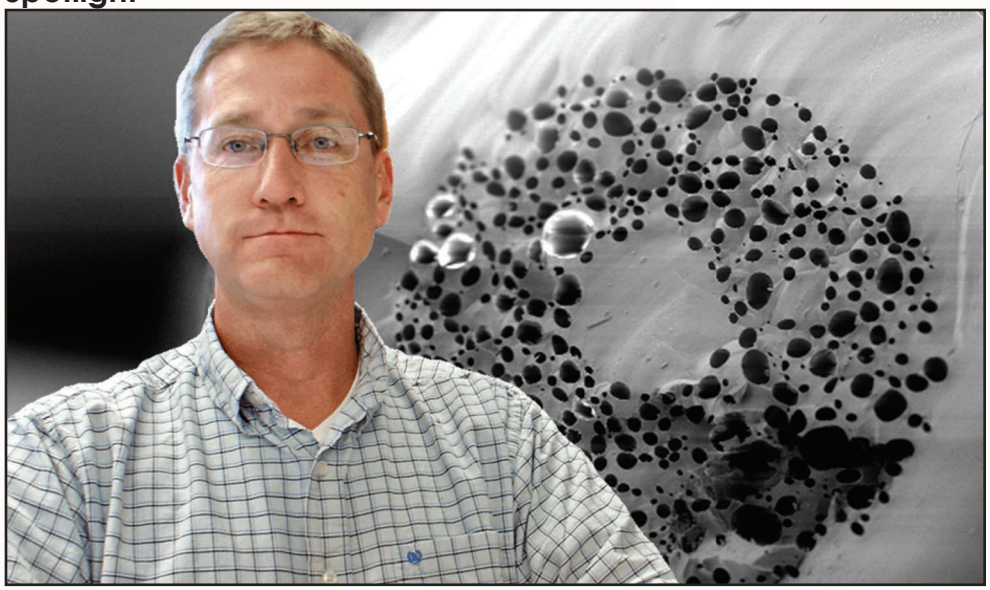
Exploring Materials at Virginia Tech

Fall 2009, Volume 12, Number 1

VirginiaTech Invent the Future

News from the Department of Materials Science and Engineering
Virginia Polytechnic Institute and State University

Research Spotlight



Professor Gary Pickrell and an SEM micrograph of RHOF

Bending Insensitive Fibers and Sensors: Two Key Applications for Random Hole Optical Fibers

by LeeAnn Ellis

"Optical fibers have found extensive commercial applications in the areas of communications and growing applications in the area of sensors," states Professor Gary Pickrell in recent published research. "Most of our long distance information transfer is being carried by light," he says, and fiber optic cables are the means by which that information travels, bringing us closer to our neighbors around the world.

Photonic crystal fibers (PCF) are fibers that improve the light guiding capabilities in optical fiber applications by incorporating ordered arrays of holes or tubes that guide light through the core of the fiber. These fibers began emerging in 1996, and the first commercial PCFs appeared on the market in 2000.

There have been barriers to bringing fiber optic technology into the home. "In applications such as this," Pickrell explains, "the normal construction process where electrical wires are fed through the wall studs and floor joists produces many sharp turns for the wires." For optical fibers, those unavoidable sharp turns can result in a significant loss of information,

continued on page 14

Edited computer simulation of bridging domains and mosaic domain microstructures of coexisting phases in PZT system at room temperature with near MPB compositions. W.F. Rao and Y.U. Wang, Appl. Phys. Lett. 90, 182906 (2007). Original Image description in page 15.

What's inside

Discover what we're made of...
www.mse.vt.edu

Research Corner

Meet Professor Gary Pickrell

by LeeAnn Ellis

By the time Gary Pickrell joined the faculty in materials science and engineering at Virginia Tech in 2004, he had already amassed an impressive industrial and research résumé. He speculates that a high school writing assignment probably sparked his interest in the field of ceramic engineering, and a ceramics-specific scholarship to Ohio State University offered further incentive to give the field a fair shake. "The more I learned about it the more I liked it," he said.

The eighth of nine children, Gary spent most of his growing-up years in Zanesville, Ohio. He is one of three engineers in a family that also includes a school principal, a business owner, a physician, and a nurse who became a lawyer. His father was a manager at Western and Southern Insurance Company, and his mother held a variety of jobs before opting to stay home and raise her five boys and four girls.

After completing bachelor's and master's degrees in ceramic engineering at Ohio State, Gary accepted a position as a research and development engineer with Owens Illinois in Toledo, where he entered into the world of product invention, scale-up, and manufacture. "That really peaked my interest," he said. "I realized that product development was a strong love of mine," as well as the science of invention. Some of the products he developed are still produced today, such as solid diffusion sources for doping silicon wafers, which are an alternative to gas diffusion sources and ion implantation.

When he decided to return to school for a doctorate in 1991, the search for a university meant finding one that met requirements for both himself and his wife Claire, a fellow ceramic engineer. At the time, they were both on the management team for Corning, Inc. in Ohio, and while Gary planned an educational leave of absence, Claire wanted to continue working for Corning. Penn State and Virginia Tech were two strong candidates with good programs in ceramic engineering and Corning plants nearby, and Virginia Tech proved to be the best choice. Gary studied under Professor Jess Brown, a long time faculty member in the MSE department with ceramics research underway.

Following completion of his doctorate, Gary spent the next year working as the general manager for Professor Brown's newly formed company, Materials Technology of Virginia (MATVA), before moving on to take a position with Selee Corporation in North Carolina, where he was again bitten by the product invention bug, this time developing a method to make very low density materials through a relatively low cost and simple process. This invention resulted in several patents and a Selee spin-off company called Porvair Advanced Materials where Gary served as the Technical Director.

He credits former classmate, Russ May, with orchestrating his return to Virginia Tech. Gary and Russ met while both were doctoral students in the materials engineering science program. "Russ was an extremely bright guy and an entrepreneur at heart, so we became friends right away." After Gary went to work for Selee Corporation, Russ would often contact him to chat or with materials questions relating to fiber optics, and one day Russ brought up the idea of Gary returning to the Electrical and Computer Engineering Department (ECE) at Virginia Tech to work on fiber optics.

"It sounded like an exciting opportunity," Gary says. "I was very interested in fiber optics and had some ideas on different types of fibers." Both he and Claire liked the area, so in 1999 they returned to Blacksburg, and Gary started out in the ECE department as a senior research scientist.

Professor Pickrell also taught classes in materials science and engineering and became an affiliate of the MSE department in 2000, and finally joined the MSE faculty in 2004. He serves as the director of the NanoBio Materials Laboratory, and he is the associate director for the Center for Photonics Technology in the ECE department, a position he has held since 2002. The Center for Photonics Technology turned out to be a wonderful place to pursue ideas. "Professor Wang, the director of the Center, gave me a lot of freedom to pursue ideas and run experiments in the area of fiber optics. I learned so much in such a short period of time, it was a great opportunity."

