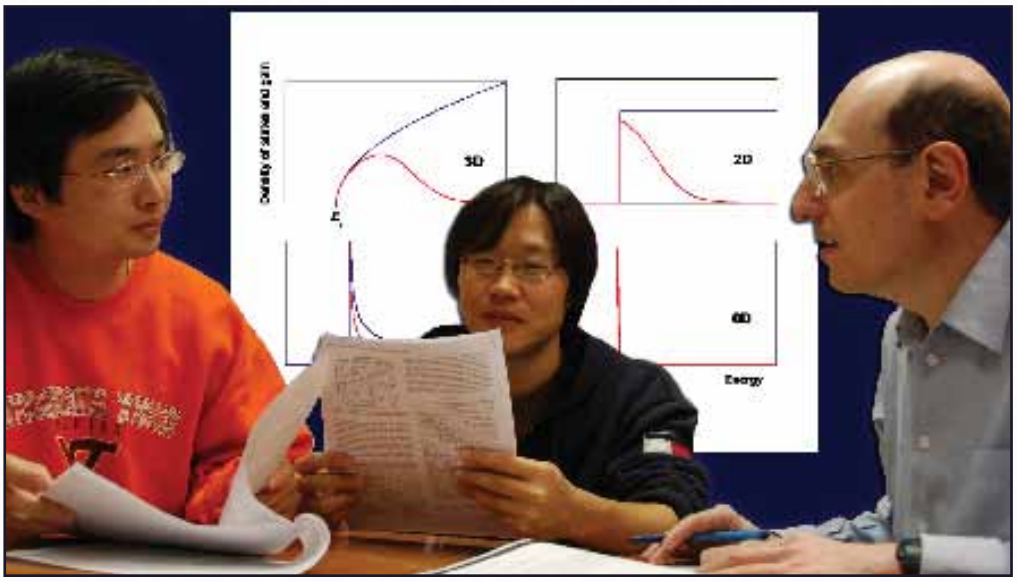
Exploring Materials at Virginia Tech

VirginiaTech Invent the Future

Spring 2008, Volume 11, Number 1

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

Spotlight Research



(from r-l) Professor Levon Asryan and his Ph.D. students Dae-Seob Han and Li Jiang

Semiconductor Quantum Dot Lasers

Levon Asryan

The emergence of devices based on nanometer-size active elements marked the era of nanoelectronics and nanophotonics. Among such elements are notably low-dimensional heterostructures, and particularly their ultimate case – zero-dimensional heterostructures commonly known as quantum dots (QDs). QDs are obtained as tiny insertions of semiconductor material of one type in a higher-bandgap host material. It is because of their small size (typically on the order of one hundredth of a micron) and strong manifestation of quantum effects that these insertions are called 'quantum dots'. Despite the fact that a QD of typical size contains thousands of atoms, the energy spectrum of carriers is discrete in a QD, quite like that in an individual atom. For this reason, QDs are also referred to as artificial, or man-made, atoms.

When embedded inside a p-n junction diode, the QDs can be stimulated in a controllable fashion to emit coherent light by applying an electric current. Such a source of stimulated light is called a QD laser. Prof. Asryan is developing theoretical approaches for enhancing the operating characteristics of such lasers.

Research Spotlight continued on page 14

What's inside

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

Border Image : Simulation of the polar domain microstructure of coherent phase separation near the morphotropic phase boundary in ferroelectric solid solution. *Courtesy of Professor Yu Wang*

Research Corner

Meet Professor Levon Asryan

From a very young age, Levon Asryan has unfailingly followed the world of physics, math, and semiconductors. In Armenia.Levon received a Distinguished Student Scholarship with Honours from the U.S.S.R. Ministry of Education to study radiophysics and electronics at the Yerevan State University. In 1988, he received his Masters of Science degree and moved to St. Petersburg in Russia to join the highly esteemed Ioffe Institute of Physics and Technology as a Ph.D. student in physics and mathematics. After receiving his Ph.D. at Ioffe, Levon continued his studies toward a Doctor of Science degree in the more specific area of semiconductors and quantum dot lasers. The Doctor of Science (Dr. Sci.) is the highest degree awarded in Russia and "it is almost equivalent to getting four Ph.D.s," Levon clarifies.

While working on his Dr.Sci, Levon worked as a research scientist (and later as a senior scientist) at Ioffe. During this time, he served as a visiting senior research scientist at the Technical University of Berlin, Germany.

