M. Dresselhaus Receives National Medal of Science

Physicist Mildred S. Dresselhaus, Institute Professor of the Massachusetts Institute of Technology (MIT), received the 1990 National Medal of Science in honor of her work with the electronic characteristics of metals and semimetals, and with science opportunities for women. President George Bush presented the award at the White House in a ceremony for 30 scientists and engineers last November.

Dresselhaus's field has been solid state physics with a focus on structure-property relations in electronic materials. Recently she has concentrated on graphite intercalation compounds, graphite fibers, and the modification of electronic materials by intercalation and implantation. Dresselhaus is also nationally known for her work in developing wider opportunities for women in science and engineering.

The National Medal of Science was established by Congress in 1959 to recognize scientists and engineers for their outstanding contributions to improving the well-being of the United States through the development or application of technology or the establishment of a technologically trained work force.

In his remarks, Bush said, "Many of today's honorees serve as prime examples of how we can effectively translate science into basic technology. I think of Millie Dresselhaus, arguably the most important, prominent physicist and engineer of her generation, whose hard work helped to revolutionize semiconductors."

Dresselhaus, who has been associated with MIT since 1960, holds faculty appointments in both the electrical engineering and computer science department and the physics department. She was elected to serve as an MRS councillor for terms beginning in 1985 and 1990, and has also served MRS as a principal editor for *Journal of Materials Research* and as a symposium organizer.

MIT Institute Professor Mildred S. Dresselhaus receives the National Medal of Science from President Bush, with Mrs. Bush looking on. Prof. Dresselhaus was cited for her research in the electronic properties of metals and semimetals and for her work in developing wider opportunities for women in science and engineering.

1990 National Medal of Science Recipients

Baruj Benacerraf, Dana-Farber Cancer Institute
Elkan R. Blout, Harvard School of Public Health
Herbert W. Boyer, University of California
George F. Carrier, Harvard University
Allan M. Cormack, Tufts University
Mildred S. Dresselhaus, Massachusetts Institute of Technology
Karl Folkers, University of Texas
Nick Holonyak Jr., University of Illinois
Leonid Hurwicz, University of Minnesota
Stephen C. Kleene, University of Wisconsin
Daniel E. Koshland Jr., University of California, Berkeley
Edward B. Lewis, California Institute of Technology
John McCarthy, Stanford University
Edwin M. McMillan, University of California
David G. Nathan, Children's Hospital, Boston
Robert V. Pound, Harvard University
R.D. Revelle, University of California
John D. Roberts, California Institute of Technology
Patrick Suppes, Stanford University
E. Donnall Thomas, Fred Hutchinson Cancer Research Center

1990 National Medal of Technology Recipients

John V. Atanasoff, Iowa State University
Marvin Camras, Illinois Institute of Technology
DuPont Company, E.I. du Pont de Nemours & Co.
Donald Frey, Northwestern University
Fred W. Garry, General Electric Co.
Wilson Greatbatch, Wilson Greatbatch, Ltd.
Jack St. Clair Kilby, Texas Instruments
John S. Mayo, AT&T Bell Laboratories
Gordon Moore, Intel
David B. Pall, Pall Corporation
Chauncey Starr, Electric Power Research Institute

Sandia Implements Massively Parallel Computing

By shifting from serial to parallel computing, Sandia National Laboratories will tackle many problems not practical previously.

Massive parallelism employs a thousand or more computer processors working in parallel to solve large and complex problems very rapidly in pieces, rather than attacking large parts one at a time, as do serial processing methods. Solutions are obtained with parallel computing up to one hundred times more quickly than with conventional vector supercomputers.

The Sandia team is particularly enthusiastic about using massively parallel processing in computer graphics. The team has achieved, for example, three-dimensional animated close-ups of micrometeoroids striking debris shields and superstructures, whose quality competes with photographic images of similar events created in the laboratory.