Professor Pickrell has received several honors in recent years. In 2004, he received an R&D 100 Award and an Outstanding Achievement Award, both related to his work with fiber optics and photonics. He has been on the Academic Dean's List for Teaching numerous times. He received a Virginia Tech Outstanding Assistant Professor Award in 2005, and in 2007, he was awarded a College of Engineering faculty fellowship. In 2008, he was promoted to Associate Professor with tenure.

The invention of new things features heavily in most of Professor Pickrell's career highlights. "That's what really drives me," he observes. "I've been very fortunate in the places that I've worked to have opportunities to do research and to invent products and to follow those products through into commercialization." He had already been awarded seven patents in 2004 when he joined the MSE department, and he has added six more since then, along with many patent applications and disclosures still pending.

One of his latest inventions, which he considers his best to date, is in the area of optical fibers and features a new type of optical fiber called the random hole optical fiber, for which two patents have recently been awarded. "It is essentially a fiber that guides light based on the fact that it has a lot of randomly sized and spaced holes in the cladding region," Gary explains. Bend sensitivity has been a huge issue in fiber optics, especially in fiber to the home telecommunications applications, where cables turning corners could result in a substantial loss of information. This work is further de-

continued on page 13

Jeremiah Abiade Receives Ralph E. Powe Junior Faculty Enhancement Award

by Susan Trulove

Jeremiah T. Abiade, assistant professor in materials science and engineering and in mechanical engineering at Virginia Tech, has received a Ralph E. Powe Junior Faculty Enhancement Award for his research to increase the electrical output of thermoelectric (TE) materials and devices.

Oak Ridge Associated Universities (ORAU) presents the Powe Award to faculty members who are in the first two years of their tenure track as an investment in promising achievements in an important area. The award to Abiade will support his research to fabricate thick and thin film oxide thermoelectrics. His group is interested in improving the thermoelectric properties of doped strontium titanates, a type of oxide material. "We are interested in oxides in general because they have very interesting properties, such as the ability to be either insulating or superconducting, and they are generally very stable at high temperatures," he said.

His group conducts their research in the Laboratory for Oxide Research and Education. The group has synthesized several samples with inert, metallic nanoparticles embedded in the bulk strontium titanate material, and is measuring the thermal transport properties in collaboration with mechanical engineering Assistant Professor Scott Huxtable and the Virginia Tech Nanoscale Energy Transport Lab.

Professor Abiade received his bachelor's degree in physics from Southern University and A&M College in 1999 where he was a member of the Timbuktu Academy and his Ph.D. in materials science and engineering from the University of Florida in 2004. He was a postdoctoral associate in the North Carolina A&T State University Department of Mechanical and Chemical Engineering before joining the faculty at Virginia Tech. ❄

Kathy Lu Receives National Ceramic Engineering Award

by Susan Trulove

MSE Assistant Professor Peizhen Kathy Lu received the 2008 Karl Schwartzwalder-Professional Achievement in Ceramic Engineering Award.The American Ceramic Society Board of Directors, upon the recommendation of the Award's Sub-committee, unanimously chose Lu for the honor. This award recognizes the nation's outstanding young ceramic engineer whose achievements have been significant to the profession and the general welfare of the American people, according to the American Ceramic Society. The awardee should have been active in civic, educational, and social areas based on her technical expertise, and have made significant technical contribution to the discipline and the society.

Professor Lu directs Virginia Tech's Innovative Particulate Materials Laboratory and concentrates her research on nanomaterials, fuel cell material design, composites, materials design, and powder synthesis. She obtained her bachelor's and master's degrees in ceramics from Tianjin University, China, in 1990 and in 1993, respectively. She obtained a second master's degree and her doctorate in materials science and engineering from Ohio State University in 1999 and 2000. ❄

Norman Dowling Named Frank Maher Professor

by Mark Owczarski

Norman Dowling, professor of engineering science and mechanics and materials science and engineering, has been awarded the Frank Maher Professorship in Engineering by the Virginia Tech Board of Visitors.

A member of the Virginia Tech community since 1983, Professor Dowling currently conducts research on fatigue, fracture, and deformation; damping in concrete; statistical and deterministic characterization of loading; life-prediction for complex loadings; and biomechanics and biomaterials. His book, "Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue," has been widely adopted and often cited. His text is used in more than 50 engineering programs in the United States and universities abroad.

He has co-authored a laboratory manual, a chapter in another book, Volume 19 in the "Handbook of the American Society of Materials International," more than 60 articles in journals and proceedings, and numerous reports. His research has been supported by the United States Navy, Air Force and Army; NASA, and many companies; the total support on all projects is approximately $2.5 million.

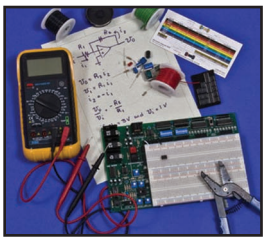
Professor Dowling is a Fellow of the American Society of Testing Materials and has received the Award of Merit and an Outstanding Achievement Award from that organization. He is serving, or has served on the Editorial board of the Journal of ASTM International, Journal of Fatigue and Fracture of Engineering Materials and Structures, International Journal of Fatigue, and the American Society of Mechanical Engineers Journal of Engineering Materials and Technology. ❄

Department News

College of Engineering Receives Grant to Fund Expansion of University's Lab-in-a-Box Program Online

by Steven Mackay

MSE Professor Bob Hendricks is co-principal investigator in a National Science Foundation grant awarded to the College of Engineering to expand its Lab-in-a-Box program for electrical and computer engineering classes. The almost $500,000 four-year grant is designed to reach online students, while helping Blacksburg students with after-hours questions. Professor Hendricks will work with Professor Kathleen Meehan from the Department of Electrical and Computer Engineering who serves as the principal investigator for the grant, Peter Doolittle, associate professor in the Department of Learning Sciences and Technology and director of the Center for Excellence in Undergraduate Teaching (CEUT). Professor Richard Clark, head of the engineering program at Virginia Western Community College will also participate on the grant.



The project builds on previously NSF-funded work that helped Professor Hendricks and others within Virginia Tech develop Lab-in-a-Box, an inexpensive laboratory kit that allows students enrolled in a lecture-based beginning electrical engineering class to design, build, and test various DC and AC circuits at home. Funding from the four-year grant project will be used to expand the use of the boxes to electrical engineering online classes, serving not only Virginia Tech students, but those outside Blacksburg. Many students at Virginia Western Community College in Roanoke, Va., Piedmont Virginia Community College in Charlottesville, Va., and J. Sergeant Reynolds Community College in Richmond, Va., already use the box in various classes, but the grant money will expand this option to those who do not have a laboratory class as an option. ❄

Engineering Professor Wins $100,000 Air Force Young Investigator Award

by Steven Mackay

The U.S. Air Force Office of Scientific Research has awarded Shashank Priya, associate professor of materials science and engineering and mechanical engineering in the College of Engineering at Virginia Tech, a $100,000, three-year renewable grant to conduct basic research in the area of high-frequency electronic components, titled Domain Engineered Magnetoelectric Thin Films for High Sensitivity Resonant Magnetic Field Sensors.