In September 2000 to 2004, Levon became a research associate professor in the Department of ECE at State University of New York at Stony Brook. The next three years produced many career highlights for Levon. In 2001, he learned that he received the Highest Award in Science and Technology in Russia (State Prize) for his fundamental investigations and development of quantum dot lasers. He shared this honor jointly with the Nobel Prize winner Zh Alferov, among others. This highly venerated award was presented with a national decree signed by the President of Russia. That same year, Levon also received the first Best Paper Award of the IEEE Journal of Quantum Electronics. In 2002, Levon finally received his Doctor of Science degree from Ioffe.

In 2001, Professor Asryan received the Highest Award in Science and Technology in Russia (State Prize); the medal and presidential decree is currently on display at the MSE main office.

The move from Ioffe to Stony Brook became a permanent move to the United States for Levon. It was not a matter of need for him but a matter of exploring different options. While at Stony Brook, Levon recalls, "I wanted to explore another option---teaching." This is how he found himself moving to Materials Science and Engineering at Virginia Tech.

In 2004, Levon joined MSE as Associate Professor working on the physics of semiconductor materials and devices, nano- and microelectronics, optoelectronics and photonics, low dimensional heterostructures, nanostructures, quantum dots and quantum well, and of course---the theory of semiconductor lasers with a quantum-confined active region, quantum dot lasers and quantum well lasers.

Currently, Levon is working with two graduate students and has recently taught his first undergraduate MSE class on the Fundamentals of Electronic Materials. According to Levon, "Teaching undergraduate students is a little difficult in the beginning. But I've learned that you have to make sure that you do not assume anything; you have to initiate the interest; they have to catch the basics and you have to catch and fix issues at early level." When asked if he liked teaching, Levon responds with a smile and a shake in the head, "I like it. I just don't like checking exams." Levon is interested in teaching the course again next year.

As a member of the MSE family, Levon has come a long way from Russia to the Northeast to Southwest Virginia. He brings him with him a list of highly impressive achievements and a passion for semiconductors.

Levon currently resides in Blacksburg with his wife and two sons. ❄

Professor **Levon Asryan** is the developer of a pioneering theory of threshold characteristics of quantum dot lasers that has predicted a number of effects observed experimentally. He proposed the concept of a temperature-insensitive semiconductor laser and developed a general theory of internal efficiency of heterostructure lasers with a quantum-confined active region. He also shares a patent with Professor Serge Luryi of Stony Brook University on "Semiconductor laser with reduced temperature sensitivity." To date, Professor Asryan has published a series of key articles, conference papers, and book chapters on the topics of quantum well and quantum dot lasers.

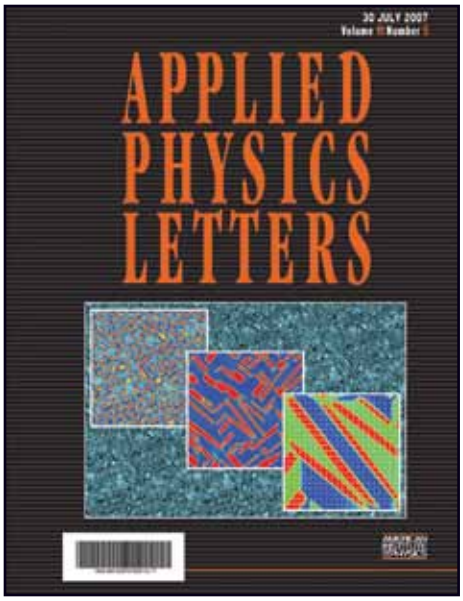
MSE Welcomes and Congratulates New Faculty

Robert W. Hendricks rejoins the MSE Department following four years as Professor in Electrical and Computer Engineering. From 1986-1996, he was Professor in the MSE Department and from 1996-2001, he was jointly appointed in the ECE Department. Prior to arriving in Blacksburg, Bob was the Chief Scientist and Manager of Materials Analysis Systems with Technology for Energy Corp in Knoxville Tennessee, and earlier was a Senior Staff Member and Associate Director of the National Center for Small Angle Scattering Research at Oak Ridge National Laboratory. He has published over 150 papers in the refereed literature on topics such as small-angle x-ray an neutron scattering from a wide range of materials including polymers, metals, coal, neutron irradiated materials, and vortices in Type II superconductors. While at VT he has been involved in the determination of residual stresses in components as large as railroad car wheels and as small as gallium arsenide microchips for cell phones. Dr. Hendricks was instrumental in creating the MSE Writing and Communications Program. He will also serve as the Director of International Programs and is the Associate Department Head designee.

