SUMMER/FALL 2001 | Vol. 3, No.1

TECHSTRACKS

MATERIALS AND NUCLEAR ENGINEERING

A newsletter for alumni and friends of the Department of Materials and Nuclear Engineering

INSIDE

Department Showcases Research

On June 7, 2001, the Department proudly hosted its first Research Review Day, formerly known as the "Board of Visitors' Meeting and Industrial Outreach." A total of twenty companies and 85 visitors participated and observed the selected posters of our graduate and undergraduate students.

THE DAY STARTED WITH DEAN Nariman Farvardin's overview of the Clark School of Engineering. The School, with its top twenty ranking, has become a national leader in interdisciplinary research and advanced technology. The presentation by Chairman Aristos Christou entitled "Materials Engineering for the 21st Century," discussed how the Department is making significant contributions in nanomaterials, organic materials, molecular electronics and materials processing.

Our contributions in titanium alloys (S. Ankem, et. al.) have made significant contributions in enhancing the strength-to-weight ratios of Naval aircraft. Multi-laminate composites coupled with stainless steel inserts have revolutionized how snow skis and snowboards are constructed. The work of our thermodynamics and microscopy groups has achieved a new understanding of phase transformations in carbon. The investigations of Peter Kofinas and Otto Wilson have concentrated on materials made by nature: bio/membranes and dental implants. Advanced materials for microelectronics investigated by our faculty have ranged from liquid crystal displays, to new dielectrics, to engineered compound semiconductors. Nanoscience in the Department now consists of molecular engineering nanoscience and NMEMs, battery electrodes and energy storage, vacuum microelectronics, nanomolecular composites, and nanostructures from organic polymers.

"Fueling the IT Engine—The Role of Materials" was the key subject matter covered in Professor Gary Rubloff's presentation.

The overview of nanotechnology and nanomaterials by Professor Gottlieb Oehrlein presented a very thorough review of the department's contributions to nanotechnology. Our world-class capabilities in scanned probe instruments include the work on scanning tunneling microscopy by Ray Phaneuf. Self-assembly and nanomaterials are extremely important in the department as shown by Kofinas' work on metal oxide nanoclusters and Robert Briber's work on nanoporous dielectrics. DNA self-assembly on inorganic surfaces has many unique possibilities for DNA memory as is shown by the work of Mohamad Al-Sheikhly. Other investigators include quantum dot devices and the focused ion beam patterning of diamond films.

Organic materials research in the department was reviewed by Dr. Kofinas. Organic materials are a key area of research for the department and ranges from liquid crystals (Luz Martinez-Miranda) to organic nanocomposites (Wilson), nanoparticles, DNA hybridization and block-copolymers (Kofinas). The work by the polymer group headed by Dr. Kofinas includes molecular imprinted hydrogels, phosphate binding hydrogels, self-assembly of nanoclusters and

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Message From the Chair

WELCOME TO THE SECOND decade of our existence. The completion of academic year 2000-2001 marked the completion of our tenth year, and what a decade it has been! During our first decade, the university and funding agencies have invested approximately six million dollars just in the department's materials science research infrastructure, which in turn has resulted in close to fifty million dollars of research expenditures by our faculty. The last decade has seen a significant expansion of materials faculty and research, the creation of a new reliability engineering program, and a movement of nuclear engineering towards reliability, safety and risk.

I welcome our friends, students and alumni to a newly formatted newsletter. We seek your contributions and comments to this publication, with which we hope to reach over 5,000 readers. In reviewing the events leading up to September, we awarded 16 Ph.D. degrees, 30 M.S. degrees and 12 B.S. degrees during academic year 2000-2001. We created and are administratively responsible for two new centers of research, The Center for Combinatorial Materials Synthesis and the Center for Optoelectronic Devices Interconnects and Packaging (COEDIP). Our faculty's research expenditures topped the seven million dollar mark, and included the initial funding of a Department of Defense MURI (Multi-University Research Initiative) on Multi-Ferroic Thin Film Materials (PI-Manfred Wuttig).

As we strive to continuously improve our academic programs and research infrastructure, the next decade will bring many exciting changes—stay tuned.

researchNOTE

Smart Actuator Licensed to TiNi Alloy

A SMART MICROACTUATOR HAS emerged from a University of Maryland lab and has landed in the research and development pipeline of TiNi Alloy Co., of San Leandro, California. TiNi Alloy recently licensed the patented composite shape-memory microactuator from the Office of Technology Commercialization and is developing it into a novel latching mechanism for fiber-optic technologies.

The microactuator, invented by Manfred Wuttig, a professor in the Department of Materials and Nuclear Engineering, and former research associate Quanmin Su, is made from a class of metals called shape-memory metals. These smart metals can be programmed to assume a particular shape when cooled below transformation temperature and then return to their original shape when heated above transformation temperature. The shape-memory alloy nickel titanium is commonly used to perform actuations because it is a reliable, high-strength and lightweight material.