Magnetoelectric thin films based structures comprised of piezoelectric and magnetostrictive composite layers can enhance the performance of current generation communication devices. The electronic components developed using magnetoelectric thin films for radars will be able to provide higher sensitivity and information while consuming less electrical power. In personal communication systems such as GPS, battery saving is a huge advantage, Priya said. The grant is part of the Air Force's Young Investigators Research Program (YIP) award. Professor Priya was among 39 outstanding scientists and engineers who submitted winning YIP proposals this year. The program invests in various research fields with the goal of developing valuable products for the military and commercial market, according to the Air Force.

Professor Priya taught at University of Texas at Arlington before joining the Virginia Tech faculty in 2007. He received his Ph.D. from The Pennsylvania State University in 2003 in materials engineering, a master's degree from Indian Institute of Science in 2000, and his bachelor's degree from Allahabad University in 1995. ❄

Marie C. Paretti Earns National Science Foundation CAREER Award for Investigating Capstone Experiences

Marie C. Paretti, assistant professor in the Department of Engineering Education, and director of the Materials Science and Engineering and Engineering Science and Mechanics Communications Program, recently earned a $405,308 National Science Foundation (NSF) Faculty Early Career Development (CAREER) award for her research regarding the experience of engineering capstone design courses both for students and faculty. The goal of her research, titled "An Exploration of Faculty Expertise and Student Learning in Capstone Experiences," is to better understand how this kind of teaching happens and what kinds of things faculty do to effectively balance their roles as teachers, evaluators, and mentors to best support student learning. Her findings will be used to help train the next generation of design faculty and increasingly enhance undergraduate engineering education.

Professor Paretti holds a bachelor of science in chemical engineering, a master of arts in English from Virginia Tech, and a Ph.D. in English from the University of Wisconsin, Madison. She joined the engineering education department at Virginia Tech in 2004. ❄

Glass-based Seal for Solid Oxide Fuel Cells Could Help Bring this Efficient Energy Technology to Market

by Susan Trulove

Solid oxide fuel cells (SOFCs) have great potential for stationary and mobile applications. Stationary use ranges from residential applications to power plants. Mobile applications include power for ships at sea and in space, as well as for autos. In addition to electricity, when SOFCs are operated in reverse mode as solid oxide electrolyzer cells, pure hydrogen can be generated by splitting water.

However, SOFCs have been flawed in the integrity of the seals within and between power-producing units. "The seal problem is the biggest problem for commercialization of solid oxide fuel cells," said Peizhen (Kathy) Lu, assistant professor of materials science and engineering at Virginia Tech. So, she has invented a solution.

Composed of ceramic materials that can operate at temperatures as high as 1,800 degrees Fahrenheit (1,000 degrees Celsius), SOFCs use high temperature to separate oxygen ions from air. The ions pass through a crystal lattice and oxidize a fuel, usually a hydrocarbon. The chemical reaction produces electrons, which

flow through an external circuit, creating electricity.

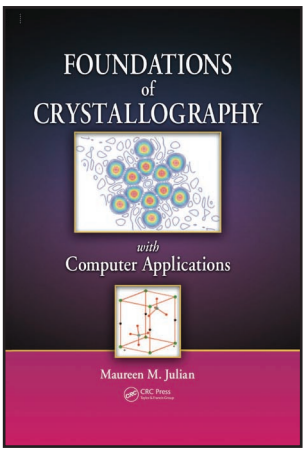
To produce enough energy for a particular application, SOFC modules are stacked together. Each module has air on one side and a fuel on the other side and produces electrons. Each module's compartments must be sealed, and there must be seals between the modules in a stack so that air and fuel do not leak or mix, resulting in a loss of efficiency or internal combustion. Professor Lu has invented a new glass that can be used to seal the modules and the stack. The self-healing seal glass will provide strength and long-term stability to the stack, she said.

The U.S. Department of Energy has funded Professor Lu's SOFC and solid oxide elecrolyzer cell research to the tune of $365,000 so far. "For solid oxide fuel cells to run, we need to have a fuel. Hydrogen is the cleanest fuel you can ever have since the by-product is water. However, there is no abundant source of hydrogen and it has to be made. The solid oxide elecrolyzer cell process for splitting water into hydrogen and oxygen is one very desirable way of doing it," she said.

"Our interest is to work on the critical material problems to enable power generation and hydrogen production in large quantity and at low cost," said Professor Lu, whose expertise includes material design and material synthesis and processing. Learn more about her work online at www.lu.mse.vt.edu/. ❄

Maureen Julian Formally Presents Foundations of Crystallography in Osaka, Japan

Dr. Maureen Julian formally presented her book, "Foundations of Crystallography with Computer Applications," CRC Press 2008, at the Twenty-First Congress and General Assembly of the International Union of Crystallography, held in Osaka, Japan, August 2008. The triennial congresses of the IUCr are the major international scientific meetings for crystallographers worldwide. Dr. Julian represented Virginia Tech at the meeting of 2,477 crystallographers from 66 countries. She presented papers in three symposiums on crystallographic education. The web site for her book is http://foundations-of-crystallography.com/ .



In the symposium on Teaching Crystallography in the 21st Century she gave a talk on "Teaching Through Student Presentations: A Festival of Crystals," which MSE graduates will recognize from her junior level crystallography class. At the beginning of the semester, each student chooses a crystal of interest such as quartz, caffeine, or polyethylene. Throughout the semester, calculations are done on these crystals, and at the Festival of Crystals each student's presentation includes the space group, the unit cell, the reciprocal lattice cell, the G and G* matrices, the powder diffraction file, and the populated unit cell. The students experience a wide variety of crystal structures, review the essential work of semester, and contribute meaningfully to the course.

In the symposium on Pitfalls and Successes in Crystallographic Teaching, Dr. Julian spoke about the "Use of Images from Neolithic Art, Clip Art, Digital Cameras, and MATLAB® in Teaching Crystallography." Textiles from the Neolithic art of

continued on page 13

Education Corner

The Materials Science and Engineering International Program

Professor Robert W. Hendricks, Associate Department Head and Director of MSE International Programs

Because we live in a global economy, it is increasingly important for students to have an appreciation and awareness of how manufacturing processes, techniques, methods, and practices vary throughout the world. Major corporations and even small businesses are looking for students with global experience and willingness to serve abroad. For example, in Germany, Dr. Clark and I met with one company who said that out of 100,000 qualified graduates that they could interview world-wide, the company typically hires 1,000 engineers. When asked how a student would distinguish herself/himself to get that one in a thousandth position, the company emphasized the student's global experience and readiness to deal with different cultures. I am hearing words to this effect from employer after employer.