Shashank Priya joins Virginia Tech as an Associate Professor with a joint appointment in the MSE and Mechanical Engineering Departments. Since 2004, Dr. Priya was an Assistant Professor at the University of Texas at Arlington where he taught courses and conducted research in MSE in topics dealing with ferroelectric materials and devices. His research interests include electroceramic heterostructures, ferroelectric thin film phenomenon, piezoelectric nanocomposites, magnetoelectric nanostructures, magnetic nanoparticles, self-assembly, electrical and stress induced phase transformations, relaxor-based piezoelectric single crystals, lead-free piezoelectrics, energy harvesting, structural health monitoring, artificial muscles, and "jellyfish." Most recently, his research has also focused on developing and commercializing wind energy harvesters and self-powered sensors. Dr. Priya graduated from the Pennsylvania State University with a PhD in Materials Engineering.

Jeremiah T. Abiade has been appointed Assistant Professor of MSE and Mechanical Engineering at Virginia Tech. Prior to this appointment, he was a research scientist in the Department of Chemical & Mechanical Engineering and the Center for Advanced Materials and Smart Structures (CAMSS) at North Carolina A&T State University. His research interests and accomplishments are in various areas generally associated with thin film deposition, processing, and characterization. Recently, his research has focused on magnetic thin films and self–assembled nanoparticles deposited via pulsed laser deposition (PLD). He has research interests in metallic thin films, novel epitaxial oxides and multilayers, and chemical mechanical polishing (CMP). Dr. Abiade received his PhD in materials science and engineering from the University of Florida in 2004 and his bachelor's degree in physics from Southern University & A&M College in 1999. Additionally, he has spent three summers (2005-2007) as visiting faculty in the Center for Materials for Information Technology (MINT) at the University of Alabama.

Department News



MSE Assistant Professor **Yu Wang** and MSE graduate student **Weifeng Rao's** research results were recently featured on the cover of the prestigious Applied Physics Letters' July 30th edition (Weifeng Rao and Yu U. Wang, Appl. Phys. Lett., 91, 052901, 2007). The editors chose a figure from Rao and Wang's manuscript entitled, "Microstructures of coherent phase decomposition near morphotropic phase boundary in lead zirconate titanate" that shows simulation results from the martensitic-type phase transformations that occur in lead titanate materials. ❄

The **MSE undergraduate program** has been ranked 16th among materials programs in the U.S., according to the 2008 US News and World Reports "America's Best Colleges" website. USNWR previously ranked the MSE graduate program 31st among peer programs nationally in their 2008 version of "Best Graduate Schools." ❄

Department News

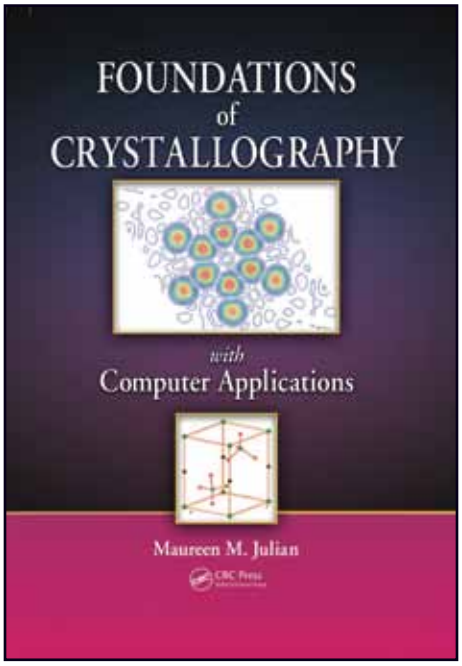
MSE Assistant Professor **Gary Pickrell** received a 2007 College of Engineering Faculty Fellow Award. Professor Pickrell's research concentrates on sensor technology and fiber optics. He has 11 patents and 88 publications, 50 of these in the last two years. Presently, he is a principal investigator on over $4 million in total funded research with his share being over $1.5 million. ❄

Professor Dwight Viehland has been named a Fellow of the American Ceramics Society in ceremonies conducted as part of the 2007 Materials Science and Technology (MS&T) Conference in Detroit, MI. Professor Viehland's accomplishments in the area of functional material design were cited.