Shape-memory alloy actuators are traditionally made by depositing a thin film of a shape-memory alloy, like silicon, on a substrate. The substrate is then removed so the shape-memory can perform its actuation. Wuttig's microactuator can be made and used without removing the substrate, simplifying the manufacturing process. The microactuator includes an elastic, stress-compensating film that has the same thermal properties as the shape-memory alloy film but doesn't have the shape-memory effect. This improves the microactuator's switching capabilities because the action occurs against the elastic deformation of the stress-compensating film, causing internal stress that influences the phase transformation and produces a more efficient reverse shape change.

—Megan Michael

This article has been reprinted from Maryland Research Magazine.

Step Right Up and Test Your...*Materials*?

Materials and Nuclear Engineering Students help bring “Boardwalk” to Maryland

A SUNNY SPRING SATURDAY attracted over 66,000 alumni and friends to the university to celebrate the third annual Maryland Day open house. As part of the festivities on April 28, 2001, the A. James Clark School of Engineering’s theme was “A Day at the Boardwalk.” Among the many booths and exhibits, faculty and students from Department of Materials and Nuclear Engineering added their own attractions to the fun.

Materials Science and Engineering undergraduate students designed a “high hitter,” the backdrop of which listed different types of materials, as well as the different departments of the Clark School. Participants were offered a chance to ring the bell with a sledgehammer and win a prize. Whereas everyone who swung the hammer walked away a winner there, only those who actually bounced a ball into a fish bowl went home with a new friend in the Nuclear undergrads’ ping-pong ball toss.

The Materials Science faculty demonstrated shape memory alloys and a superconductor. Observers watched as faculty members altered the original shape of an alloy and then heated it, at which point it returned to its original shape. They also saw liquid nitrogen being used to cool a superconductor to below its transition temperature, allowing the levitation of a magnet.

Although not your usual attraction on your typical boardwalk, Nuclear faculty and students offered tours of the university’s nuclear reactor. This training reactor is not enclosed on the top so that its core may be directly observed. Participants in the Maryland Day tour were also able to look into the core of the operating reactor during the tour, as well. T

Research Review Day
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a nanoscale solid-state battery. However, the work extends even to environmental engineering covering anion remediation and toxic pollutant remediation from wastewater.

The role of risk technologies in engineering was reviewed by Mohamad Modarres. Risk technologies and its applications to enhancing the safety of nuclear energy provides the core funding for the Department’s research group in this area. Dr. Modarres also presented recent results from applications for enhancing food safety in the area of agriculture.

The research day concluded with the viewing of over 90 posters presented by our graduate students. The posters were judged by a selected group of industrial visitors and the top four posters received a monetary award, and more importantly, their placement for one year in the Department’s conference room. The event has now become an annual one, therefore be on the alert for our next research review day to be held in late Spring 2002. T

Clockwise from top left: Materials Science students with their “high hitter;” a young contender tests his muscles with the “high hitter;” visitors watch a memory alloy change shape; using liquid nitrogen to cool a superconductor

Oehrlein Brings New Plasma Laboratory to Department

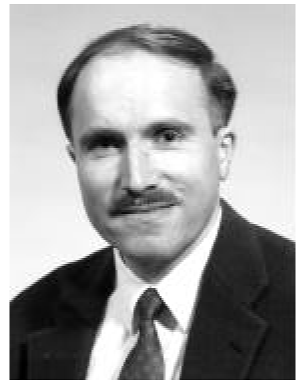
An array of state-of-the-art tools for plasma processing of advanced materials has become operational in the Department of Materials and Nuclear Engineering and the Institute of Research in Electronics and Applied Physics. The new facility, called the Laboratory for Plasma Processing of Materials, is located in the Energy Research Facility and directed by Professor Gottlieb S. Oehrlein.

A plasma, Oehrlein explains, is an electrified gas consisting of electrons, ions, and neutrals; it is also known as the "Fourth State of Matter," in addition to the solid, liquid and gaseous states. Plasmas occur naturally in the form of flames, lightning, astronomical nebulae, and interstellar matter like our sun, but man-made plasmas have recently become indispensable for advanced materials processing in many high-tech industries. The microelectronics industry employs plasma-based etching tools to produce the billions of microscopic features in thin films with precisely controlled dimensions that are required in computer chips; they also use plasmas to synthesize insulators, conductors, diamond thin films, solar cells, and high-temperature superconductors. Plasmas are also used to harden the surfaces of cutting tools and to modify surfaces of plastics so paint will stick to them.

Graduate student Xuefeng Hua and visitor Masanaga Fukusawa (Sony Corp.) performing surface analysis of plasma-treated material.