As a result of this trip, the acknowledgment of the need for students to have global experience, and in response to one of Dean Benson's priorities, which is to increase opportunities for undergraduates to study abroad, our department gave birth to the MSE International Program in the summer of 2008. Our goal is to increase the opportunities for MSE students to have a global experience in the field of materials science and engineering through international collaboration with institutions around the world.

In developing our program, we have found that it is not necessarily important which language the student learns or which country the student visits. What is important is a) that the student learns a foreign language and b) the student learns something about the culture of the host country. These two learning objectives are intertwined especially when they are in the host culture. When they study a foreign language, they do not just learn words; it is almost inevitable that they learn the language through context (and thus, culture). Moreover, they will learn the culture's customs, their bureaucracy, what drives their quality and processes.

Second, no matter whom the students work for, the probabilities that they have to deal with international issues are high. The competition to move up to a senior management position most likely entails abilities to collaborate with different cultures. If the students exhibit competence in learning a foreign language and willingness to work with different cultures, they move to the front of the line for employment and promotion.

It is important to note that within the MSE department, international activity has always been alive and thriving. Faculty members have individual collaborations with different institutions outside the United States; we have graduate students from all over the world; and undergraduate students have studied abroad with the help of Virginia Tech's Study Abroad Program.

(L-R) MSE Department Head Dr. David Clark, Zhenduo Cui, Dean of School of Materials Science and Engineering at Tianjin Univeristy, and MSE Professor G.Q. Lu

What we are developing in the MSE International Program is strong collaboration, on a departmental level, with different institutions around the world. We aim to provide these international opportunities to our undergraduate students. We acknowledge that on a graduate level, the students are older and are more independently capable of working with international institutions. It is trickier at the undergraduate level because we are working with 18-23 year old students who often have never been out of the country. We want to provide a safe and secure experience—an environment in which the parents can have great confidence. In this sense, personal contact and enormous trust between institutions are imperative for developing a successful program. This means key involvement with faculty and staff from both institutions, activities which require significant financial resources.

Currently, we are developing strong collaborations with two institutions: the Department of Materials and GeoSciences at the Tecnische Universität Darmstadt in Germany, and the School of Materials Science and Engineering at Tianjin University in Tianjin, China.

For Darmstadt, we now have an official Memo of Understanding (MOU) at a university level. This partnership with Darmstadt came out of the long-standing relationship with Darm-

stadt and the Department of Mechanical Engineering here at Virginia Tech. It is also important to note that Darmstadt has an outstanding International Program. For Tianjin, we have both the official MOU and the Letter of Implementation (LOI) at the university level. Our MSE Professor G.Q. Lu is responsible for this relationship. He is also currently serving as adjunct to Tianjin.

To ensure our associations with these institutions, Dr. Clark has visited Tianjin and Darmstadt and I have visited Darmstadt three times. Professor Lu visits Tianjin several times a year. On the other side, Darmstadt faculty members have visited Virginia Tech. In fact last year, Professor Karsten Alba from Darmstadt spent a six-month sabbatical in Blacksburg working with MSE Professor Diana Farkas in the field of computational materials.

Because of these relationships, we now have opportunities for our undergraduate students, and it is exciting to see the interest in these international prospects. Last July, Calvin Lear, a junior, and Brian Allik, a senior participated in Darmstadt's summer cultural program. The cultural program runs for six weeks and the students get six transfer credit hours, three for a foreign language and three for humanities. In addition, Calvin stayed an additional three weeks to work with Professor Alba on computational materials science.

For Tianjin, at the end of July, Professor G.Q. Lu and Professor Lou Guido accompanied three undergraduate students for a three-week cultural visit. Amanda Krause, a junior this fall, Nathan May, a senior, and Dennis Hollich also a senior, were introduced to the Chinese language and culture. They spent time with faculty and students, visited several materials-oriented industries, and of course, other places of cultural significance. In order to offer academic credit for these experiences, we have created a new course, MSE 4984: Special Study: International Study Abroad. Students can earn 3-6 credits with 1 credit hour per week of study at an international university.

continued on p.15

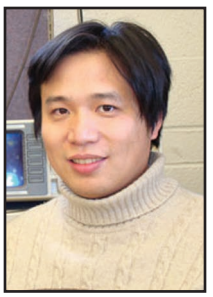
Meet Bob Hendricks

ROBERT (BOB) W. HENDRICKS is Professor in the Department of Materials Science and Engineering at Virginia Tech and is jointly appointed as Professor in the Bradley Department of Electrical and Computer Engineering. He serves as the Associate Department Head and Director of International Program in the Department of Materials Science and Engineering. He holds the BMetE (1959) and PhD (1964) degrees from Cornell University and an MBA (1985) from the University of Tennessee.

Dr. Hendricks came to Virginia Tech from Oak Ridge, Tennessee where he was first on the staff of the Metals and Ceramics Division of Oak Ridge National Laboratory (1964 -1981) and then was Manager of Analytical Systems and Chief Scientist with Technology for Energy Corporation (1981-1986). While at ORNL he was the Associate Director and co-founder of the National Center for Small-angle Scattering Research. While in industry, Dr. Hendricks was the driving force behind the development of three major materials analysis and characterization instruments: a) the ORNL 10-m Small-angle X-Ray Scattering Camera; b) the ORNL 30-m Neutron Small-angle Scattering Facility; and c) the TEC Model 1600-Series of Portable Apparatus for Residual Stress (PARS). Industrial Research Magazine awarded Hendricks the prestigious IR-100 award in 1977 for his development of the SAXS facility, citing the instrument as one of the most significant new technical products of the year.

On joining the faculty of Virginia Tech in 1986, Professor Hendricks turned his attention to undergraduate education. In the early 90's, he created the MSE Writing and Communication program, the first "writing across the curriculum" program at the University. In the late 90's he took a leadership role in creating the Center for Microelectronics, Optoelectronics, and Nanotechnology (MicrON). Most recently, he developed Lab-in-a-Box, a new concept for providing hands-on laboratory experience in introductory electric circuits courses. Dr. Hendricks is a Fellow of the American Association for the Advancement of Science (1978) and the American Physical Society (1979) and is a member of The Metallurgical Society, The Materials Research Society, and is a Senior member of the IEEE. He has received four outstanding performance awards: Union Carbide Corporation Outstanding Performance Award (1980), the Dean's Award for Excellence in Public Service (1996 and 2001) and the Dean's Award for Excellence in Teaching or Teaching Innovation (2006). Professor Hendricks has authored/edited two books, has published over 150 papers in the refereed literature, and holds 4 US patents. He was also recently inducted as a Fellow in ASM International. ❄

Student News



MSE Ph.D. candidate, Junyi Zhai, was selected for the Director's Postdoctoral Fellowship at the Los Alamos National Laboratories (LANL) in New Mexico.

Zhai was one of nine students from around the nation selected from more than 300 candidates reflecting a broad range of disciplines in science and engineering. "Junyi made several important and original contributions during his thesis research at Virginia Tech," says Dwight Viehland, Ph.D., professor of materials science and engineering. "His research efforts have resulted in 10 first author publications in quality peer-reviewed journals," he said.