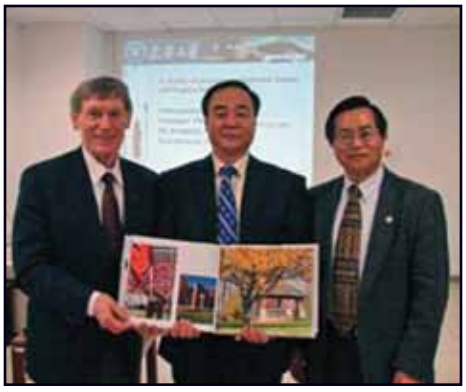
Professor Viehland is also the recipient of Virginia Tech's 2007 Alumni Award for Excellence in Research. The award is presented to Virginia Tech faculty members who have made outstanding contributions and advancements in their fields.

As an experimental solid-state scientist, Professor Viehland studies the structure and properties of condensed matter and thin layers. His research includes phase transitions, ferroelectricity, piezoelectricity, magnetostriction, and magnetoelectricity. Since joining Virginia Tech, the Viehland Laboratory began a new area of research that involved the development of novel materials/composites with large magnetization-polarization exchanges.

Professor Viehland has published over 300 refereed journal articles, with about 4500 citations, holds a number of issued patents, and has been the PI of about $7million in research funding during his career. He has previously served as chair of the Electronics Division of the American Ceramic Society (ACers), co-chaired the Annual Conference on Composites, Materials and Structures, and will serve as the program chair for the ACerS annual meeting in 2008. ❄



Dr. Maureen M. Julian of MSE has completed her new textbook entitled *Foundations of Crystallography with Computer Applications*, to be published by CRC Press, Taylor & Francis Group, on April 8, 2008. MSE-VT students will recognize this work from Dr. Julian's several years of development and test-piloting of the book in MSE 3134. For more information and ordering details, visit Amazon.com.



MSE Department Head **David Clark** and MSE/ECE Professor **GQ Lu** visited Beijing and Tianjin, China from November 17 to 24 to promote Virginia Tech's education and research programs, and to explore potential collaboration. In Beijing, they toured Grirem Advanced Materials Co, a leading R&D and manufacturing facility of nonferrous and rare earth materials for microelectronics and optoelectronics. The also delivered seminars to faculty and students in School of Materials Science and Engineering at Tsinghua University, a highly respected university in China. They visited Tianjin University, which is also recognized for strong engineering programs. They met with the Dean of the School of Materials Science and Engineering and discussed specific ways for collaboration. Professor Clark gave a seminar to a roomful of MSE faculty and students. They also met with the president of Tianjin University, Dr. Ke Gong. ❄

MSE Research Associate Professor **Carlos Suchicital** is currently collaborating with Professor Louis Guido on the supervision of the newly organized Semiconductor Thin-Film Synthesis Laboratory.

Professor Suchicital oversees the day-to-day functioning of the facility and together with Professor Guido do material formulations and film growth. Both also collaborate on efforts to bring funding for the continuity of the facility's operation and students supervision. ❄

The Nanoscale Characterization and Fabrication Laboratory (NCFL) celebrated its grand opening on September 07, 2007. The 16,000 square feet facility is located in the Corporate Research Center adjacent to Virginia Tech's campus in Blacksburg VA, and is operated by the University's Institute for Critical Technology and Applied Science (ICTAS). The state-of-the-art facility is housed in a dedicated building designed to shield sensitive instruments from environmental factors such as building vibrations, stray electromagnetic fields, and temperature fluctuations. It operates as a service center with a cost structure tailored to serve the needs of researchers from Virginia Tech and from the surrounding industrial community. MSE Professor **Bill Reynolds** serves as the NCFL Director.

Visit the NCFL website for more information: http://www.ictas.vt.edu/ncfl/ ❄

Semiconductor Thin-Film Synthesis Laboratory

Department of Materials Science and Engineering
Department of Electrical and Computer Engineering

The Semiconductor Thin-Film Synthesis Laboratory is a 1,000 ft^2 facility equipped with an AIXTRON 200/4 RF-S metal-organic vapor phase epitaxy (MOVPE) system that was specially designed and built for the synthesis of compound semiconductor alloys and nanostructures.