Plasmas are produced by adding energy to a gas. For instance, strong electric fields may be used to accelerate free electrons in a gas. The energetic electrons collide with the gas atoms and molecules, producing an electrified gas consisting of many different types of ions and energetic neutral atoms/molecules that are highly reactive. The production of such reactive species at temperatures close to room temperature has opened up a wide spectrum of new possibilities for the formation and manipulation of materials that was previously inaccessible.

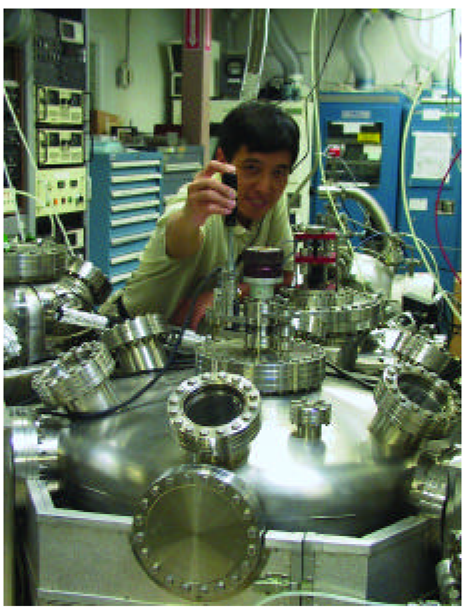
Even the simplest plasma processing tool is very complex. The major scientific theme of the research performed in the Laboratory for Plasma Processing of Materials is the characterization and understanding of the processes at the plasma-material interface that control the properties of the material that is ultimately produced. This research requires a variety of equipment, including reactors that can produce the plasmas, instruments that characterize the plasma and the plasma-treated materials, and measurement tools that evaluate the crucial variables that determine the ultimate usefulness of the materials and structures thus produced. The plasma studies also involve many collaborative efforts with industrial laboratories and universities throughout the world. For instance, a visiting scientist from Japan, Masanaga Fukusawa, will return to his homeland at the end of November, after spending more than a year collaborating with University of Maryland researchers on leading-edge research in the field of plasma-based materials. Fukusawa, who is on leave from his job at Sony Corporation, played an important role to establish together with Dr. Xi Li and graduate students Li Ling, Xuefeng Hua, and Xiang Wang, the new Laboratory for Plasma Processing of Materials. Fukusawa came to the University of Maryland to work with Dr. Oehrlein in order to investigate a number of issues related to the use of plasmas in the semiconductor industry. Fukusawa ultimately hopes to benefit from this work by being able to contribute aspects of this technology to Sony Corporation's Playstation III.



Dr. Gottlieb S. Oehrlein

"The goal of our work is to establish optimal plasma processes for advanced materials and produce predictive models of plasma processes," explained Oehrlein.

"For instance, about 30 to 40 percent of the equipment installed in computer chip-manufacturing plants today use plasmas, which will benefit directly from the work performed in the new laboratory." The plasma-related projects, he said, have received funding by the Department of Energy/National Science Foundation joint initiative on Plasma Science, the Semiconductor Research Corporation, International SEMATECH, and companies like Inficon and Air Products. T



Dr. Xi Li working on the multi-chamber vacuum system used for plasma processing of materials. Various plasma devices are connected to a ultra-high vacuum sample transfer system and a multi-technique surface analysis apparatus.

facultyPROFILE

Mirela Gavrilas

WHEN MIRELA GAVRILAS BEGAN her undergraduate studies in nuclear engineering in 1986, she had no idea that she would return ten years later as a faculty member in the same department. But when Dr. Yih-Yun Hsu (now Professor Emeritus) introduced her to the world of heat transfer and the developing 2x4 Thermalhydraulic Loop Facility—one of only three university integral test facilities in the U.S.—she was hooked. By her sophomore year, she received a Nuclear Regulatory Commission Senior Reactor Operator's License and became increasingly involved in nuclear science and the College of Engineering. In her senior year she was one of the two students asked in the College to name their favorite faculty member; of course, she chose Dr. Hsu. She was also chosen to give the address at her commencement ceremonies in 1990. When introducing her, Dr. George Dieter, then the dean of the College of Engineering, spoke about her desire to return to the university as a faculty member, although she had never told him of it directly.

Dr. Gavrilas did, however, talk about it with her faculty in the Department of Materials and Nuclear Engineering. The department faculty, together with Dr. George Dieter, Dr. Marilyn Berman, and Dr. Jim Newton, encouraged her to go to M.I.T. to get her Ph.D., and then return to Maryland.

Dr. Gavrilas is now an assistant professor in the Department of Materials and Nuclear Engineering and the Director of the 2x4 Thermalhydraulic Loop Facility, and has just overseen the completion of the facility's Organization for Cooperation and Development/Committee for Safety of Nuclear Installations' (OECD/CSNI) international standards problem for computational fluid dynamics code verification. This exercise was the first to use an integral test facility to obtain experimental data in this field.

