AT&T Introduces Self-Focusing Lasers

Scientists at AT&T Bell Laboratories have made experimental self-focusing lasers, called zone lasers (Z-lasers), which need no lenses to focus their light.

Z-lasers emit light vertically from their surface instead of horizontally as conventional edge-emitting lasers do. They are temporally and spatially coherent lasers that need no external binary grating or lenses. They are also high-power lasers, operating at more than 200 mW. They have a narrow line width, less than 0.4Å and fixed polarization and a cicular beam spot.

The Z-lasers are made, using molecular beam epitaxy, of layers of InGaAs, GaAs, and AlGaAs, each 70Å thick, sandwiched between two semiconductor Bragg mirrors. The lasers have diameters of 120 microns and operate in a Fresnel-lens-like transverse mode. Their optical zones are separated by reactive ion-etched trenches. Focusing ability comes from the optical-phase flip (back and forth 180 degrees) from zone to adjacent zone. Because of the way they are designed and processed, their output light tends to converge, which is not possible with other lasers.

Further information on the Z-lasers is included in a technical paper presented at the International Electronic Devices Meeting on December 5, 1993, in Washington, DC, sponsored by the Institute of Electrical and Electronic Engineers (IEEE).

SiGe Channel Speeds Hole Conduction

A transistor developed at Cornell University could increase the speed of some consumer electronics by as much as 40% because it allows holes to travel just as fast as electrons so that n and p channel devices can have identical electrical characteristics. Also, conventional silicon processing supports this method, so no special processing is required.

Electrical engineering professor Yosef Shacham-Diamand and student Kaushik Bhaurnik took a traditional MOSFET device and added a layer of silicon-germanium (SiGe) to confine holes to a conducting channel. Adding a SiGe layer about 100Å thick created a quantum well that captures the holes and provides them with an "express lane" for current conduction. Using a gate length of 0.2 μm, the holes in the SiGe layer travel at speeds exceeding that of holes in silicon. For CMOS (complementary metal oxide semiconductor) low-power devices, the technique adds density to the circuit, enhancing the electronics. The device is extremely efficient, operating at 1.5 V.

The researchers report the switching speed of the device at 35 GHz. Typical p channel devices yield about 10 GHz. A 0.2 μm device yields 5 mA of current, compared to about 3 mA without the SiGe layer.

European Study Recommends Using More Polymers in Cars

A study published by Euromotor Reports (London), *Closing the Loop—The Car Recycling Challenge*, recommends that all car makers and their associations join to control polymer use in cars through an international body, such as a United Nations working group. But instead of limiting polymer use in cars, the study surprisingly recommends that designers

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use more because it enhances lightness and fuel efficiency. The study does warn, however, that the weight of plastic in cars has soared from 2% in the 1960s to 12% in today's cars, with a forecast of more than 20% by the late 1990s.

The Euromotor Reports study details all of Europe's car recycling experiments and adds many examples from the United States. It covers aluminum, glass, tires, and many polymers. The authors, who discuss both incineration and recycling, hold that the initiative for such developments must come from the plastics industry as a whole, to cope with its huge solid waste disposal problem—not from the auto industry.