Sandia's list of current massively parallel computing projects includes:

- Fast molecular dynamics simulations of atomic systems with a few thousand atoms. The work has shown parallel machines are also competitive for small simulations as well.
- Calculating the electronic structure of solid-state systems using about 100 atoms. These simulations are important to surface science studies, the synthesis of new catalysts for industrial processes, and the design of new compound semiconductor materials.
- Modeling the effect of meteoroids and orbital space debris on space structures and the resulting damage to shielding and superstructures.
- Modeling electron beam microscopy by Monte Carlo simulation of electron trajectories through composite materials. The parallel code runs up to 150 times faster than the vector supercomputer version because all the electron trajectories can be simulated in parallel.
- Simulation of mass diffusion and thermal energy transport by finite element methods.
- Development of advanced parallel techniques to solve nonsymmetric systems of equations and time-dependent partial differential equations for applications of semiconductor device modeling and fluid dynamics.
- Representation of rarefied gas flow around space vehicles by Monte Carlo simulation of the molecular collisions and chemistry occurring in the upper atmosphere.
- Judging the fit of molecules for use as catalysts, such as for processing coal slurries into liquid fuels or for removing carbon dioxide from exhausts.

The processing has been carried out by two massively parallel "hypercube" supercomputers and a 16,384-processor Connection Machine. Sandia has both multiple-instruction/multiple-data (MIMD) and single-instruction/multiple-data (SIMD) computer types for different styles of problem development.

New Paint Useful in Space, on Earth

A new coating designed to protect equipment and craft in space may also be a superior housepaint.

Equipment in space is often coated white to reflect heat radiation that otherwise can damage components. In time, however, as this coating is exposed to high-intensity ultraviolet light, the electrons and protons of the solar wind, and chemically active atomic oxygen found in space, the whiteness yellows, lowering its reflective ability.

The new white, aluminum doped, zinc-oxide compound, originally developed at Alfred University by associate professor of ceramic engineering James Cordaro and graduate student Howard Rafla-Yuan, resists yellowing more than previous paints. Thanks to the aluminum component, the new compound not only resists yellowing, but also allows a spacecraft to uniformly dissipate electrical charges that build from the solar wind.

To test the new paint, Cordaro is working with NASA's Goddard Space Flight Center to get samples affixed to the European Retrievable Carrier, scheduled to go into orbit in late 1991. He has already subjected paint samples to 10,000 million rads of radiation in a linear accelerator, a much higher level than the amount found in space, resulting in only slight discoloring.

The new material may benefit homeowners in a practical way. A zinc-oxide based paint would be less expensive than one with titanium dioxide, a common component for white paint. Also, the new paint is a natural fungicide with increased resistance to mildew. Cordaro also hopes to test the new coating in space for durability and resistance to the chalking and fading that occur in conventional house paints in sunlight.

The International Lead-Zinc Research Organization, a consortium of zinc manufacturers and miners, has so far committed $150,000 to the research project in order to develop a commercially viable product.

Cordaro is also working with the International Copper Association on a black coating which uses copper. The black coating may also have applications in space. For example, it may be used to paint the inside of a space telescope where reflections must be eliminated.

R&D Cuts May Harm U.S. Mining Industry

The U.S. mining industry may lose its competitive edge because of a steep decline in its R&D effort, according to recent findings by a committee of the National Research Council (NRC). *NewsReport*, a monthly NRC publication, published the report, showing that expenditures for internal and contracted R&D in the mining industry declined from $133.5 million in 1980 to $22.5 million in 1988.

Furthermore, the committee found a disturbing decline in both the number of students attracted to mining engineering, and the number of mining engineering programs offered by schools. Twenty such programs are left of the 26 existing in 1980. Of the 20, several are in jeopardy because of low enrollments and waning program budgets.

The report, which focused on the steel, aluminum, copper, lead, and zinc sectors, called current research "insufficiently imaginative," and communication between researchers and hands-on engineers "poor."

"The technology in use today was already on the shelf by the late 1950s," said Ray Beebe, senior vice president of Homestake Mining Co. (San Francisco) and vice chair of the NRC's Committee on Competitiveness of the U.S. Minerals and Metals Industry. "What we don't have and truly need is an ongoing stream of technology in the pipeline."

The mining industry was healthy and growing until the 1970s when the Vietnam War ended and the oil crisis hit, the *NewsReport* article said. Since then, the industry has scaled back considerably with an ensuing decline in R&D. The committee also pointed out that while materials research and development has increased for other industries, there is a need for a combined governmental, industrial, and academic program to integrate and intensify mining and minerals R&D.

While recent years have been profitable in the mining industry, paralleling the general economic upswing, "We simply aren't putting enough emphasis on the technology needed to propel the mining industry successfully into the 21st century," Beebe warns.

