Chan Named NSF Presidential Faculty Fellow

Siu-Wai Chan, an associate professor of materials science and metallurgy in Columbia's School of Engineering and Applied Science, was awarded a $500,000 Presidential Faculty Fellowship from the National Science Foundation (NSF) for her work in thin film research and studies of electrical transport in oxide materials. The fellowships recognize young faculty who demonstrate promise in scientific or engineering research and in teaching. According to NSF officials, Chan is the first materials scientist to win the award.

Chan's research project, "Grain Boundaries of Ceramic Oxide," involves the behavior of materials at the nanoscale level. Formed by the meeting of two independently growing crystals, grain boundaries influence conductivity, strength, and resistance to corrosion in a wide range of materials. Using thin films, electron microscopy, impedance spectroscopy, and critical current measurement at temperatures from 4 to 90 K, Chan hopes to discover more about materials' behavior at grain boundaries and interfaces.

Chan earned a bachelor of science degree in metallurgy and materials science from Columbia in 1980 and an ScD in materials science and engineering from the Massachusetts Institute of Technology in 1985. Director of the Electron Microscopy Facility in Columbia's Henry Krumb School of Mines, she has authored or co-authored 44 research articles and holds a U.S. patent on patterning in superconducting ceramics.

Drexel Curriculum Puts Freshmen in the Lab

Curriculum planners at Drexel University have replaced the school's traditional theoretical undergraduate engineering curriculum with a laboratory-based, problem-solving approach to teaching the fundamentals of engineering. Under the new program, which formally begins in September 1994, first- and second-year students will spend a minimum of three hours each week in the university's new high-tech engineering lab equipped with Hewlett-Packard Company's test and measurement instruments.

According to Drexel engineering professor Robert Quinn, most engineering schools focus on theoretical math and science courses for the first two years. The Drexel approach emphasizes practical engineering courses at the outset. "We get students working in the lab right from the beginning of their first semester," said Quinn.

"Our freshmen know how to use oscilloscopes, signal generators, amplifiers, power supplies; they're very technically sophisticated," said Quinn. "Students are required to interpret and present the results of their experimental work, so they sharpen their critical thinking, communication, and presentation skills. These skills give our students a competitive advantage in their engineering careers."

After completing their first year of studies, Drexel engineering students alternate six-month periods of cooperative work experience with on-campus learning. The new curriculum is helping make the co-op semesters a more valuable experience for both students and employers.

Another benefit of the new program is a reduction in the drop-out rate for engineering students. "In the past, we'd graduate about 40% of the students initially enrolled in an engineering program," said Quinn. This year Drexel expects to graduate approximately 60 of the original 100 students in the first class to go all the way through the new program, "a 50% improvement in our student-retention rate," says Quinn.

Drexel's five-year engineering program began as a pilot program in September 1989, with 100 students. As enrollment grew, the university built new facilities equipped with Hewlett-Packard test and measurement instruments. Drexel will celebrate the opening of its Bennett S. Le Bow Engineering Center in September.

The Drexel curriculum project is being funded in part by a five-year, $2.1-million grant from the Engineering and Science Education Directorate of the National Science Foundation. The Directorate designated Drexel's curricular endeavor as the lead project in a 10- institution, $4.5-million research effort that seeks to improve the quality of undergraduate engineering education in the United States.

Rincón Joins Institute of Construction Sciences

Jesús Ma. Rincón, currently a research staff member with CSIC, (Consejo Superior de Investigaciones Científicas), the main research organization in Spain, has joined the CSIC's Institute of Construction Sciences in Madrid where he will serve as chairman of the Glass-Ceramics Research Group. He will conduct several European Community projects on recycling of industrial wastes from the metallurgical industries into new glasses and glass-ceramics for building materials. For 23 years, Rincon has conducted research in glass-ceramics, their processing, and microstructural and microanalytical characterization, mainly by electron microscopy and physical and technological characterization. He recently began focusing on the recycling of industrial wastes in these and new materials. A visiting professor at the University of California's Materials Science Department during 1984–85, he has also served as the general secretary and editor-in-chief of the Spanish Glass and Ceramic Society.