Features of the MOVPE System

- One key feature of the MOVPE System is it's capability of operating in an H_2-only, mixed H_2 plus N_2, or N_2-only growth ambient. This capability is crucial in attempts to synthesize electronic-grade InAsN alloys that are lattice matched to GaAs or InP substrates and thus contain nitrogen mole fractions that are well beyond the "dilute nitride" limit that has been explored to date. The similarity of gas flow constants between N_2 and NH_3 (compared to H_2 and NH_3) allows the flexibility of varying the V/III ratio during growth without changing the gas flow dynamics (i.e., temperature profiles, gas velocity, source partial pressures). Thus, the V/III ratio can be used as a design parameter to improve material quality by controlling the point defect chemistry and dopant solubility.

- Another key feature is the capability to support both metal-organic liquid and hydride gas forms of arsenic- and nitrogen-bearing source molecules. With metalorganic sources, such as tertiarybutyl arsine and dimethlyhydrazine, it will be possible to achieve complete pyrolosis at lower growth temperatures than with arsine or ammonia. Thus, the growth temperature can be varied over a wide range to increase donor or acceptor doping concentration while simultaneously incorporating nitrogen at mole fractions up to 40%. In addition, the AIXTRON reactor is equipped with an EpiRAS-200TT optical monitoring instrument for measuring the true surface temperature of the evolving film as well as layer thickness and surface roughness. This in-situ optical measurement capability is invaluable for tracking changes in the growth mode under conditions of high nitrogen content and high majority carrier doping concentrations.

The Semiconductor Thin-Film Synthesis laboratory is run and operated by **Professors Louis Guido and Carlos Suchicital**. The facility is affiliated with the MSE and ESM Departments**.**

Education Corner

Dr. Sean McGinnis and Green Engineering Education in MSE

Dr. Sean McGinnis directs the Green Engineering Program (http://www.eng.vt.edu/green/index.php) at Virginia Tech as part of his joint research faculty appointment in MSE and BSE (Biological Systems Engineering). Initiated over a decade ago before sustainability was a commonly-heard term on campuses, this program strives to raise students' awareness regarding the environmental impacts of engineering practice. The program also teaches tangible skills that students can take to academic, corporate, or governmental careers to design products, processes, and systems such that environmental impacts are minimized. This program serves all departments in the College of Engineering, but as a materials scientist by education and industrial experience, Dr. McGinnis has a particular interest in transforming MSE education and training to include this green engineering and sustainability concepts.

Clockwise: Dr. Sean McGinnis and his Green Engineering Senior Design Team– Russ Shaffer (ISE), Danielle Willgruber (MSE), and Brady Beemer (BSE).

Green Engineering is broadly defined and focuses on the design of products (and processes and systems) with the goal of minimizing environmental impact while still meeting other critical design criteria. This design approach requires that environmental constraints be defined and considered from the start and is important since environmental impacts occur through all phases of a product's life cycle: extraction of raw materials from the environment, inputs of energy and materials for manufacturing processes, consumption of energy and materials for product use, disposal of the product at the end of its life, and transportation of materials throughout these phases. This systems-thinking perspective is critical since benefits in one phase of the life cycle may result in significant impacts in other phases. This approach has not been common in the education or training of engineers, and the result is products that have significant environmental impacts.

The Green Engineering Program is a mixture of education, research, and outreach. Education is the core and strength of this program. An 18-credit concentration has been available for the past 6 six years. Last spring, this concentration was approved as a university minor available for students graduating in spring semester 2009. The minor requires two core courses (Introduction to Green Engineering and Environmental Life Cycle Analysis), two engineering courses with disciplinary environmental content, and two interdisciplinary courses which broaden the students' understanding of environmental issues outside engineering. This curriculum is unique among US universities in its interdisciplinary reach across all departments in the College of Engineering. Most other environmental programs at large research universities are either based outside of engineering or are focused narrowly in one or two engineering departments.

This Green Engineering Program has historically had a strong tie to the Department of Materials Science and Engineering at Virginia Tech. Professor Ron Kander, former MSE faculty, directed the program for several years and taught various classes. Professor Steve Kampe has also been a member of the Green Engineering advisory board and has worked to implement these concepts into the MSE curriculum.