Zhai will collaborate with LANL scientists and engineers on fundamental and applied research on nanotechnology and microelectronic thin films.

"This is a very important opportunity for me," says Zhai. "I can learn a great deal from the world-class scientists at LANL," he said.

Established in 1943, LANL is the premier national security science laboratory. Its mission is to develop and apply science and technology in three areas:

- To ensure the safety, security, and reliability of the U.S. nuclear deterrent
- To reduce global threats
- To solve other emerging national security challenges.

Zhai is originally from the city of Nanjing, China, and earned a bachelor of science in chemistry and a master of science in materials science and engineering from Tsinghua University in Beijing. ❄

MSE graduate student Tyler Horseman was awarded the Macromolecular Interfaces with Life Sciences (MILES) IGERT scholarship for a two-year period beginning in the Fall of 2008. The MILES program is funded by NSF and awards the scholarships to individuals working with macromolecules involved in oxidation processes. He is entering his second year and is seeking a Ph.D under MSE Assistant Professor Abby Morgan. His current project involves developing an antioxidant delivery system based on gelatin microparticles as a therapeutic for osteoarthritis. ❄

The Department of Animal and Poultry Sciences at Virginia Tech awarded MSE graduate student, Andrea Rojas, the VT-IMSD fellowship for her first year in graduate school in June 2008. This award, which stands for the Virginia Tech Initiative to Maximize Student Diversity is given to minority students seeking a career in the biomedical or behavioral sciences. Andrea is a Ph.D student currently studying the motion of bacteria through applied electric fields to produce scaffolds for bone and cartilage growth. She is co-advised by Professor Alex Aning of the Materials Science and Engineering Department and Dr. Rafael Davalos of the Biomedical Engineering Department. ❄

Students and Faculty Inducted into Alpha Sigma Mu

by Diane Folz

In May 2009, MSE held its first Alpha Sigma Mu induction in over 20 years. Alpha Sigma Mu, the materials honor society, recognizes students and faculty for academic performance and contributions to the field. In this first ceremony, seven students and two faculty were inducted. They included students Carlos Folgar, David Gouldey, David Gray, Charles Hammond, Dennis Hollich, Laura Patrick, Kristen Zimmermann, and faculty Kathy Lu and Gary Pickrell. ❄

MSE Students Study Microwave Processing for Curing Finishes on High-Quality Instrument Woods as their Senior Design Project

by Diane Folz

MSE seniors Charles "Chase" Hammond, William "Cary" Hill and Charles Sprinkle did their capstone design project on microwave curing of finishes on high quality instrument grade wood samples provided by Taylor Guitar Company.

Their project involved designing a continuous microwave oven system, complete with a motorized conveyor system, to cure the polymer coatings. Over the course of the two semester project, they scaled up from 1" by 3" test specimens processed in a single mode microwave oven to pulling planks of approximately 5" wide by 24" long through a fixed frequency multimode microwave field.

In October 2008, they traveled to the University of Hartford (UHa) in Connecticut where they presented their concept to students in the student branch of the Acoustical Society of America. In January 2009, two students from UHa joined them on the project by performing vibrational tests on the samples the MSE seniors had generated in the Microwave Processing Research Facility in the spring 2009 semester.

In June 2009, the five students traveled with faculty members from VT and UHa for a site visit to Taylor Guitars where they received a complete factory tour, including the engineering facilities and hightech wood storage facility (aka, "Taylor Fort Knox"). They presented their findings to Matt Guzzetta, Senior Industrial Designer, and Steve Baldwin, Senior Finish Consultant, at Taylor and discussed the future of the collaboration. The project was very well-received and will continue in 2009-10 with a new group of students.

Faculty advisors for this multiyear, interdisciplinary project include Diane Folz at Virginia Tech, and Patricia Mellodge and Bob Celmer at the University of Hartford. ❄

Lunar Rock-like Material May Someday House Moon Colonies

by Steve Mackay

Dwellings in colonies on the moon one day may be built with new, highly durable bricks developed by students from the College of Engineering at Virginia Tech.

Initially designed to construct a dome, the building material is composed of a lunar rock-like material mixed with powdered aluminum that can be molded into any shape. The invention recently won the In-Situ Lunar Resource Utilization materials and construction category award from the Pacific International Space Center for Exploration Systems (PISCES). The award was one of two prizes given out this year by the research center, which is dedicated to supporting life on the moon and beyond.

Winning College of Engineering student team members included :

- Eric Faierson, a doctoral student in the materials science and engineering department from Hampton, Va.;
- Michael Hunt, a materials science and engineering master's degree candidate from Virginia Beach, Va.;
- Susan Holt, a doctoral student in materials science and engineering from Christiansburg, Va.;
- Scott Hopkins, an undergraduate mechanical engineering student from Yorktown, Va.;
- Sharon Jefferies, a master's degree student in the aerospace and ocean engineering department from Newport News, Va.;
- Michael Okyen, an undergraduate mechanical engineering student from Yorktown, Va.; and
- Brian Stewart, a materials science and engineering doctoral student from Hayes, Va. ❄

(L) A composite of simulated lunar regolith and powdered aluminum heats up via wires as part of the fusion process that forms a brick.

MEPS NEWS Materials Engineering Professional Societies

MSE's official student organization

MEPS Students Attend Materials Science and Technology 2009

This year, fourteen undergraduate students and three graduate students attended MS&T'09 in Pittsburgh, Pa., sponsored by TMS, ASM International, ACerS, and AIST. Students attended technical symposia and participated in several Material Advantage student activities. The MEPS officers attended the Material Advantage Chapter Leadership Workshop and other chapter leadership activities. MSE senior Jill LeBlanc represented Virginia Tech in the student speaking contest and placed third out of eleven students. Charles Sprinkle and three additional students presented the MSE demo kits at the ACerS annual meeting and gained much support for the project. ❄

Students Combine Fun and Work at the 33rd Annual Conference on Composites, Materials and Structures

Twelve MEPS students were selected to attend the 33rd Annual Conference on Composites, Materials and Structures – ITAR Sessions held in Cocoa Beach, Florida in January of 2009. Virginia Tech students were joined by students from Missouri University of Science and Technology, the University of Delaware, and New Mexico Tech. Students were given this opportunity to attend a classified conference in which they were able to sit in on sessions and network with companies around the United States. This conference was not only fun for students, but it provided a valuable opportunity to distribute resumes to obtain a summer internship, co-op, or full time job. ❄

MEPS Students Participate in Service Projects

In February 2008, MSE juniors participated in the College of Engineering Pre-College Initiative Day (PCI) which reaches out to minority middle and high school students in Southwest Virginia. Demonstrations included silly putty, smart materials, and liquid nitrogen ice cream. This project was a professional development collaboration between PCI director, Trey Waller, and MSE faculty member, Christine Burgoyne. ❄

Students and Faculty Attend Congressional Visits Day

In March 2008, fourteen MSE students, and three faculty members traveled to Washington, D.C., to participate in Congressional Visits Day (CVD). CVD has been an annual event for several years for practicing scientists and engineers through TMS and the Federation of Materials Societies (FMS) and was recently expanded by Material Advantage to include a student-focused event. The CVD event brings engineers, researchers, scientists, educators, and technology executives to the nation's capital to increase visibility and awareness for science, engineering, and technology. Students and faculty met with Congressmen and/or their staff to advocate federal support for fundamental research in the physical sciences and engineering. ❄

MEPS students at work in Cocoa Beach

Cary Hill explains Smart Materials to a PCI student

The MSE Virginia Tech contingent gets ready to meet with politicians on Congressional Visits Day.