She is also the Undergraduate Nuclear Engineering Program Director. In working with her students, Dr. Gavrilas remembers her own experiences as an undergraduate at the university. "I try to be very nurturing and encouraging with my students, just as my faculty were with me. I want to continue that tradition in the Department, and at Maryland." T

The Material World

By Megan Michael
Photography by John T. Consoli

From the nickel-based super alloys of jet engines to the ultra-pure glass that is the backbone for high-speed fiber-optic networks, new materials have contributed greatly to the scientific and technological advances that transformed our world in the second half of the 20th century. Now, as materials scientists and engineers try to gain even more control over the material world, they are promising to radically transform our lives yet again.

IT SEEMS OBVIOUS TO SAY THAT materials are everywhere. They make up the clothes we wear, the pots and pans we use for cooking, the cars we drive, the houses we live in and the computers we use at home and work. There are about 50,000 different materials that make up the various things in our world, and all are based on the 100-plus elements of the periodic table, combined and manipulated into new and useful substances.

Yet for all the materials we think of as the building blocks of our world—from cinderblock to fiber-optic cable—scientists say they represent only a fraction of the materials that will occupy our homes and workplaces in the 21st century. In fact, an entire new universe of high-tech materials is being explored and refined in the laboratories of scientists and engineers at the University of Maryland, where materials research has become a key area in the University's efforts to apply its work to problems outside of academia.

"Within the next 15 years, materials science and engineering projects will result in a whole bandwidth of new, rewarding technologies that will impact fields such as communications, health, environment and transportation," says Ramamoorthy Ramesh, a professor in the University's departments of physics and materials and nuclear engineering and associate director of the Materials Research Science and Engineering Center, or MRSEC. Ongoing projects at Maryland promise to drastically reduce the size and price of computers and other microelectronics devices, promote healthy living with detectors that can prevent skin cancer and sensors that can manage diabetes, and protect our environment by cleaning up polluted industrial wastewater.

At Maryland's MRSEC, more than 20 faculty members and research associates and assistants are working on materials science and engineering projects, from fabricating and manipulating the properties of nanostructures to improving the electrical, magnetic and optical properties of materials for sensors, process integration and computer and microelectronics memories.

The research spans three academic divisions—the College of Computer, Mathematical and Physical Sciences, the Clark School of Engineering, and the College of Life Sciences—and smaller departments. "Advanced technologies and new discoveries form the fields of physics, chemistry, mathematics and engineering have really powered materials science and engineering in the last 40 years," says Ramesh.

Maryland's MRSEC is part of the National Science Foundation's network of 29 Materials Research Science and Engineering centers across the country

that explore innovative materials and stimulate research and education within the field of materials science. Noting Maryland's strength in materials research, the NSF recently announced a major grant to be shared between Maryland's MRSEC and Rutgers, the State University of New Jersey. The joint center will receive $10 million over the next five years, of which approximately $9 million will go to Maryland. "Researchers on our campus are exploring novel uses of thin film metal oxides, studying the dynamics of surfaces and developing novel techniques to probe extremely small structures," called nanostructures, says Ellen Williams, professor of physics at Maryland and director of the joint center. In addition to the basic research, the center will take on educational outreach initiatives and foster greater collaboration with private industry.

The New Alchemy

DESPITE ITS MODERN, HIGH-TECH applications, the interdisciplinary field of materials science and engineering has its roots in a much older discipline—metallurgy, the science of metals. Metallurgy has always had an immensely useful role in human civilization, and advances in metals came to define entire periods of human existence, from the Bronze Age to the Iron Age and beyond.

As modern metallurgy and other scientific fields progressed, researchers began studying new materials, including super alloys, glass and polymers, which resulted in the birth of the new alchemy in the 1960s. That alchemy has lead to some of the greatest achievements of the late 20th century, including the information technology and microelectronics revolutions that put cellular phones and personal computers into the hands of everyday consumers.

Yet despite the myriad of substances that make up the objects in our world, almost all are derived from the four basic classes of materials—ceramics, electronics/photonics, metals, and polymers. These are the ingredients that materials scientists and engineers work with in their quest to make things faster, stronger, smarter, lighter, more durable, and cheaper. To accomplish these goals, they must first understand the structure, processing, and properties of materials—from the atomic level to the microscopic and macroscopic levels.

Left to right:
Ramamoorthy Ramesh, Professor of Physics and Materials and Nuclear Engineering, and Associate Director, Materials Research Science and Engineering Center;
Peter Kofinas, Assistant Professor of Materials and Nuclear Engineering;
T. "Venky" Venkatesan, Professor of Physics and Electrical Engineering, and R.D. Vispute, Assistant Research Scientist in Materials and Nuclear Engineering

Magical Memories for Microelectronics

RAMESH'S RESEARCH—SUPPORTed by the NSF and by industry leaders like Telecordia, Motorola, and IBM—is focused on enhancing the random-access memory of computers. Random-access memory, better known as RAM, is the driver behind most computer functions, facilitating the commands and communication within and between various programs and computer operating systems.