Currently, two courses required for MSE students have integrated environmental concepts to the degree that they count toward the Green Engineering Concentration/Minor. In MSE 2044, Fundamentals of Materials Engineering, sophomore-level students are required to write a research paper about the materials engineering aspects of a particular product or technology. In addition to traditional introductory materials science content, the students in this class are introduced to the basic concepts of green engineering. They are then asked to consider and comment upon the implications of green engineering and sustainability in their research paper. For

continued in p.15

Meet Sean McGinnis

Dr. Sean McGinnis has traversed engineering disciplines, states, and countries to realize his passion for both engineering and the environment. He began his engineering career as a chemical engineering student at the University of Minnesota. After taking a required materials science course, Sean decided that he was more interested in solid states and decided that he would like to apply his engineering knowledge to materials. After receiving his Bachelor's degrees in Chemical Engineering and Materials Science and Engineering, he moved to California to get his Master's and Doctorate degrees in Materials Science and Engineering at Stanford University.

While Sean had always been interested in the environment, it took a long time to make the connections between materials and the environment. "As a student, engineering and the environment were considered as two separate entities and their interactions were rarely discussed." This separation of interests continued even as he held a postdoctoral appointment at Uppsala University in Sweden to work with research on fullerene and metal carbide thin films. In 1997, Sean moved back to California to work as a process engineer in the area of sputtered magnetic thin films at Intevac, Inc, in Santa Clara, California. "As I moved on with my career, I worked in the labs as an engineer on the one hand, and on the other hand, I was concerned about environmental issues. It wasn't clear to me, though, how I could have a positive impact on the environment as I was going on with my life as a materials engineer."

His professional interest and involvement in green engineering was more of a wakeup call to the possibilities combining both his profession and his personal interest in engineering and the environment. In 1998, Dr. McGinnis moved to the east coast to work for Johnson & Johnson's Spectacle Group as a research scientist, R&D coating group manager, and later, "Design for Environment" plant champion. Three years into working at the company's plant in Roanoke, Sean realized that working on materials and their integral connection with the environment was what he wanted to focus on. "At Johnson and Johnson, which is a progressive company, they had already begun incorporating environmental concerns in their products and processes." When the company was sold in 2005, Sean was at the point of his career where he needed to find a professional path that would merge both his interests in engineering and the environment.

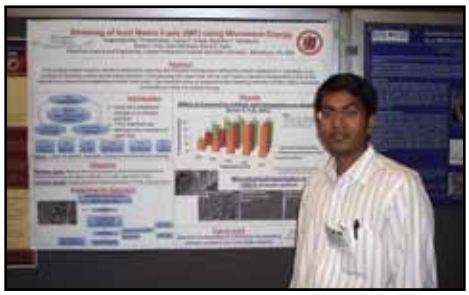
And this is how he found Virginia Tech's Green Engineering Program. In 2005, Sean joined the MSE and the Biological Systems Engineering (BSE) departments as a jointly appointed Senior Research Scientist and Director of the Green Engineering Program. He now directs the Green Engineering program which teaches students about the environmental implications of engineering practice across all College of Engineering disciplines.

With the Green Engineering Program, Sean is once again traversing disciplines. His plan is to create awareness and inform students across disciplines about addressing minimizing environmental constraints on the front end through design choices. Because green engineering is only one piece of a bigger environmental movement toward "sustainability," Sean expresses that "it is a mistake to believe that we can solve environmental problems solely with technology. It is a complex mix of technology, psychology, policy making, economics, and many other disciplines." His interdisciplinary "green" senior design class is currently an amalgam of students from biological systems engineering, materials science engineering, civil engineering, and finance.

When asked if he would go back to the industry, Sean believes that he would make a bigger environmental impact by working with students than working on a specific product. "Yes, I could work in the industry and still disseminate environmental responsibility by working on a product or technology. In this sense, the improvements would likely be materials - specific. However, if I can make 30---or a thousand students aware of the environmental issues in their fields of expertise—then I believe I can make more of a difference."❄

Student News

In June, recent B.S. graduate **Jenny Mueller** presented in the student research symposium at the Society for the Advancement of Material and Process Engineering (SAMPE) conference held in Baltimore, Maryland. Her talk entitled "Characterization of Modified Mesophase Pitch Derived Graphite Foams" was a co-winner in the senior category. Jenny, is presently working on her M.S. in MSE at Virginia Tech and is conducting experiments on graphite foams at Oak Ridge National Laboratories. ❄



