and bridges.

Introducing the award recipients, Sir Geoffrey Allen, a former president of The Institute of Materials, said, "Constructed from glass fibers embedded in a plastic matrix, the product range includes a footbridge, a canal drawbridge capable of carrying trucks, and walkways which can be attached to road and rail bridges thus allowing maintenance to be carried out without interrupting the flow of traffic."

The award was presented during a special ceremony held at Buckingham Palace.

The Institute of Materials, incorporated by Royal Charter, is actively concerned with the science, technology, production, and use of engineered materials derived from ceramics, metals, polymers, and composites.

Chemical Reactions Carried Out in Carbon Nanotubes

In work conducted at the Ecole Polytechnique Federale de Lausanne in Switzerland, Walter A. de Heer, a professor in the School of Physics at the Georgia Institute of Technology, and his collaborators carried out chemical reactions in carbon nanotubes with inside diameters of less than 10 nm and lengths of 1 µm. The work, reported in the December 13 issue of *Science*, could ultimately have important applications in microelectronics and other fields in which extremely small conductors and other structures would allow production of new types of nanoscale devices.

The researchers formed carbon nanotubes, then opened the ends of the tubes and allowed capillary action to fill them with molten $AgNO_3$. In the final step of the process, they decomposed the silver nitrate into metallic silver by heating the tubes with a beam from an electron microscope.

The process resulted in chains of tiny silver beads within many of the nanotubes, each bead separated by a pocket of gas under pressure estimated to be as high as 1,300 atm. Though not attached to the walls of the nanotubes, the beads remain wedged in place by high levels of friction.

Electron microscope study showed some thinning of the nanotube walls, indicating that the chemical reaction involved in metallizing the silver nitrate caused some damage. However, because the tubes are made up of multiple layers of carbon, the thinning of the walls should not diminish their ability to host chemical reactions.

The researchers found that only a small percentage of the nanotubes—those with diameters of at least 4 nm—were filled with the silver nitrate. This shows that the capillary action used to fill the tubes depends on the diameter of the nanotubes. De Heer said, "If the diameter is relatively large, the liquid will go in easily, but if the tube is narrow, the liquid might not go in at all."

The relationship between size and capillary action is opposite of what would be expected in the "macro" world, where narrower tubes normally create a stronger attraction for liquids. But in nanoscale structures like the tiny tubes, de Heer believes the cylindrical shape alters electrical charges to cause reduced reactivity.

Based on their studies, the researchers developed mathematical formulas that can be used to predict the capillary action associated with tubes of different diameters. Even small differences in the polarizations of the nanotubes had significant effects on the amount of capillary action that occurred.

Er-Doped Si LEDs Achieve High Efficiency and MHz Modulation

A research team led by Salvo Coffa at CNR-IMETEM, a laboratory of the National Council of Research in Catania, Italy, has designed and fabricated Er-doped light-emitting diodes (LEDs) operating at 1.54 µm with a high ($>1\times10^{-4}$) room-temperature efficiency and allowing direct modulation of the light signal at MHz frequencies.

In the last 10 years, Er doping has been recognized as a promising approach to the fabrication of an efficient light source in Si. Er ions exhibit an internal 4f shell transition at 1.54 µm, a standard telecommunication wavelength, that can be excited electrically when the rare earth ions are incorporated in Si. Two problems have so far hampered the optoelectronic applications of Er-doped light-emitting Si diodes: (1) The efficiency of the light emission at room temperature appears to be impractically low as a consequence of a reduced pumping efficiency at high temperatures and of the onset of fast nonradiative processes; and (2) with the radiative lifetime of the excited Er ions close to 1 ms, the elimination of nonradiative routes (necessary for the achievement of high efficiency) would impede a direct modulation of the diode at frequencies above 1 kHz, thus requiring external modulation of the light signal.