Spring 2009 Materials Science and Engineering Bachelor of Science Degrees

Justin G. Brons

Jason Bradley Dodson

Niklas P. Floyd

Meredith E. Fotta

Robert W. Fox

Stewart Tobin Gibert

David B. Gouldey

Matthew W. Greenough

Charles D. Hammond

William Cary Hill

Carl A. Ostrowski

Bradford C. Schulz

Kevin T. Sheets

Eric S. Singer

Charles M. Sprinkle

Richard R.Umemoto

Andrew G.Yeshnik

Kristin A. Zimmermann

Summer 2009 Materials Science and Engineering Bachelor of Science Degrees

Aaron J. Buck

2008-2009 Materials Science and Engineering Undergraduate Awards and Scholarships

Michael Stuback Memorial Scholarship
Eric Miller

Thomas G. Stroyan Memorial Scholarship
John Sions

John H. Kroehling
Mark Briguglio
Adam Blomberg
Jill LeBlanc
Bradford Schulz
David Gouldey
Meredith Fotta
Cary Hill
Matthew Hiser

Alfred E. Knobler
Robert Fox
Aaron Blomberg
David Brock
Annie Ellis

Pratt Scholarship
Matt Hiser
Jessica Piness

William McAllister
Jill LeBlanc

Eleanor Davenport
Karen Kokal
John Sions

Benjamin Bock
Bradford Schulz

Ronald S. Gordon
Jessica Piness

Gary S. Clevinger Memorial
No award for this period

CEED
Kathleen Campbell

Kimberly Clark Scholarship
Amy Armstrong

Gilbert and Lucille Seay
Aaron Blomberg
Adam Blomberg
Mark Briguglio
David Brock
Annie Ellis
John Goetz
Cary Hill
Eric Miller

Bernard Silverman
Meredith Fotta
David Gouldey

Ted and Drusilla Kirby
David Gouldey

2008 Materials Science and Engineering Graduate Degrees

Doctor of Philosophy

Name	Advisor	Dissertation Title
Hu Cao	Viehland	Phase Transformations in Highly Electrostrictive and Magnetostrictive Crystals: Structural Heterogeneity and History Dependent Phase Stability
Satenik Harutyunyan	Reynolds	Influence of External Magnetic Field on Magnon-Phonon Interactions in a Cracked Ferromagnetic Body
Li Jiang	Asryan	Theoretical Study of Performance Characteristics of Semiconductor Quantum Dot Lasers
Jairaj Payyapilly	Logan	Formation and Growth Mechanisms of a High Temperature Interfacial Layer Between Al and TiO2
Jialin Wang	Yoon	AFM Surface Force Measurements Between Hydrophobized Gold Surfaces

Master of Science

Name	Advisor	Title
Makarand Karmarkar	Priya	Smart Material Composites for Magnetic Field and Force Sensors
Guangyin Lei	G.Q. Lu	Synthesis of Nano-Silver Colloids and Their Anti-Microbial Effects
Niven Monsegue	Aning	Solid State Synthesis of Bulk Amorphous Ni-50at% Ti Alloy
Jennifer Mueller	Kampe	Determining the Role of Structure and Porosity on the Thermal Properties of Graphite Foam
Naili Yue	G.Q. Lu	Planar Packaging and Electrical Characterization of High Temperature SiC Power Electronic Device
Andrew Zeagler	Aning	Structure and Processing Relations in Ni-W Amorphous Particle Strengthened Ni Matrix Composites

Celine Mahieux receives 2008 Outstanding Alumni Award

by Lynn Nystrom

Celine Mahieux, who earned her master's degree in materials science and engineering and her doctorate in materials engineering science from Virginia Tech in 1996 and in 1999, respectively, is the 2008 recipient of Virginia Tech's College of Engineering's Outstanding Young Alumni Achievement Award.

Mahieux is the director of change management and the carbon capture plant program manager for Alstrom, a worldwide company specializing in power generation and rail transportation. She faces the significant challenge of setting up innovative, state-of-the-art programs to build power plants that will capture the carbon dioxide gas that is emitted into the atmosphere and is thought to contribute to global warming. She is in charge of forming the corporate response to new developments in technology and market shifts, to multi-business projects sponsored by the sector.

She is particularly excited about her charge to develop pilot projects to capture the carbon dioxide emissions. "We are challenged from every direction on this project - technology, economics, legislation. And we are looking at all of these considerations but our main focus is the technology. We hope to have these power plants available commercially by 2014 for demonstrators and 2020 for worldwide commercial release," Mahieux said.

Her credentials lead one to believe she will make the target date. She was one of four individuals or teams nominated for the 2005 French Engineer of the Year award in the industry category. The nomination was based on her successful development of a composite-based thrust bearing that has since been successfully used within a power generation turbine. Mahieux was named a runner-up for the French Engineer of the Year award, sponsored by the French Minister of Finances and Industry, and co-administered by France's National Council for Engineers and Scientists.

In 2004, Mahieux earned a six-sigma master belt certification, allowing her to train and certify other students in a business process improvement methodology designed to optimize customer requirements and expectations. Alstom considers her an expert in international business management, composite materials, ME, product and business optimization methodologies, and quality control. She speaks English, French and German fluently.

She holds four patents and is the author of "Environmental Degradation in Industrial Composites," a technical reference book released by Elsevier Scientific in January of 2006. She also received the 2004 JEC Composites international innovation research award for her work.

Mahieux met her husband, Jon Medding, while they were both enrolled at Virginia Tech.

He received his undergraduate and graduate degrees in ME in 1994 and in 1996, respectively. He currently works for ABB, and they live in Birmenstorf, Switzerland with their daughter Sarah, 5, and son, Raphael, 1. ❄

(L-R) Dean Richard Benson, MSE Department Head David Clark, Celine Mahieux, and ESM Department Head Ishwar Puri

Meet Professor Pickrell continued from page 2

scribed in the Research Highlight article on page 1.

Away from the office, Gary enjoys working out, canoeing, kayaking, and keeping up with the activities of his children, Lydia, 15, and Alex, 12. But his true passion is fishing. "I enjoy the solitude," he says, "and I find it's a good opportunity to think. When you get out away from everything and everybody, it's a good time to sort things out in your mind both personally and from a research standpoint." In fact, a lot of ideas have come to him while sitting in a boat out on the New River. "Things just roll around in your mind while you're waiting for that fish to bite. Some people get their ideas in the shower, sometimes I get mine fishing." ❄

Maureen Julian continued from page 5

Peru, the Middle East, and Crete illustrate symmetry.