Raghunath Rao Thridandapani won first place in the Fuels Category at the Global Nuclear Energy Partnership 2007 Annual Meeting in Phoenix, AZ in October for his poster, "Sintering of Inert Matrix Fuels (IMF) using Microwave Energy" (R. Thridandapani , C. Folgar, B. Sandbrook, D. Folz, S. McGinnis, D. Clark). Raghu works under the supervision of Dr. David Clark in the Microwave Processing Research Facility. ❄

MSE graduate student **Ben Poquette** has been named the 2008 College of Engineering Outstanding Graduate student. Ben was selected based on his academic performance, scholarly performance, and professional and service activities to the college. He will be honored by the Graduate School during Graduate Education Week in March. Ben was previously awarded the 2006 Outstanding Graduate Student Service Award and was named a Citizen Scholar by the Graduate School in 2006. This past fall, Ben was one of five students selected to participate in the 2007 Graduate Life Center Seminar Series, a symposium that provides selected faculty and graduate student leaders the opportunity to share the results of their research and discuss their passion for learning. Ben has completed his graduate studies under the guidance of Professor Steve Kampe and is now employed as a research scientist at Nanosonics, Inc. in Blacksburg. ❄

In November, MSE graduate student **Satenik Harutyunyan's** abstract was selected as one of the top five among contributing graduate student talks at the American Society of Mechanical Engineers (ASME) 2007 Congress held in Seattle, WA. Her presentation was part of the symposium entitled, "Structures and Materials for Aerospace and Lightweight Design." Her award consisted of travel grant to the Congress from the Robert and Mary Haythornthwaite Foundation. She is currently completing her Ph.D. dissertation on the effects of magnetic fields on defects in ferromagnetic materials with Professors Bill Reynolds and Davresh Hasanyan. ❄

Six **MSE students and two faculty** traveled to Washington D.C. to participate in the first-ever Materials Advantage version of Congressional Visit Day. 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 expanded this year to include a student-focused event. Like last year, students and faculty met with Senators and Congressmen or their staffs to advocate federal support for fundamental research in the physical sciences and engineering.

Following a half-day orientation that brought participants up-to-date on the events currently being conducted on Capitol Hill and proper visitation protocol, the VT team visited the offices of Senator Jim Webb. The group also attended congressional hearings discussing federal support for biomedical research (hosted by Senators Tom Harkin, D-IA, and Arlen Spector, R-PA), and hearings of the House Science and Technology Committee on the 2008 National Science Foundation budget (hosted by Representatives Brian Baird, D-WA, and Vernon Ehlers, R-MI). ❄

On March 17, 2007 (St. Patrick's Day), twenty three **MSE juniors** traveled to the Institute of Advanced Learning and Research (IALR) in Danville to participate in this year's VT STARS Family Technology Awareness Week. Our students conducted interactive demos to introduce concepts in materials science and engineering to middle school and high school students and their parents. As part of the MSE students' outreach project for the Professional Development course (MSE 3884), their presentations ranged from demonstrations of the response of materials to variance in temperature (ice cream and liquid nitrogen, imploding cans), to applications for ceramics (superconductors), metals (metal casting), and polymers (bouncy balls). ❄

MEPS NEWS

Materials Engineering Professional Societies
MSE's official student organization

MEPS receives Outstanding Chapter Award for the 3rd Year

For the third year in a row, the Virginia Tech Materials Engineering Professional Societies (MEPS) has received a Materials Advantage Outstanding Chapter Award. Selection for the award is based on a chapter's activities over the previous academic year; contributing to the national organization's recognition of the Virginia Tech's Student Chapter were MEPS participation in MSE recruiting activies, their hosting of the MSE/COE tailgating activities, their active participation in College E-week activities, and their support of the JUMR project. Award ceremonies were conducted at the 2007 Materials Science & Technology (MS&T) Conference in Detroit.

Materials Advantage is a nationally-organized consortium of the student chapters of The Materials Society of AIME (TMS), ASM International, the American Ceramic Society (ACerS), and the Association for Iron and Steel Technology (AIST). ❄

MEPS 2007-2008 Officers

President
Andrew Smith

ACerS President
Katherine Clark

AFS President
Andrea Rojas

ASM/TMS President
Russell Beckner

MRS President
Jennifer Mueller

Secretary
Michael Asaro

Treasurer
Tom Johnston

Faculty Advisor
Diane Folz

MEPS Students Combine Work and Play at the Daytona

In February 2008, students from Virginia Tech, New Mexico Tech, the University of Missouri – Rolla, and Alfred University came together to serve as meeting pages for the 32nd Annual Conference on Composites, Materials and Structures at the Hilton Resort in Daytona Beach, Florida. Here, the students, along with faculty and staff from VT, enjoy an evening of food and fun at a local seafood restaurant. ❄