The novel diode structure realized at CNR-IMETEM, as reported in the September 1996 issue of *Applied Physical Letters*, solve these two problems by enabling simultaneously an efficient pumping of Er ions and a fast turn-off time of the electroluminescence signal. Multiple Er and O implants were performed to realize a uniform concentration of 10^{19} Er/cm^3 and 10^{20} O/cm^3 in the depletion layer of a p^+-n^+ Si diode. Operation of the diode under reverse bias at the breakdown, which occurs by Zener at -5 V, results in an intense 1.54 µm room-temperature light emission. Within the depletion layer, Er ions are efficiently pumped by hot carriers impact excitation (with a cross section of 1×10^{-16} cm^2) and decay with a long lifetime (100 µs) since nonradiative processes are severely inhibited in this layer. On the other hand, when the diode is turned off, the electroluminescence signal dies off in a time as short as 100 ns, allowing fast modulation of the light signal. This fast turn-off is a consequence of very efficient, Auger-type, nonradiative decay of the excited Er ions which only set in when, at the diode turn-off, the depletion layer shrinks and the excited Er ions are suddenly embedded within the heavily doped ($\sim10^{19}$/cm^3) neutral regions of the diode.

These results open perspectives to the use of Er-doped Si LEDs as efficient and fast switching light sources in integrated Si-based optoelectronics. Detailed investigations of the excitation mechanisms indicate that by proper design of the device structure (aimed to increase the total amount of Er ions in the depletion layer and take full advantage of the strength of nonradiative Auger processes), efficiency up to 1% and modulation up to 100 MHz are achievable.

Twenty NSF-Nominated Scientists and Engineers Receive Presidential Honor

President Clinton has named 20 young, independent researchers nominated by the National Science Foundation (NSF) to receive the first annual Presidential Early Career Awards for Scientists and Engineers (PECASE). These researchers have demonstrated excellence and promise in scientific or engineering research, as well as the potential for eventual leadership in their respective fields.

NSF's recognition includes grants of up to $500,000 over a five-year period for individual recipients of this presidential award. Awardees are faculty members known for accomplishments in research, education, and service to the public. These scientific and engineering leaders will serve as advisors to the president on emerging and developing trends and discoveries in their fields. Their contributions are also expected to foster other innovative and far-reaching developments in science and technology, increase awareness of career potential in science and engineering, and highlight the importance of science and technology.

NSF-nominated PECASE recipients include **Peter J. Delfyett, Jr.**, University of Central Florida, for optics and electrical engineering; **Marc A. Edwards**, University of Colorado, for corrosion control and environmental engineering; **Charles M. Marcus**, Stanford University, for the physics of electron conduction; **Massoud Pedram**, University of Southern California, for engineering of electronic circuits; **Ruey-Jen Hwu Sadwick**, University of Utah, for optoelectronic systems engineering; and **John W. Sutherland**, Michigan Technical University, for environmentally conscious manufacturing engineering.

Ken Wilson Receives DOE Distinguished Associate Award

Ken Wilson of Sandia National Laboratories has received a Department of Energy (DOE) Distinguished Associate Award for his "pioneering research on the interactions of energetic plasmas with materials, application of this research to magnetic fusion plasmas, and leadership in design and R&D for critical in-vessel components and systems for the International Thermonuclear Experimental Reactor." Wilson has been studying the interaction of materials with magnetic fusion plasma since arriving at Sandia in 1974 with a PhD degree in materials science from Cornell University. He currently manages the Surface Chemistry Department and the Magnetic Fusion Energy program at Sandia. He is also a U.S. Home Team manager for the International Thermonuclear Experimental Reactor, a proposed fusion energy device.

The award was presented by Anne Davies, Associate Director for Fusion Energy, at a December 11, 1996 ceremony in Germantown, MD. It is the highest nonmonetary award for employees of DOE-owned, contractor-operated facilities.

Linda E. Jones Receives 1996 Graffin Lectureship

Linda E. Jones, assistant professor of ceramic engineering at the New York State College of Ceramics at Alfred University, is the 1996 recipient of the George D. Graffin Lectureship in Carbon Science and Engineering bestowed by the American Carbon Society. Through the lectureship, Jones will be invited to colleges and universities throughout North America to deliver a lecture entitled, "The Performance and Applications of Carbon: A Structural Perspective."