Integrated circuit memory chips have become increasingly important as personal computers and computerized equipment find their way into almost every facet of modern society, Ramesh says. Currently, dynamic random-access memory, or DRAM, is the hard-core fast memory that all personal computers use. But DRAM suffers from a need to be periodically refreshed and from losses of information in the event of a power failure or system crash. Traditional DRAMS use dielectric materials like silicon dioxide that are nonconductors of direct electric current, to provide support functions such as "read" and "write" commands.

"For years, researchers have been looking for new ways to make a nonvolatile memory that is fast like the DRAM but continues to store data after the chip has been powered down," Ramesh says. "And one way to capture this magical memory is with ferroelectric materials."

Ferroelectric materials are crystalline substances that have a spontaneous electric polarization reversible by an electric field, making them ideal candidates for a new kind of computer memory that holds information longer and more securely. Early research found, however, that capacitors manufactured with ferroelectric materials, after running through the loop of the two stable states a million times, weakened and lost their ferroelectricity.

Ramesh and his research team have been working on the ferroelectric memory solution for about 10 years. Typical to the field of materials science and engineering, their biggest breakthrough came about by accident. "Our original assumption was that to make a nonvolatile memory with ferroelectric materials, we had to make a film of ferroelectric single crystal so that there wouldn't be variations in properties across the film. We thought this would fix the problem of fatigue.

"It turns out that it was not the answer," adds Ramesh. But in the process of trying to make a single crystal film, Ramesh introduced something that others had not. Instead of using typical metals like aluminum, platinum, or gold to make a three-component capacitor, Ramesh used a conducting oxide metal yttrium barium copper oxide, or YBCO. "We put the YBCO first and last. Then all of a sudden the fatigue went away," he says. "The key to the invention was trying a new material combination and using the YBCO, because the chemical interface between a ferroelectric and a metal oxide is very different from the interface between a ferroelectric and a conventional metal."

Now Ramesh and his team are addressing the development and fabrication issues of ferroelectric random-access memory, or FRAM. "Some of the issues that we're trying to work out are understanding what happens to the properties of

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The Material World

continued from page 7

the materials as we approach the micro- and nanoscale and how to actually fabricate devices at these tiny scales," he says.

Already, Ramesh has been awarded 16 patents related to his FRAM research, and he is working with the university's Office of Technology Commercialization to transfer the FRAM technology from the laboratory to the manufacturing stage. "There is a lot of university and industry competition out there, including the big [integrated circuitry] companies like Toshiba, Hitachi, and Samsung," Ramesh says. "Because what we're designing here is a low-powered, non-volatile memory that could eliminate both the DRAM and the hard drive, drastically change the architecture of a computer and revolutionize microelectronics equipment of tomorrow, it has become a race to market."

Unique UV Detectors

T. "VENKY" VENKATESAN, PROFESsor of physics and electrical engineering, is wearing dual hats these days as a university leader in the field of materials science and an industry leader with his startup company, Neocera, Inc. of Beltsville, Md. Venkatesan founded Neocera in 1989 to apply research in using metal oxides for high-temperature superconductors to thin-film electronics. Today, Neocera is a mature microelectronics- and sensor-based instrumentation company with materials expertise in thin-film development and production.

Neocera pioneered the development of an important materials research tool called the pulsed laser deposition system, or PLD. The tool is used to process thin films of multi-component materials, including high-temperature superconducting films and thin films of ferroelectric materials. The PLD process involves placing a ceramic target in a vacuum chamber, where a pulsed laser beam vaporizes the surface of the target. The vapor condenses on a substrate, resulting in a thin film of complex material.

At Maryland, Venkatesan's research is focused on three technology areas—high-temperature superconductors, metal oxide thin films, and wide-band gap semiconductors. "The wide-band gap program has the potential to result in novel lightning materials," he says.

For the program, Venkatesan has joined efforts with R.D. Vispute, an assistant research scientist in the Department of Materials and Nuclear Engineering, to explore the use of metal oxides such as zinc oxide (ZnO) and magnesium zinc oxide (MgZnO) as wide-band gap semiconductors. "These wide-band gap semiconductors are the materials that can emit light in the blue region, so they can be used for a wide variety of applications such as blue light-emitting diodes and lasers, high power switches and transistors, and detection and sensors," Venkatesan explains.

With funding from the U.S. Army Research Laboratory, Venkatesan and Vispute have been able "to grow high quality MgZnO thin films that have superior thermal, electrical, optical, and mechanical properties," says Vispute. In one application of the MgZnO thin films, the team has developed a patent-pending ultraviolet light detector that can be activated and tuned to detect a certain range of UV light.