S.R. Nutt Named to M.C. Gill Chair

Steven R. Nutt, professor in the Department of Materials Science, University of Southern California, has been named to the M.C. Gill chair in composite materials. He will direct the newly formed Center for Composites Research, an interdisciplinary body with a focus on composites science and engineering, and will also serve as codirector of the Center for Electron Microscopy and Microanalysis.

Previously a professor at Brown University, Nutt directed its Electron Microscopy Facility from 1987 to 1993. He is the author or co-author of more than 50 articles and two book chapters on composite materials.

Pressure Increases Production Speed of Carbon-Carbon Composite

Scientists at the Georgia Institute of Technology report that forced flow-thermal gradient chemical vapor infiltration can reduce the time required for producing carbon-carbon composite parts. They say they can currently deposit the carbon matrix about 30 times faster than in conventional processes.

The process also allows more specific control of material characteristics, and could even produce thicker components than those currently produced. The material's light weight and ability to withstand high temperatures make it attractive for use in jet, rocket, and gas turbine engines. Its high thermal conductivity also makes it ideal for managing heat in electronic equipment.

The new process uses pressure to force carbon containing propylene, propane, or methane vapor through the layers of fabric, which are heated to 1200 °C in an electric furnace. The flow provides faster infiltration, producing finished parts one centimeter thick in as little as eight hours. Since the forced flow process ensures that infiltration will occur, it can be operated at a wider range of processing conditions than conventional techniques. Researchers believe this flexibility will help materials scientists tailor the carbon-carbon

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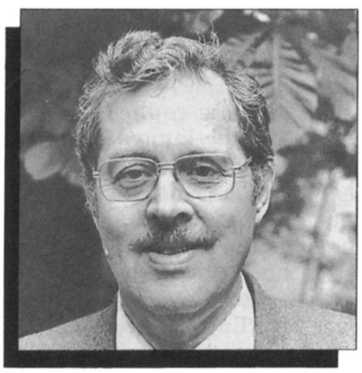
composite to specific needs. That flexibility may also allow the addition of special graphitization catalysts or oxidation inhibitors to the fiber-reinforced composite as it is being formed.

Development of the process is supported by the U.S. Air Force's Office of Scientific Research. W.J. Lackey, principal research scientist at the Georgia Tech Research Institute, is collaborating in the work with Pradeep Agrawal in Georgia Tech's School of Chemical Engineering.

Acta Metallurgica Medal Awarded to Haasen

Peter Haasen has been posthumously awarded the 1994 Acta Metallurgica Gold Medal, an international award recognizing outstanding ability and leadership in materials science. Haasen was director of the Institute for Metal Physics at the University of Göttingen in Germany until shortly before his death on October 18, 1993.



Haasen is best known for his work with Labusch on the theory of solid solution hardening in alloys and for his work on the dynamics of dislocation motion in semiconductor (diamond cubic and zinc blende) crystals and on the decomposition of crystalline and amorphous alloys using atom-probe field-ion microscopy. His textbook, *Physical Metallurgy*, has been translated into Japanese and Chinese, and is in its second edition.

After obtaining his undergraduate and graduate degrees from the University of Göttingen, he was a research fellow at the Institute for the Study of Metals at the University of Chicago and also at the Max-Planck-Institut für Metallforschung in Stuttgart and then assistant professor at the University of Stuttgart. He has also been a professor and dean of the faculty of science at Göttingen.

His distinguished career also included the following honors: the Georg-Heyn Award of the Deutsche Gesellschaft für Metallkunde, the R.F. Mehl Award of TMS-AIME, the Van Horn Distinguished Lecturer at Case Western Reserve University, the Le Chatelier Grand Medal of the Société Française de Métallurgie, and the German-French Alexander von Humboldt prize for Franco-German cooperation. In addition, he was a founding member of the European Academy of Arts and Sciences.

The medal will be presented to Mrs. Haasen in Göttingen on October 7, 1994, at a commemorative day for Mr. Haasen.

Optical Tweezers Provide Insights into Polymer Physics

Researchers at Stanford University are using a recently developed tool called "optical tweezers" to directly manipulate individual molecules—in this case, polymer strands—to gain insights into the physical properties of polymers at the molecular level. Previously, only bulk properties have been studied.