Finally in the symposium on Crystallographic teaching using new computer and Internet-based approaches, she presented a talk on "Use of MATLAB® in teaching crystallography." Advanced computer languages such as MATLAB® are invaluable in teaching crystallography. Starter programs at the end of each chapter of her book reduce the burden of coding and at the same time allow the student to progress rapidly in understanding the crystallography.

The Julians visited the Golden Pavilion in Kyoto, slept on tatami mats with buckwheat husk pillows, and drank lots of green tea. ❄

Research Spotlight continued from page 1

referred to as optical bend loss. As light travels through the optical fiber, the fiber acts as a waveguide, keeping light inside the core by means of total internal reflection. "When you bend an optical fiber," Pickrell said, "you lose part of the optical signal, and the amount you lose depends on how tightly you bend it and the characteristics of the fiber."

In 1999, Professor Pickrell and colleagues began developing a new type of fiber that may be promising for the fiber to home market, or "the last mile" of taking the information from the long distance trunk line into the home. This fiber, referred to as the "random hole optical fiber" (RHOF), exhibits significantly decreased bend sensitivity, thereby improving the signal retention of the fibers when they are bent.

In work published in 2008, the research team performed experiments to compare the bend sensitivity of some commercial fibers with that of the RHOFs. They measured the amount of optical signal loss based on winding each fiber one, two, or three turns around an aluminum mandrel. The RHOFs showed significantly improved bend sensitivity compared to the other fibers.

These RHOFs also have applications in the area of gas sensors (nano-structured optical fiber sensors). Gaseous emissions are a by-product of many industrial processes such as glass melting, metal casting, energy related industries, chemical processing, and transportation. Monitoring and controlling these emissions is becoming a significant consideration with growing global awareness of environmental concerns.

In a paper published in 2004, Pickrell stated, "Energy from coal-fired power plants will continue to play a dominant role in the energy landscape well into the next century." He further suggested that because there are vast coal reserves within the U.S., investing in energy production from coal that is clean and efficient is wise. The first step toward clean energy production is the ability to monitor the gas emissions.

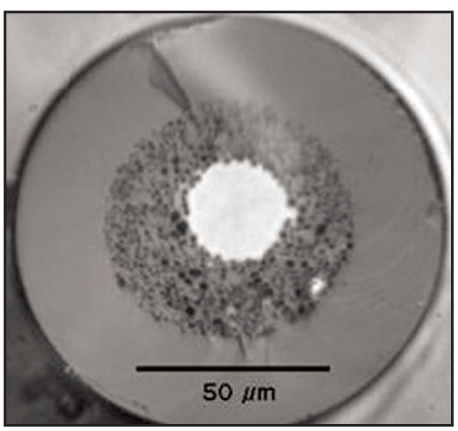
An important part of emissions monitoring and advanced process control involves "accurate and reliable detection of various gases at high temperatures over a wide range of concentrations." These gases include hydrocarbons, nitrogen oxides, carbon monoxide, carbon dioxide, and oxygen.

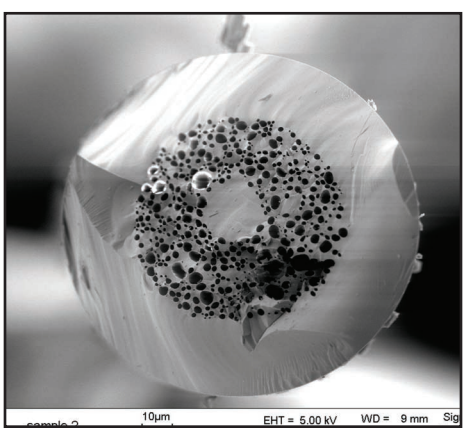
Optical fiber-based sensors have proven useful in measuring various chemical and physical parameters. However, the use of conventional optical fibers poses problems in high temperature environments "because of the diffusion of dopants from the core to the cladding region," resulting in changes in the modal properties of the fiber. These fibers confine light to the core by relying on a difference in composition between the core and the cladding region of the fiber.

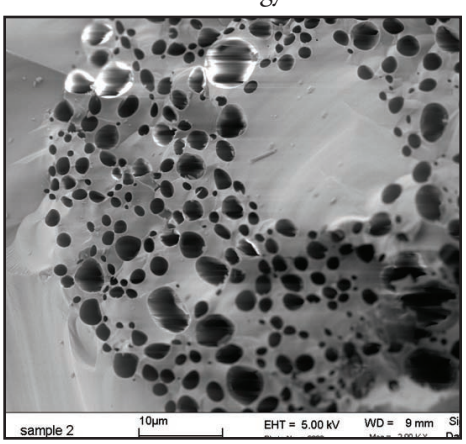
Professor Pickrell and his colleagues have demonstrated the gas sensing capabilities of the RHOFs. "You can put these fibers out into the environment and the gas molecules will penetrate the holes in the fiber." A portion of the optical signal propagating in the fiber, the evanescent field, will see and interact with the gas molecules, and it is absorbed at a specific wavelength corresponding to the vibrational transitions of the gas molecules. "So you see peaks in the signal that correspond to a particular chemical species," he explains. "Each gas has its own set of fingerprints and it's possible to determine which gases are present by the wavelengths of the absorptions, and how much by the intensity of the absorption at each wavelength."

Creation of RHOFs is done using a new process developed by Professor Pickrell and his colleagues, which forms the "holes" in situ during the fiber draw. This produces "a large number of randomly sized and spaced holes around the central core region." Light is confined to the core region "through a reduction in the average effective refractive index of the cladding, produced by the holes in the cladding region. The "holes" of course, are the cross-sections of the tubes which run random lengths through the fiber." This design eliminates the problem of dopant diffusion in the core or cladding region of conventional fibers that can occur in high temperature environments, because there are no "dopants" in the RHOF fibers.

The Department of Energy is funding a project to utilize random hole optical fibers along with another new type of fiber that Professor Pickrell's research group has developed to measure gases in high temperature environments. For this DOE research, he is targeting coal fired boilers and coal gasification systems to measure various gases of interest in the fossil energy area. ❄







(Images L-R) Optical micrograph of RHOF fiber under illumination from the far end of fiber; SEM micrograph of RHOF; and SEM micrograph of RHOF magnified

MSE International Program continued-from page 7

On a more extensive collaboration, we have David Gouldey, who is enrolled in our 5-year BS/MS degree, going to Darmstadt this fall to finish his master's degree thesis research. He will participate in a 6-week German course in September and October and will then be taking engineering courses, some in German, in mid-October. His thesis (which will be written in English) will be advised by Professor Wolfram Jagermann, Dean of the Department of Materials and Geosciences at Darmstadt and Professor Dimitris Pavlides in Electrical and Computer Engineering at TU-D. Also serving on David's committee will be Professor Bill Reynolds. I will serve as the committee chair.