NSF, DOE, and Argonne Sign Research Agreement

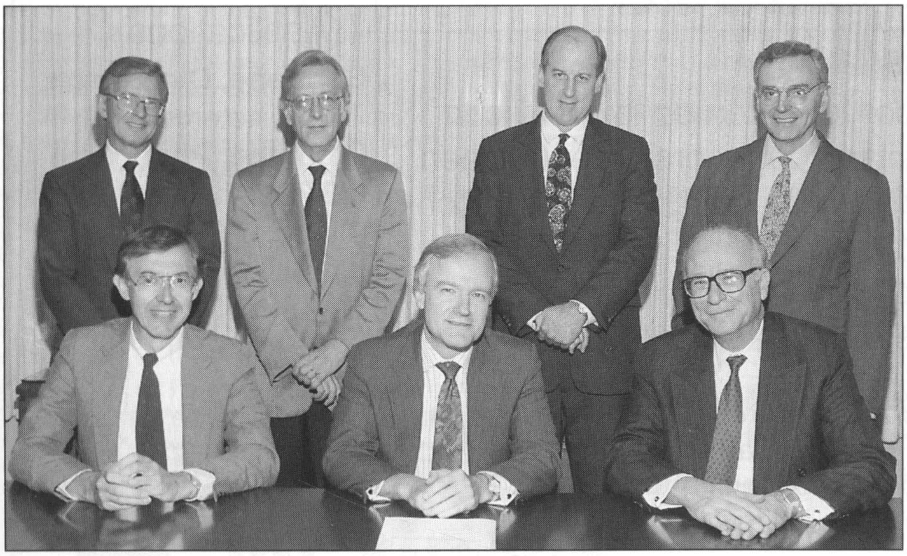
On September 17, 1993, the National Science Foundation, the U.S. Department of Energy, and Argonne National Laboratory signed the first agreement explicitly encouraging joint research between NSF-funded universities and national laboratories.

Under the memorandum of understanding, Argonne and university faculty will jointly identify promising advanced materials projects that match the university's research and education needs and also fit the interests and capabilities of Argonne's research programs. Advanced materials is a technology area regarded as critical by the Clinton administration, which is also promoting cooperation among its agencies.

Joint projects have been pursued in the past but, according to Argonne's director, Alan Schriesheim, "the agreement will expand joint research programs... [and] will also provide unique educational opportunities at Argonne for graduate students."

Proposals covering the jointly identified research and citing the partnership are to be submitted by a university to NSF and will be subjected to the standard NSF peer review process. Successful proposals will receive an NSF grant to support the university research faculty and graduate students while DOE existing program funds will cover Argonne researchers and facilities.

Argonne, one of nine multiprogram national laboratories of the U.S. Department of Energy, is operated by the University of Chicago. The Laboratory has strong programs and capabilities in materials and related disciplines and is the site of several major national user facilities.



NSF, DOE, and Argonne representatives sign memo of understanding. Seated (left to right): James F. Decker, acting director, Office of Energy Research, DOE; Frederick M. Bernthal, acting director, NSF; and Alan Schriesheim, director, Argonne National Laboratory. Standing (left to right): Karl Erb, senior science adviser, NSF; Adriaan de Graaf, deputy director, Division of Materials Research, NSF; William C. Harris, assistant director for mathematical and physical sciences, NSF; Joseph Bordogna, assistant director for engineering, NSF.

NSF oversees one of the largest materials research and development programs of any U.S. federal agency. The primary emphasis of these programs includes synthesis and processing, understanding fundamental principles, applications, and the training of future scientists and engineers.

European Community Development Proposal Adopted

A proposal for the fourth Framework program of the European Community (EC) for research and technological development has been adopted by the European Commission. The EC has earmarked approximately $15 million for the program, which will cover all research activities between 1994 and 1998.

To maximize available resources and increase economic spin-offs, the Framework program will give priority to the following:

- Greater integration between national and EC activities by improving the coordination of major projects;
- Closer cooperation on strategic projects which combine the development of key technologies with research that is close to the market;
- Greater concentration within each sector on a smaller number of problems and generic technologies with a multisector impact. Research on transport will be conducted in a structured fashion, concentrating on technology evaluation and social issues; and
- Improved dissemination of research findings, particularly to small- and medium-sized enterprises, to improve the translation of scientific breakthroughs into commercial success.

In addition to these goals, a greater flexibility will be sought in the Framework program so the EC can respond more quickly to scientific and technological changes.

R.M. German Honored for Powder Metallurgy Research

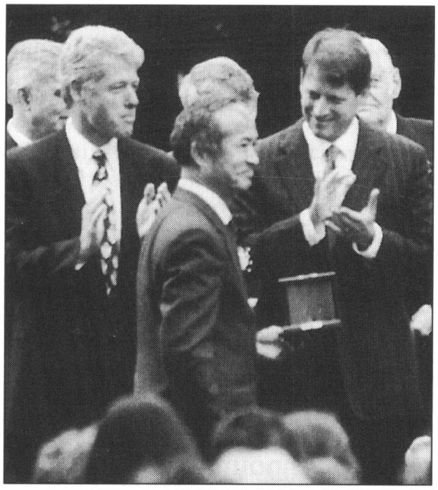
Randall M. German has received the Technical Development Award from the Japan Institute of Metals in Nagoya. The award was for his research in collaboration with Hideshi Miura and Tadatoshi Honda of Kumamoto University on "Development of High Performance Sintered Alloy Steels by Metal Injection Molding Process."