The development of optical tweezers is an offshoot of the use of lasers to cool down groups of atoms to extremely low temperatures. With precisely tuned lasers, the scientists were able to slow the atomic velocities down to a few centimeters per second. Using another laser beam, they were able to trap and manipulate microscopic particles immersed in water. Although the tweezers worked well on spheres, they did not work directly on individual molecules like polymer chains floating in water. Finally, researchers attached strands of viral DNA (also a polymer) to a sphere's surface. In addition, they used a dye that selectively attached to DNA and made it fluoresce brightly enough to be seen clearly with a high-resolution video camera.

In the first of two papers that appeared in the May 6 issue of *Science*, researchers measured the time it took DNA strands of different lengths to snap back, or relax after being fully extended. Next, using the optical tweezers, they stretched the DNA out while moving the microscope stage sideways. When the chain was fully extended, they stopped the stage and allowed the polymer to return to its undisturbed length. Results were consistent with existing theory called "dynamic scaling" that states that the time it takes for polymers to relax varies as a power of the length. Relaxation times varied as a power of 1.6 with the length, so that a polymer strand twice as long took about three times as long to relax while one three times the length took 5.8 times longer.

(continued on p. 8)

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The second paper provides descriptive support for the movement of tangled bunches of polymers by reptation. Developed by Pierre-Gilles de Gennes, this theory proposes that an individual polymer in such materials must move like a snake crawling through a large tangle of other snakes. It can move easily forward or backward along its length, but sideways motions are restricted by adjacent polymer strands that push in from every direction.

Reptation theory helps explain the unusual properties of Silly Putty™ and Crazy Glue™, both polymers. When Silly Putty is thrown against a surface, the impact comes faster than the polymer chains can rearrange themselves, so they act as if they are solid and the ball bounces. When subjected to forces over longer periods of time, as when pressed by hand, the strands have time to respond so the material can be molded into different shapes. Reptation also underlies the process of plastic welding, the secret of Crazy Glue. The glue causes the chains from different types of plastic to intertwine and interlock, forming a very strong bond.

The researchers added large amounts of undyed DNA aqueous solution along with a dyed DNA strand attached to a plastic sphere. Using the optical tweezers, researchers moved the sphere rapidly along complicated, looping paths while the DNA strand unraveled behind. After the sphere was stopped, the polymer began relaxing and contracted along the same path that the sphere had traced out.

Prof. Steven Chu and graduate students Thomas T. Perkins, Douglas E. Smith and Stephen R. Quake (Oxford University) contributed to the relaxation studies. The research was supported in part by grants from the U.S. Air Force Office of Scientific Research, the National Science Foundation, and an endowment established by Theodore and Frances Geballe.

0.1 Micron Transistors Yield High Performance

Researchers at the Massachusetts Institute of Technology have reported the highest performance to date of transistors with channel lengths of 0.1 micron, about seven times shorter than transistors in the most advanced commercial semiconductor chips available today.

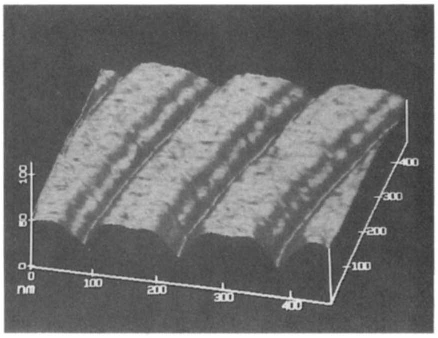
The transistors exhibit the highest electron velocity to date for a given amount of drain-induced barrier lowering (DIBL), an undesirable "short-channel effect" which arises when transistors are shrunk below about 0.25 micron channel length. The effect was minimized by implanting ions in such a way that the output of the transistor was well-isolated from the input.

The researchers used x-ray lithography to pattern the critical gate portion of the transistor, which regulates the flow of electrons. Because x-ray lithography is more economically feasible in manufacturing than other methods such as electron-beam lithography and photolithography, the MIT team feels this could, perhaps, change current practices in the semiconductor industry.

These results were reported in a paper presented at an international conference on VLSI technology in Honolulu, June 7–9, 1994. Authors of the paper are Hang Hu, Lisa Su, Isabel Yang, Dmitri A. Antoniadis, and Henry I. Smith.