The detector could have immediate commercial applications, Venkatesan says, particularly for sunbathers and other people who spend a lot of time outside and are at risk of overexposure to damaging UV rays from the sun.

"The watch would have a UV-dosing meter that has an alarm that would go off when there has been enough sun on the body," says Venkatesan.

Other future applications of the UV detector include ultra-high temperature measurement devices, missile warning systems, communications, and information retrieval technologies. "The UV detector technology could bring about major changes to data storage equipment like compact discs and digital video discs," says Vispute. "CDs' storage density is largely determined by the wavelength of the probing laser. Using a short wavelength UV lasers would decrease the [area of information] on the disc, effectively quadrupling CDs' data-storage capacity."

Pharming Polymers

ANOTHER CRITICALLY IMPORTant area in materials science and engineering research is "developing the interface between materials and medicine," says Peter Kofinas, associate professor in the Department of Materials and Nuclear Engineering. "Some of the questions researchers in the medical area are asking themselves are, 'How do we get new materials to deliver drugs at various rates of delivery? How can we develop a drug that would last for a few days in a single dose?' or 'How do we make implantable sensors?'"

Kofinas is trying to find answers to these questions through his research in polymeric materials, which have broad crossover applications in fields ranging from microelectronics to environmental science. One of his main focuses is the development of new biomaterials—novel hydrogels—for use as pharmaceuticals or as sensors.

Polymers are very large molecules made up of smaller component molecules, called monomers, that can be linked together in various ways, resulting in microstructures like linear chains or dense, interconnected networks, explains Kofinas. Hydrogels are simply crosslinked polymer networks that are highly swollen with water.

Kofinas and his research team have developed polymeric hydrogels that can lock up glucose from food in the human body without being absorbed into the bloodstream, making it a potentially safe and effective method for controlling conditions like diabetes and obesity. The glucose-binding polymer, which is awaiting a patent, could lead to treatments for millions of people around the world who suffer with glucose-related health conditions. In another project, Kofinas has a patent pending on a glucose-sensing polymer that could be implanted in diabetic patients to detect and monitor hypoglycemia and to administer insulin.

Kofinas is also working on a method to use phosphate-binding polymeric hydrogels to treat polluted wastewater. The hydrogels are capable of removing conventional nutrient pollutants like phosphorus and nitrogen from wastewater as well as toxic contaminants like ammonium perchlorate. The technology, which is also awaiting a patent, could be used to treat various types of wastewater from industry, agriculture, and other sources, he says.

Materials Rewards

WHILE NOT AN EXHAUSTIVE LIST, these are a few of the areas where materials research and engineering at Maryland are advancing science and solving real-world problems. Moreover, according to a report from the Federal Coordinating Council for Science, Engineering, and Technology, continued development of advanced materials and engineering technologies is an important contributor to broader economic prosperity, environmental well-being, and overall quality of life in the United States. The report emphasizes that advanced materials research will contribute to increased energy efficiency, improved environmental quality, sustained national security, reduced health-care costs, the development of information super-highways, reconstruction of highways and bridges, and the production of new transportation vehicles that will carry the United States well into the 21st century.

Continued university-industry-government partnerships like those at Maryland are vital to the achievement of these and many more materials science and engineering rewards, for it is through the concerted research efforts and discoveries of these communities that we will be able to gain control and claim victory over the material world. T

This article has been reprinted from Maryland Research Magazine.