In her lecture, Jones will discuss the levels of structure within the three forms of carbon: graphite, diamond, and buckminsterfullerene. She will discuss how structural understanding of the element/material can be applied to key and emerging technologies linked to carbon-based materials.

Jones obtained her BS degree in chemistry from Mary Washington College, and her master's and doctoral degrees in materials science and engineering from The Pennsylvania State University. Jones' research interests include novel forms of carbon; high-temperature solid-gas reactions; high-temperature structural composite materials and fibers, including the role of microstructure, physical properties, and chemistry on oxidation and mechanical behavior; and environmental aspects of high-temperature decomposition/processing of ceramics and glass.

Jones is a member of the American Carbon Society, and currently serves as director of the Society; the American Ceramic Society; the Society of Women Engineers; and the New York Academy of Sciences. She is chair-elect of the Western New York Section of the American Ceramic Society. She has over 55 publications.

TMS Honors Scientists at the 1997 TMS Annual Meeting

During the 1997 Minerals, Metals & Materials Society's (TMS) Annual Meeting and Exhibition in Orlando, February 9–13, scientists have received distinguished awards.

Robert O. Ritchie, professor of materials science at the University of California—Berkeley has received the Structural Materials Distinguished Materials Scientist/Engineer Award for outstanding contributions to the fundamental understanding of fatigue performance of advanced structural materials including metal matrix composites for defense and commercial applications.

Ritchie received his ScD and PhD degrees in materials science from Cambridge University. He is a Fellow of ASM International and the Institute of Materials, London and vice-president and Honorary Fellow of the International Congress on Fracture. He has authored and co-authored over 275 papers and edited nine books.

Julia R. Weertman, Walter P. Murphy Professor at Northwestern University Robert R. McCormick School of Engineering and Applied Science, has received the 1997 Leadership Award for her leadership in policy setting in national materials committees, in the TMS Council, and as chair of a premier materials engineering department. She received her DSci from Carnegie Mellon University. She is a Fellow of ASM International and TMS. She has published numerous technical papers and reports, edited several books on materials science and engineering, and has two patents.

Sossina M. Haile, assistant professor at the University of Washington, has been named recipient of the Robert Lansing Hardy Award for 1997 in recognition as a young person in the broad field of metallurgy showing exceptional promise of a successful career. She has received her PhD degree in materials science and engineering from the Massachusetts Institute of Technology. She has received numerous honors including the NSF National Young Investigator and Humboldt Fellow. She has 19 publications.

Terence E. Mitchell, a Fellow at Los Alamos National Laboratory, has been named TMS Fellow in recognition for illuminating esoteric shadows of the electron microscope and their application to scientific and engineering problems. Mitchell received his PhD degree in physics from the University of Cambridge. He is also a

Fellow of ASM International, the American Ceramic Society, and the American Physics Society.

David N. Seidman, Walter P. Murphy Professor of Materials Science and Engineering at Northwestern University has also been named TMS Fellow, recognized for his theoretical and experimental studies of the degrees of freedom in alloy grain boundaries through field-ion microscopy and computer simulation. Seidman received his PhD degree in physical metallurgy from the University of Illinois at Urbana-Champaign. He is a member of the Advisory Board of Materials Science Forum and a Special Editions Editor and member of the Editorial Board of *Interface Science.*

Laser Microscope Images Serotonin in Live Cells

Cornell University researchers, using nonlinear laser-microscope technology developed at Cornell, have produced images displaying the neurotransmitter serotonin in live cells in real time, and they have measured the concentration of serotonin in secretory granules. The microscope, which uses pulsed lasers for excitation, can record ultraviolet (uv) fluorescence images of live cells without using uv illumination to detect and image cellular activity.