Layered Nanoscale Thallium(III) Oxide Superlattices Achieved

Researchers in the Graduate Center for Materials Research at the University of Missouri-Rolla reported in the June 10 issue of *Science* that it is possible to electrodeposit nanoscale layered structures based on thallium(III) oxide in a beaker at room temperature. The layered structures were created by pulsing the applied potential during deposition.



STM image of cleaved thallium(III) oxide defect-chemistry superlattice deposited by pulsing the overpotential between 90 and 300 mV. The higher overpotential layer has a higher apparent height in the STM image.

The oxide used to grow the superlattices is atypical, having the electronic properties of metals and the optical properties of degenerate semiconductors. The defect chemistry of thallium(III) oxide is a strong function of the applied potential. High overpotentials favor oxygen vacancies, while low overpotentials favor cation interstitials. The transition from one defect chemistry to another in this nonequilibrium process occurred in the same overpotential range (100–120 mV) that the rate of the back electron transfer reaction becomes significant.

Scanning tunneling microscopy demonstrated that the conducting metal oxide samples were layered. X-ray diffraction was used to show that samples with layers as thin as 6.7 nm were superlattices. A typical superlattice has thousands of these nanoscale layers. The epitaxial structures are a new type of superlattice having the high carrier density and low electronic dimensionality of high T_c superconductors.

The research was directed by Jay A. Switzer, professor of chemistry at the University of Missouri-Rolla.

Chaudhari Directs Trieste Physics Center

Praveen Chaudhari, senior physicist with the IBM T.J. Watson Research Center, has been chosen to direct the International Center for Theoretical Physics (ICTP) in Trieste. The Center specializes in training physicists from developing countries. The selection was made by the governing council of the ICTP which met at the International Atomic Energy Agency, Vienna, in June.

Chaudhari has written more than 150 technical papers and has served as a senior adviser to both the U.S. and Indian governments. With Merton C. Flemings, he co-chaired the Committee on Materials Science and Engineering, which produced the report, *Materials Science and Engineering for the 1990s: Maintaining Competitiveness in the Age of Materials*, for the National Research Council.

Former ICTP director Abdus Salam retired at the beginning of the year.

Fullerenes Speed Diamond Film Growth

A technology developed at Argonne National Laboratory uses buckyballs (fullerenes) as a direct source of carbon to produce diamond films at least six times faster than current methods. Argonne chemist Dieter Gruen, who invented the process, said, "Growing them six times faster could reduce costs as much as 75 per cent."

The usual process for growing diamond films uses hydrogen and methane; the methane provides carbon for continuing film growth. But in this method carbon cannot attach to the film until hydrogen carries out a series of reactions, freeing the carbon and opening a place on the

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film surface to which carbon can bond. This results in hydrogen contamination of the film.

Argonne's approach, Gruen said, is faster because it eliminates hydrogen and methane and their associated intermediate steps. In the new process, microwaves excite a mixture of argon gas and fullerene vapor to break buckyballs into carbon atoms that bond directly to the film, producing a purer film more efficiently.

The projected market for diamond films is $4.5 billion annually by the year 2000. The work on growing diamond films directly from fullerenes was funded by the Department of Energy's Office of Advanced Energy Projects.

ACA Awards Go to Bedzyk and Coppens

The 1994 Martin J. Buerger Award of the American Crystallographic Association has been given to Philip Coppens, distinguished professor at the State University of New York, Buffalo. The award recognizes his pioneering roles in developing diffraction methods to accurately determine electron density in molecules and transition metal complexes, in applying synchrotron radiation to problems in chemical crystallography, in developing methods to analyze modulated structures, and in studying the response of crystals to rapidly changing external perturbations. The author of 240 scientific publications, he is currently president of the International Union of Crystallography.

The ASA's 1994 Bertram Eugene Warren Diffraction Physics Award has been given to Michael J. Bedzyk in recognition of his advances in the study of surfaces and interfaces through the use of variably period standing waves. Bedzyk opened up a new field in wet and dry interface research through the realization that the reflection from a mirror was the (000)Darwin diffraction condition and could be used to generate a variable period standing wave for studying thin-film and interface structures on length scales up to several hundred angstroms removed from the reflecting surface. Educated at the State University of New York at Albany and at Brockport, Bedzyk is currently an associate professor in the Department of Materials Science and Engineering at Northwestern University and also a staff scientist in the Materials Science Division at Argonne National Laboratory. □