German also received the 1993 Kuczynski Prize of the International Institute for the Science of Sintering for his book *Particle Packing Characteristics.* The prize is given for fundamental contributions in the area of sintering.

German is the Brush Chair Professor in Materials with the Engineering Science and Mechanics Department at Pennsylvania State University, where he teaches powder metallurgy and particulate materials processing.

Cho Receives National Medal of Science

At a White House ceremony on September 30, 1993, Alfred Y. Cho, director, Semiconductor Research, AT&T Bell Laboratories, received the National Medal of Science from President Clinton. The medal honors "individuals deserving special recognition by reason of their outstanding contributions to knowledge of the physical, biological, mathematical, or engineering sciences." The medal was given to Cho for his pioneering development of molecular beam epitaxy (MBE), an important method for growing semiconductor crystals in ultrahigh vacuum.



Alfred Cho (center), director, semiconductor research, AT&T Bell Laboratories, holds the National Medal of Science as U.S. President Clinton (left) and Vice President Gore (right) applaud.

In the early 1970s, Cho developed and refined the MBE crystal growth method, and disseminated this technology to the semiconductor community. MBE has since developed from evaporation and sublimation of metal sources to include the use of gas sources and other chemical precursors.

"Just the thought that my peers have nominated me for such an honor gives me a tremendous sense of satisfaction and encouragement to continue my work. To have actually won the medal is beyond my wildest dreams," said Cho.

A native of Beijing, China, Cho joined Bell Labs in 1968 after earning bachelor's, master's, and doctoral degrees in electrical engineering from the University of Illinois. He became director, Materials Processing Research at AT&T Bell Labs in 1987, and assumed his current position in 1990. Cho, who has been honored with numerous awards for his contributions to the semiconductor industry, was named a Bell Laboratories Fellow in 1993.

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Ultrasonic AFM Looks Below Surface

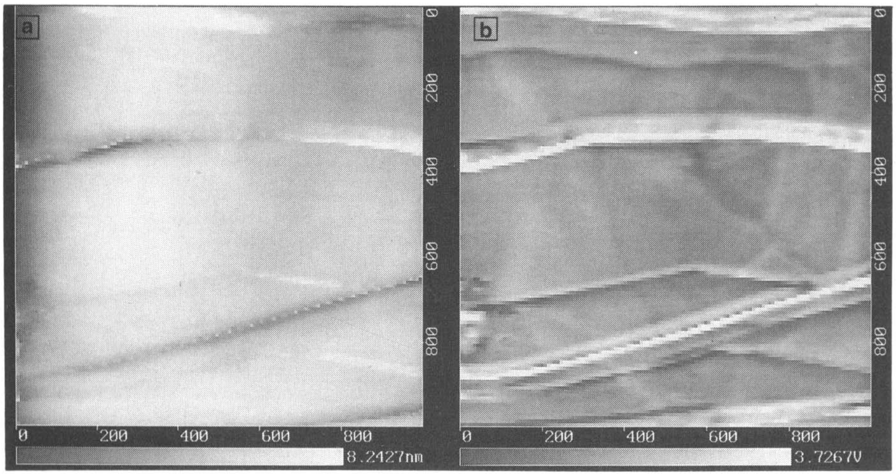
A new type of atomic force microscope (AFM) has been developed by Japan's Mechanical Engineering Laboratory under the Ministry of International Trade and Industry (MITI). By using the so-called ultrasonic force mode (UFM) the microscope can look tens of atomic layers below the surface of an object. Although the scanning tunneling microscope and the traditional AFM can track above the ridges and grooves to resolve the surface structures of objects at the molecular and atomic levels, neither can look below the surface.