The report specifically recommends research and funding priorities for the following areas:

- Geo-sensing, a highly sophisticated technology for predicting variations in ore, indicating faults, and guiding mining operations with precision.
- Safety, by developing means of rock extraction without explosives, and through greater emphasis on automation and robotics.
- Cooperation, including consortia between the mining industry and universities and other researchers to pursue technologies otherwise too complex, risky, or expensive to research alone. Such partnerships could also help attract new students into the field.

From: *NewsReport* **XXXX** (10) (1990) p. 2.

New Technology Developed for Containerless High Temperature Materials Processing

Aerodynamic-acoustic levitation has made containerless processing of almost any liquid possible. The process came from joint research by Containerless Processing, Inc. (CPInc) and Intersonics, Incorporated (ISI), both of Northbrook, Illinois.

The process achieves stable levitation of laser-heated solids and liquids at very high temperatures. Successful positioning of liquid aluminum oxide (Al_2O_3) at temperatures exceeding 2600 K has been demonstrated in the ISI laboratory.

Containerless conditions allow deep undercooling of a melt so homogenous nucleation predominates. An advantage of undercooling is the ability to synthesize glass and amorphous materials before crystallization occurs. This capability is possible with containerless processing, since container-induced heterogeneous nucleation is reduced. A mixture such as calcia, gallia, and silica, a known reluctant glass-former, produces a glass by the containerless method when processed at over 1750 K.

This processing technique has applications in the synthesis and melt processing of metals, alloys, ceramics, glasses, semiconductors, superconductors, and other materials. The open architecture provided by this technique allows easy optical and physical access to the sample during all stages of processing. This allows considerable flexibility for unique processing applications such as crystal growth, fiber pulling, and production of very fine-grained ceramics.

Superclean Coal Burning Reduces Greenhouse Gases

Scientists have finished a 240-hour test run as part of a process to produce a superclean, low greenhouse gas-emitting technology for generating electricity from coal. The tests, run with high-sulfur coal at the University of Tennessee Space Institute, a Department of Energy-funded test facility, have shown promise for greatly improved power plant efficiency and reduction of pollutants, including up to 42% less carbon dioxide compared to conventional. About 95% of sulfur pollutants were also captured, and nitrogen oxide and particulates were held to well below the amount allowed by today's air quality standards.

The "ultraclean" magnetohydrodynamic (MHD) technology burns coal near 4800°F in an electrically conducting plasma that is channeled through a mag-

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netic field, thus producing electricity. Heat from the process is also converted to electricity by producing steam force. Another key objective of the tests was to determine the most suitable construction materials to use with the extremely hot, potentially corrosive gases in an MHD system.

High T_c Transistor Shows Promise in Electronic Circuits

A "superconducting flux flow transistor" (SFFT), a recent development of high T_c superconducting materials promises integration between existing semiconductor and low-temperature superconducting electronics.

The SFFT, developed jointly by scientists and engineers at Sandia National Laboratories and the University of Wisconsin is the first "active" device (one that can produce power gain) made entirely from new high T_c superconducting materials. "Passive" devices—inductors and some microwave components such as filters and delay lines—have recently been made elsewhere from the new materials and are the first commercially available high T_c superconducting microelectronics.

The best results come from SFFTs made from thin films of thallium-based superconducting materials. The most widely studied materials in the recent pursuit for high T_c superconductor applications have been based on yttrium. The thallium-based transistor can serve as an interface between conventional, low-temperature superconducting electronics, which usually operate at a liquid-helium temperature of 4 K, and semiconductor electronics.

In addition, circuitry based on the SFFT to date includes amplifiers, oscillators, phase shifters, and mixers—essential components of electronic communications and signal processing technology. Microwave amplifiers built with the SFFT show a gain of 10 dB at 4 GHz, and SFFT mixers (devices that combine frequencies to generate a different output frequency) have operated at 35 GHz.

Further research will be undertaken to develop the technology around the SFFT for a family of applications including both active and passive components. Paul Peercy, manager of Sandia's Compound Semiconductor and Device Research Department, says the SFFT and associated circuitry now being developed have outstanding promise. "We have demonstrated a set of circuits based on the SFFT that allows us to do a wide variety of signal processing directly with high T_c integrated circuits without the need for external circuitry of any kind."

Ceremonies Mark Opening of Kanagawa Science Park

The Kanagawa Science Park (KSP) outside of Tokyo celebrated its opening with an international set of speakers on October 24, 1990. The Science Park is set in Kanagawa Prefecture (province), home to an array of major Japanese firms accounting for 1% of the gross world's product.