recentGRADUATEs

2000-2001 Ph.D. Recipients

La Rhonda Borum, "Enhanced Colloidal Stability of Hydroxyapatite" Advisor: Wilson — MSE
Robert Esser, "Niobium/Gold Thin Film Metallizations for GaAs Devices and Circuits" Advisor: Christou — MSE
Jason Edward Floyd, "Evaluation of the Predictive Capabilities of Current Computational Methods for Fire Simulation Using the HDR T51 and T52 Tests With A Focus on Performance-Based Fire Codes" Advisor: Wolf — NE
Chandan Ganpule, "Nanoscale Phenomena in Ferroelectric Thin Films" Advisor: Ramesh — MSE
Ingrid Jenkins, "Switching Dynamics in Lead Based Ferroelectric Thin Films" Advisor: Ramesh — MSE
Francisco Joglar-Billoch, "A Methodology for Fire Risk and Hazard Assessment" Advisor: Modarres — MSE
Fei Li, "Assessment of Pressure Vessel Failure Due to Pressurized Thermal Shock With Consideration of Probabilistic-Deterministic Screening and Uncertainty Analysis" Advisor: Modarres — RE
Maria Linnik, "Novel Devices and Heterostructures Based on Modulated Dielectric Properties of Materials" Advisor: Christou — MSE
Scott A. Matthews, "Processing and In Situ Characterization of Thin Film (TiNi) (TiPd) Shape Memory Alloys" Advisor: Wuttig — MSE
Frances Mayhew, "A Study of Oxidation Products in Thermally Aged Cellulose Film" Advisor: Block — MSE
K. Kevin Mun, "Hydrogen Transport and Distribution in a Passively Cooled PWR Containment" Advisor: Wolf — NE
Yuan-Te (Tony) Peng, "Hydrogen Sensor Based on Electroplated Palladium on Optical Fiber Bragg Grating" Advisor: Sirkis — MSE
Wendy Sarney, "Microanalysis of Semiconductor Thin Films for Military Optoelectronic Device Applications" Advisor: Salamanca-Riba — MSE
Zhibin Tan, "Methodology for Analyzing Reliability of X-Ware Systems" Advisor: Mosleh — RE
C. Wesley Tipton, "Pyroelectric Response of Perovskite Heterostructures Incorporating Conductive Oxide Electrodes" Advisor: Ramesh — MSE
Nagarajan Valanoor, "Impact of Substrate on Structure and Electrical Properties of Pb-Based Ferroelectric Thin Films" Advisor: Ramesh — MSE
Yiheng Xu, "Real-Time In-Situ Chemical Sensing, Sensor-Based Film Thickness Metrology, and Process Control in W-CVD Process" Advisor: Rubloff — MSE

Congratulations to the Class of 2001!

Members of the Materials Science and Engineering Undergraduate Class of 2001 (left to right): Gideon Schneider, Mark Usefara, William Choi, Allan Jaworkski, Brett Neuberger, Kevin McCarthy, Arthur Cresce, and Taesoon Kwon

SURF Program Finishes Second Year

THE DEPARTMENT OF MATERIALS and Nuclear Engineering recently completed the second successful year of its Summer Undergraduate Research Fellowship Program (SURF). Attracting students from such universities as Dartmouth, Iowa State, Rowan, and Virginia Tech, as well as the University of Maryland, this ten-week program matched eight undergraduate students with Materials Science faculty to conduct research, write a paper, and present their findings in a poster session on August 7, 2001. This session, attended by faculty and graduate students, allowed these students the opportunity to present their research in a conference or research review day format.

In addition to conducting research, the students attended weekly seminars led by faculty on a variety of materials related topics and participated in field trips to government agencies and private facilities.

The students, faculty mentors, and their research are as follows:

Dale Apgar with Dr. Sreeramamurthy Ankem: "Biomedical Applications of Titanium"

Charles Brooks with Dr. John Kidder: "Atomic Layer Chemical Vapor Deposition of Tantalum Oxide and Titanium Oxide Films"

Erin Camponeschi with Dr. Otto Wilson: "Silica NanoComposites for Biological Uses"

Jason Hattrick-Simpers with Dr. Ichiro Takeuchi: "Scanning Microwave Microscopy of Epitaxial Combinatorial $Ba_{1-x}Sr_xTiO_3$ Samples"

Michael Krashin with Dr. John Kidder: "Chemical Vapor Deposition of Strontium Niobate Films"

Corey Love with Dr. Sreeramamurthy Ankem: "Ambient Temperature Creep-Fatigue Interaction in Titanium Alloys and Intermetallics"

John Read with Dr. Ichiro Takeuchi: "Flip Chip Magnetic Tunnel Junctions"

Marta Vornbrock with Drs. Manfred Wuttig and Ramamoorthy Ramesh: "Heusler Alloy Thin Films: A New Class of Functional Materials" T

SURF participants, from left: John Read, Faculty Advisor Dr. John Kidder, Jason Hattrick-Simpers, Erin Camponeschi, Charles Brooks, Michael Krashin, Dale Apgar, Marta Vornbrock, Corey Love, and Dr. Ichiro Takeuchi

Alfred P. Sloan Foundation Sponsors Scholars

THREE PH.D. CANDIDATES IN THE Department of Materials and Nuclear Engineering are gearing up for the fall semester, after successfully completing their first year as Sloan Scholars.

Brian Harris, Randy Jacobs, and Olugbenga Famodu are currently pursuing their Ph.D.s in the areas of microwave processing of materials, thin films, and combinatorial synthesis, respectively. While any university would be eager to have such students matriculate on their campus, the Department of Materials and Nuclear Engineering obtained special funding and incentives for these students to earn their Ph.D.s at the University of Maryland.

The Sloan Scholarship, sponsored by the Alfred P. Sloan Foundation, is a program designed to increase the number of underrepresented minority students (African Americans, Hispanic Americans and Native Americans) receiving Ph.D.s in mathematics, natural science, and engineering. In deciding the award, the Foundation seeks mathematics, natural science, and engineering faculty who can successfully recruit, mentor, and graduate minority students from a Ph.D. program. It reviews the prospective faculty's past record and plans for minority student recruitment and retention, what role these faculty would expect to play with respect to Sloan Scholars, and the expectations for financial support of Sloan Scholars beyond the amount of the Slaon Scholarship. The Foundation reviews the participating faculty annually, the results of which can affect the scholarship amounts in subsequent years.