Finally, we have undergraduates who will be spending the Spring Semester of their junior year abroad, taking their courses in a foreign language and transferring credit back to VT. For example, it is planned that Calvin Lear will spend his spring semester in Darmstadt while Matthew Glazer will be spending half of his junior year in Tianjin. They will take a full load of courses in materials science and engineering in German and Chinese respectively. Matthew is in a unique position to take classes in Chinese as he had five years of Mandarin Chinese in high school. As further preparation for his coming trip, Matthew is currently studying Chinese in Radford University and will be working on an independent study with Professor G.Q. Lu. This independent study will be written and presented in Chinese.

While all of these opportunities at hand are quite exciting, there is much to do. For instance, we have preparation and assessment to think about. How do we adequately prepare students for their pending collaboration? How do we assess the success of this collaboration? What we have worked on so far is to give our students opportunities to study abroad. How do we now flip the coin and have international undergraduate students come and experience working/studying with us here in MSE at Virginia Tech? Furthermore, how do we continue to develop this international program so that it also serves as a recruiting tool for outstanding undergraduate and graduate students?

I believe that the future of this endeavor depends on the continued personal contact and strong partnerships that faculty, and graduate and undergraduate students create with different institutions from all over the world. It is quite important to understand that the program aims to serve as a fluid, open-ended, yet effective system for different and new international collaborations. There is indeed much to do, but with continued support from every sector of our institution—alumni, faculty, graduate and undergraduate students—we can provide our students an exceptional global experience in materials science and engineering. ❄

Heads Up continued from page 16

Congressional Visits Days, MS&T and creation of new demonstration kits as outreach tools have put them in leadership roles in national student activities. Our MEPS students continue to be among the most active in the College of Engineering. They continued to host home game tailgates for students, faculty and alumni. Although one of the smallest student groups in size, they won E-Week again this year!

Our hard work in preparation for ABET paid off. We received no weaknesses or deficiencies and were commended for our integrated communications program. Immediately after the ABET visit, we began working on the SACS document in preparation for that visit in the summer of 2010. SACS is conducting a 10-year assessment of both our undergraduate and graduate programs. Gary Pickrell, Bob Hendricks, Kathy Lu and Kim Grandstaff are doing an excellent job in getting us ready.

This year, two of our faculty accepted positions at other universities. Yu Wang joined Michigan Tech in August of this year and Paul Gatenholm returned to Chalmers University in spring of this year. We will miss both of these faculty members but wish them well in their new endeavors.

As always, we thank our alumni for their continued support and loyalty. Please e-mail us, stop by the department for a visit or join us during one of our pre-game tailgates. Just stay in touch! ❄

Exploring Materials at Virginia Tech

Department of Materials Science and Engineering
213 Holden Hall (0237)
Virginia Tech
Blacksburg, Virginia 24061

We always enjoy hearing from alumni and friends.
Send us a note or send an email.
email: mse@vt.edu
website: www.mse.vt.edu

Editor
Christine Burgoyne

Contributing Writers
Professor Levon Asryan
Professor David Clark
LeeAnn Ellis
Diane Folz
Dr. Maureen Julian
Steve McKay
Lynn Nystrom
Susan Trulove

Faculty Newsletter Advisor
Professor Abby Morgan

Computer simulation of bridging domains and mosaic domain microstructures of coexisting phases in PZT system at room temperature with near MPB compositions, where a mapping between components of polarization (Px, Py, Pz) and color elements (red, green and blue) is employed to represent the polarization states.

Image courtesy of:
Weifeng Rao and Professor Yu Wang

Heads Up!

David Clark

MSE Department Head

Did you know that Holden Hall (home to MSE) was completed in 1940 at a cost of $157,239? Using Engineering Fee funds, we recently renovated the sample preparation lab (about 1% of the total space in Holden) at a cost of $85,000! When the polishing wheel station was removed, an alumina waste reservoir was found beneath the floor. David Berry describes this as an "artifact of polishing media" holding over 10 gallons of stratified alumina from more than 60 years' worth of sample polishing. Just think how many thousands of samples it took to produce this historical relic.

The present-day MSE Department evolved from two former departments, ceramic engineering (1928) and chemistry and metallurgy (1883). In 1964, the two departments merged to become the Department of Metals and Ceramics Engineering, which became the Materials Science and Engineering Department in 1992.

We have come a long way since these early days and the past year proved to be another one of significant accomplishments thanks to the concerted efforts of our faculty, staff, students, alumni and advisory board. Here are only a few of the highlights.

- Our undergraduate program enrollment is over 100 and is ranked 15th by U.S. News & World Report.
- Our graduate program enrollment is 60 and is ranked 23rd by U.S. News & World Report.
- Our research expenditures increased from $2,747,863 last year to $4,319,439 this year.
- We published 94 papers in journals and 11 in refereed conference proceedings.
- We submitted 89 new proposals totaling $26,483,022. Thirty-six of these totaling $6,488,335 were funded.
- We submitted 4 patent disclosures and received 1 patent (Gary Pickrell).
- Our faculty members received notable awards including the Frank Maher Professorship (Norm Dowling), the highly competitive POWE award from Oak Ridge Associated Universities (Jeremiah Abiade), and the Karl Schwartzwalder Professional Achievement in Ceramics Engineering (PACE) award from the American Ceramics Society and Institute of Ceramic Engineers (Kathy Lu).
- Bob Hendricks was inducted as a Fellow in ASM International.
- Kathryn Logan and her students received First Place in the 2008 Pacific International Space Center for Exploration Systems (PISCES) Lunar Habitat Design and In-situ Resource Utilization Student Competition.
- Our international program activities are developing very nicely. We have undergraduate students who visited Tianjin University this summer under the supervision of G.Q. Lu and Lou Guido. One of our BS/MS students will begin one year of study at Darmstadt University in Germany this Fall. Also we have undergraduate students who attended a cultural program for 6 weeks in Darmstadt.
- VT-FIRE is progressing well under the leadership of Bob Hendricks
- We held the first Alpha Sigma Mu (the MSE Honors Society) induction in over 20 years at Virginia Tech. Seven students and two faculty were inducted this Spring.
- The MSE students organized the 2nd JUMR symposium at MS&T 08.
- We continue to work together with ME to begin to develop a Nuclear Engineering Program.
- We continue to play a major role (through Sean McGinnis' leadership) in the Green Engineering Program together with BSE and the College of Engineering.

We are very proud of the recognition received by our graduate and undergraduate students in their academic and service activities. Their participation in national activities such as

continued on page 15

VirginiaTech
Invent the Future
Department of Materials Science and Engineering
213 Holden Hall (0237)
Virginia Tech
Blacksburg, Virginia 24061
www.mse.vt.edu

Non-Profit Org.
U.S. Postage
PAID
Blacksburg, VA 24060
Permit #28