KSP consists of an incubator center, an innovation center, including R&D and prototype design labs, and an R&D business park. These facilities are in an urban setting with about 1,500,000 square feet of space, including laboratories, a hotel and conference center. KSP broke ground in 1987 and began operation about a year ago.

S. Hirata, chairman of the Japan Development Bank, Gavril Popov, mayor of Moscow, and Rustum Roy, professor of technology and society at Pennsylvania State University, were featured speakers at the opening. Rustum Roy's talk, entitled "Japan's Culture to Match Its Technology in the XXIst Century," addressed Japan's successful domination of world technology. Roy said that Japan's cultural heritage of cooperation ironically had helped Japanese industry defeat competitively based Western technology.

Nicholas A. Peppas Receives Pharmaceutical Recognition

Nicholas A. Peppas, professor of chemical engineering at Purdue University, was elected a Fellow of the American Association of Pharmaceutical Scientists. He was recognized as a "distinguished member who is an acknowledged leader and outstanding contributor to the pharmaceutical sciences."

A major portion of Peppas' research addresses the use of polymers in pharmaceutical applications, more specifically, surface modification for improved mucoadhesive behavior and structural charges for improved diffusional and release behavior. He has been at Purdue since 1976 and was the 1988 president of the Controlled Release Society. Presently he serves as chair of the Materials Division of the American Institute of Chemical Engineers.

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AIP Corporate Associates Consider Emerging Technologies and Tech Transfer

The American Institute of Physics' most recent annual Corporate Associates meeting gave about 130 participants an opportunity to consider the theme of "Physics: Emerging Technologies and Technology Transfer." The annual meetings, a service for the Corporate Associates, usually cover a broad spectrum of science and policy matters and also offer insights into the activities of the host institution. Sandia National Laboratories, Albuquerque, New Mexico, host for this meeting, arranged tours of its laboratories working on semiconductor research and processing and also its major accelerator and weapons effects facilities.

During evening banquet ceremonies, Albert Narath, president of Sandia, spoke on "National Laboratories and Economic Competitiveness." He talked about technology transfer and how industry might capitalize on the national laboratories as a resource, a theme that permeated the talks throughout the two-day program. During the same ceremonies, the AIP Science Writing Award was presented to Bruce Murray of the Jet Propulsion Laboratory for his book *Journey into Space.*

Four presentations covered individual scientific topics: thin film synthesis and surface modification (J. Gerardo, Sandia); binary optics (Wilfred Veldkamp, MIT Lincoln Laboratories); strained-layer semiconductor devices (P. Peercy, Sandia); and quantum electron devices (F. Capasso, AT&T Bell Laboratories).

Raymond Balcerak of the Defense Advanced Research Projects Agency talked about fostering a competitive technology base, and Roland Redington of General Electric's R&D Center spoke on medical electronics. Prof. Edward Stone (Caltech), newly appointed director of the Jet Propulsion Laboratory, provided a fascinating description of NASA's Voyager program and the spacecraft's encounter with the planet Neptune. Presentations on nonlinear processes (D. Campbell, Los Alamos National Laboratory), neural networks (J. Hopfield, Caltech), and the energy industry (V. Dugan, Sandia) rounded out the program.

Senator Pete V. Domenici (R-NM), unable to attend because of ongoing budget negotiations in Washington, DC, sent a videotape of his address, "The Role of the National Labs in National Technology Transfer." The audience questioned the senator over a live telephone link.

Domenici's remarks focused not only on using the national laboratories to enhance U.S. industrial competitiveness but also on the role universities might play in this process. He concluded by suggesting that those in academia do more to direct their students toward applied research while at the university and to encourage them to join industry on graduation. The senator was most open to suggestions from the audience and encouraged listeners to recommend to him potential improvements to recently enacted laws governing the mechanisms for transferring technology from taxpayer-supported facilities to U.S. industry.

In a telling observation about the state of technology transfer in the United States today, Veldkamp said that the relationship between a federal laboratory and industry is often ephemeral and that the liaisons which transfer technology can be short-lived and opportunistic. He described this ephemeral process as "mate and die." Although the general tone of the meeting regarding science and technology capabilities available in the United States was positive, the underlying tone concerning technology transfer mirrored Veldkamp's critique. □

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