This scholarship program was underway in the Clark School of Engineering when Materials and Nuclear Engineering

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alumniPROFILE

C. Robert Crowe

Alumnus C. Robert Crowe (Ph.D., '75) is a professor at Virginia Tech, a joint appointment between Materials Science and Engineering and Mechancial Engineering. Also affiliated with Virginia Tech's Center for Intelligent Materials Systems and Structures, Dr. Crowe's research interests are aerospace metals and alloys, smart materials, and process modeling and simulation.

PRIOR TO JOINING VIRGINIA TECH IN 1998, DR. Crowe was most recently associated with the Defense Science Office of the Advanced Research Projects Agency (DARPA) in Arlington, Va. There Dr. Crowe was responsible for developing and supporting programs in advanced materials, especially in metal matrix composites, smart materials, metals and alloys, and materials processing science.

After receiving his B.S. (1967) and M.S. (1968) in metallurgy from the University of Tennessee, Dr. Crowe joined the Naval Weapons Laboratory in Dahlgren, Va., where he began his research on solving stress corrosion cracking problems in depleted uranium alloys and understanding high strain rate fracture and fragmentation, which received international attention. After receiving his Ph.D. in Materials from the University of Maryland in 1975, Dr. Crowe moved to the Naval Surface Weapons Center in Silver Spring, Md., where he became leader of the Corrosion Group. There he developed new electrochemical techniques to study the corrosion resistance of metals, alloys, and metal matrix composites, which are just now emerging as viable engineering materials.

In 1983, Dr. Crowe joined the staff of the Composites Section at the Naval Research Laboratory where he supervised the development of advanced metal matrix composites. This effort involved the development of unique processing technology to produce advanced MMC's and characterization of the products; it is anticipated that these materials will provide significant advances in future aircraft. In 1987 Dr. Crowe became the head of Physical Metallurgy Branch of NRL, responsible for a broad-based research program in physical metallurgy consisting of studies on phase transformations, ordered intermetallics, steels, titanium alloys, composites, welding and joining, high temperature effects, corrosion, and failure analyses.

In addition to his work with the federal government, Dr. Crowe was also an instructor at the University of Maryland where he taught senior and graduate-level courses in materials science and served on the reviewing committee of several Ph.D. candidates.

Dr. Crowe has authored or coauthored more than 90 publications and government reports. He is an editorial advisor for Advances in Corrosion Science and Technology, a reviewer for Metallurgical Transactions and other metallurgic journals, and reviews proposals for the National Science Foundation. He is listed in *Who's Who in the East*, is a member of Sigma Xi honorary and the AIME, and is a Fellow of the American Society for Materials. Dr. Crowe was issued a patent in 1976 for "Incendiary Alloys Existing as a Dispersion of Incendiary Particles in a Non-Incendiary, Atmospheric Attack Resistant Matrix." T

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Assistant Professor Otto Wilson, Jr., was interested in expanding the program to his department. "Professor Darryl Pines had already obtained the scholarship for students in his department, Aerospace Engineering. When I approached the Sloan Foundation to see if we include our students, we were told that we needed to submit a new grant application. I wrote the proposal for our department, and was thrilled to learn that we were funded for two additional Ph.D. candidates for the 2000-2001 year," he said.

The $40,000 award is to be used to support the students' costs of pursuing a Ph.D. The Scholar may draw on this money at any time during his/her tenure in the Ph.D. program to cover the cost of tuition, stipend, books, summer support while working toward the Ph.D., travel to professional meetings, or other approved purposes. In addition, to the grant from the Sloan Foundation, the University of Maryland generously offered matching funds. T

endNOTEs

The Joint ASM/TMS Student Chapter at the University of Maryland has won the 2001 ASM/TMS "Chapters of Excellence Contest for Promotion of the Field." The award, consisting of $500 cash and a framed certificate, will be announced at the Student Career Forum on November 4, 2001, in Indianapolis, Indiana, and presented to advisor Prof. Sreeramamurthy Ankem and chapter representatives at the TMS Annual Meeting & Exhibition Awards Banquet, Tuesday, February 19, 2002, in Seattle, Washington. Congratulations to all!

TECHSTRACKS is published several times a year for alumni and friends of the Department of Materials and Nuclear Engineering at the A. James Clark School of Engineering.

Your alumni news and comments are welcome. Please send them to: Techstracks Editor, Department of Materials and Nuclear Engineering, 2135 Chemical and Nuclear Engineering Building, College Park, MD, 20742-2115.

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