"This technique caught serotonin granules in the act of releasing the substance, without damaging the cell or changing the process and without requiring any external fluorescent marker," said W.W. Webb, Cornell professor of applied and engineering physics, who led the work. "It is a new way of doing three-dimensional uv microscopy in functioning cells and the best way we know of for doing uv microscopy in thick tissues," Webb said.

The studies, reported in the January 24 issue of *Science*, shows that a laser in the 700–750 nm wavelength (infrared) fires photons bunched in very short pulses (each 10^{-13} s), which are focused by the microscope so that there is a high probability that three photons arrive at the same time (in about 10^{-16} s) at the same molecule near the focus. Molecules such as serotonin and tryptophan, which can normally be excited only with deep ultraviolet (~250 nm) illumination, are now excited by simultaneously absorbing three infrared photons and, subsequently, fluorescence in the uv. These photons are collected as the laser is scanned through the specimen, and the resulting three-dimensional image can be viewed and analyzed on a computer monitor. For these studies, the researchers used basal leukemia cells from rats.

"This three-photon excitation produces very high energy corresponding to shorter absorption wavelengths than was possible before, without killing the cells," Webb said.

Serotonin is a neurotransmitter that is becoming increasingly important as medical science learns of its role in a host of human disorders. The nonlinear laser-microscope technology may be useful in gaining an understanding of a broad spectrum of physiological and psychological effects of this—and other—neurotransmitters. The technology could be useful, then, for researchers in designing more effective drugs for a host of disorders.

Recently Announced CRADAs

Oak Ridge National Laboratory (Oak Ridge, Tennessee) and **American Magnetics Inc.** (Oak Ridge, Tennessee) signed a cooperative research and development agreement to produce a new superconducting electric current lead for powering cryogenic systems, which operate at temperatures of 4.2 K.

Stephen L. Jones Receives Ehrhardt Prize

Stephen L. Jones, a PhD candidate at the University of Missouri—Rolla (UMR) has received the international Ehrhardt Prize for atomic physics research. Jones is studying what happens when three atomic particles interact. His research concentrates on what happens when three atomic particles get close together from a knowledge of what happens when they are far apart. The award is named after Helmut Ehrhardt, a professor who retired this year as chair at the University of Kaiserslautern and deputy president of the Deutsche Forschungsgemeinschaft (DFG).

Program to Study MR Fluids: Smart Materials for Automotive and Other Applications

An interdisciplinary program entitled "Synthesis, Properties, and Applications of Magnetorheological [MR] Fluids" has been launched under the direction of Pradeep P. Phulé, an associate professor of materials science and engineering at the University of Pittsburgh. MR fluids represent a family of controllable or smart materials that have the ability to undergo rapid (within ms), and nearly completely reversible changes in their rheological properties upon the application of an external magnetic field. MR fluids usually consist of fine (1–5 mm) particles of a magnetically soft material (typically iron, iron oxide, or other magnetic ceramic materials) dispersed in a liquid. In the absence of an external magnetic field, MR fluids exhibit a relatively small apparent viscosity (10–1000 MPa) and, therefore, flow similarly to commonly encountered dispersions such as paints. When a magnetic field is applied, the particles self-assemble into pearl chains and the material behaves as a viscoelastic solid having an apparent yield stress of ~100 kPa. Given the ability of MR fluids to support a field-controllable shear stress and dissipate mechanical energy, they have attracted considerable attention for vibration-damping and torque-transfer applications. The automotive industry, in particular, has been interested in the development of such devices as semi-active shock absorbers, clutches, and engine mounts. The program will concentrate on the development of novel MR fluids based on mesoscale particulates and on developing a better understanding of the underlying science. Interdisciplinarity, teamwork, and strong collaborative ties with the engineers and scientists at the Scientific Research Laboratories of the Ford Motor Company are some of the features of this program according to Phulé. John Ginder, a senior technical specialist at the Ford Scientific Research Laboratories, has been a collaborator. □

1997 MRS SPRING MEETING
March 31–April 4
San Francisco, California