According to Oleg Kolosov and Kazushi Yamanaka, the principal researchers, the UFM-type AFM represents a major advance in studying the structure of materials at the nanoscale level. The technique is advantageous for investigating the dynamic viscoelastic properties of both organic and inorganic materials in an AFM. The researchers say that with further improvements in the resolution, the microscope could be used to study atomic clusters and to view deoxyribonucleic acid and other biomolecules.

The instrument is basically an AFM with an ordinary ultrasonic wave-generating element mounted above the specimen stage. Ultrasonic waves cause the sample to vibrate up and down; due to the nonlinearity in the tip-sample interaction force curve, *F*(*Z*), a small-amplitude ultrasonic vibration of less than 2Å is detected as the average displacement of a cantilever. UFM operation is useful for detecting ultrasonic vibrations with frequencies up to the GHz range, using a soft microfabricated AFM cantilever with a resonant frequency below 100 kHz.

These features make it possible to image not only at the surface, but also at a certain distance below the surface. An ultrasonic element capable of generating waves of up to 150 MHz pulses is incorporated into the prototype, giving a resolution of approximately 5 nm. On atomically flat surfaces, the resolution could be improved to the subnanometer level.

F.S. Myers



(a) Surface boundaries of highly oriented pirographite are visible on the surface AFM topography image. (b) Using UFM reveals additional subsurface grain boundaries.

Alexander von Humboldt Awards Announced

The Alexander von Humboldt Foundation has announced the names of newly selected Senior Scientist Awardees, Research Fellows, and Hosts of German Lynen Fellows in chemistry and engineering. Among those who will be supported by the AvH Foundation to conduct research at universities in Germany for one or more years are a number of MRS members.

Walter George Klemperer of the University of Illinois received the Humboldt Award for Senior American Scientists in chemistry. **Christopher Ober** of Cornell University and **Michael Wright** of Utah State University were selected as outstanding young scientists in chemistry to receive Research Fellowships for a research project in Germany. Chosen to receive funding in the field of chemistry for a German postdoctoral researcher under the Feodor-Lynen program were **Steven L. Bernasek** and **Jeffrey Schwartz** from Princeton University and **Josef Michl** from the University of Colorado at Boulder.

Awards to Senior American Scientists in engineering include: **Robert Averback**, University of Illinois; **Vaclav Vitek**, University of Pennsylvania; **Man Yoo**, Oak Ridge National Laboratories; and **Frederick Lange**, University of California. **Glenn Beltz** of Harvard University and **Karl Robinson** of the Naval Research Laboratory were chosen as young scholars in engineering for a Research Fellowship in Germany. Among engineering scientists selected to receive funding for a German postdoctoral researcher under the Feodor-Lynen program are: **J.W. Morris**, University of California; **William C. Johnson**, Carnegie Mellon University; and **Surendra P. Shah**, Northwestern University.

Applications for the Humboldt Awards, given three times per year, can be obtained by writing to: Alexander von Humboldt Foundation, 1350 Connecticut Avenue NW, Suite 903, Washington, DC 20036. Phone (202) 296-2990; fax (202) 833-8514; e-mail: humboldt@umail.umd.edu.

Titan Develops Tire and Plastic Recycling Systems

Two commercial recycling systems for tires and plastics have been developed by Titan Technologies, Inc.

The tire recycling system vaporizes scrap tire rubber through natural catalysts which operate in a self-contained plant at low heat levels of 230°C to return discarded tires to their original components of oil, carbon black, and steel for resale. Comparable technologies operate 500°C higher and use chrome or granulated rubber instead of shredded tires. The higher heat produces less usable byproducts and increases pollution.

Plastics and composites can also be converted by the same low-temperature catalytic conversion process and recycled into low molecular weight hydrocarbons for use as chemicals or fuels. Initial tests of plastic blasting media (beads used by the Air Force to strip paint off aircraft) and aerospace composite materials (including boron/epoxy) show that both can be converted to simpler chemical constituents. □

Franklin F.Y. Wang, founder of *Materials Letters*, died August 30, 1993; see p. 48.