Dominating E-Week

For the fourth time in the last five years, MEPS has taken top honors in the annual engineering (E-) week activities sponsored by the Student Engineering Council (SEC), February 18 - 22, 2008. Despite having the smallest number of students in the college, MSE dominated activities this year, amassing 72,000 points in competitions that included building structures from cans of donated can goods, duct-taping a fellow student to a wall, penny hoarding (penny wars), student versus professor trivia contests, and trubuchet. The second place department finished with 19,000 points.

Again, MSE proves that excellence is not measured by numbers alone! ❄

2008 Materials Science and Engineering Bachelor of Science Degrees (Expected)

Michael Asaro
Bradley Bailey
Andrew Baker
Daniel Barb
Russell Beckner
William Church
Katharine Clark
Devin Crawford
Brittany Ferrell
Meredith Fotta
David Gloekler
Christopher Glomb
Benjamin Gordon
Thomas Johnston
Sladjan Lazarevic
Elizabeth Logan
Daniel Martin
Erica Hartsell Moore
Joseph Norman
Andrea Rojas
Bradley Shevock
Andrew Smith
Danielle Willgruber
Kevin Yu
Chelsey Zacherl

2007-2008 Materials Science and Engineering Undergraduate Awards and Scholarships

Dean's Scholarship
Chelsey Zacherl

Alfred E. Knobler
Kathleen Campbell
Christopher Dykema
Annie Ellis
Meredith Fotta
David Gloekler
Christopher Glomb
David Gouldey
Thomas Johnston
Jill LeBlanc
Elizabeth Logan
Daniel Martin
Joseph Norman
Andrea Rojas
Danielle Willgruber
Mark Yoo
Kevin Yu
Kristen Zimmerman

Ronald S. Gordon
Benjamin Gordon
Chelsey Zacherl

John H. Kroehling
Brian Allik
Ryan Benoit
Mark Briguglio
Michael Yeh Chin-Chia
Connor Edsall
Niklas Floyd
Robert Fox
Matthew Greenough
Charles Hammond
Matthew Hiser
Dennis Hollich
Eric Miller
Eric Moffatt
David Moore
Erica Hartsell Moore
Kevin Sheets
Bradford Schulz

Thomas G. Stroyan Memorial
Michael Harvey
Lindsay Hockensmith

MSE Faculty
Katharine Clark

Michael Stuback Memorial MSE Scholarship
Andrew Smith

Micron Foundation
Benjamin Gordon
David Gouldey

William C. McAllister Leadership Scholarship
Jill LeBlanc

Gilbert and Lucille Seay
Dennis Hollich
Erica Hartsell Moore

Gordon W. Jones
Mark Briguglio

Peter and Phyllis Pruden
Eric Moffatt

Margaret B. Massie and Virginia D. Elder
Kathleen Campbell
Erica Hartsell Moore

2007 Materials Science and Engineering Graduate Awards

Name	Advisor	Thesis/Dissertation Title	Present Position
Doctor of Philosophy			
Ted Asare	Kampe	Investigating Ferroelastic and Piezoelectric Vibration Damping Behavior in Nickel-Barium Titanate and Nickel-PZT Composites	Special Metals, Precision Castpart Corporation, New Hartford, NY
Christelle Julian	Claus	Self-Assembly of Matching Molecular Weight Linear and Star-Shaped Polyethyleneglycol Molecules for Protein Adsorption Resistance	Nanosonics, Inc. Blacksburg, VA
Morsi Mahmoud	Clark	Crystallization of Lithium Disilicate Glass Using Variable Frequency Microwave Processing	Advanced Technologies and New Materials Research Institute Alexandria, Egypt
Joshua Monk	Farkas	Study of Nanowires Using Molecular Dynamics Simulations	Ames National Labs Ames, Iowa
Ben Poquette	Kampe	Understanding Ferroelastic Domain Reorientation as a Damping Mechanism in Ferroelectric Reinforced Metal Matrix Composites	Nanosonics, Inc. Blacksburg, VA
Master of Science			
Steven Kyriakides	Case	Characterization of Shear Strengths and Microstructures for Charred Rocket Motor Insulation Materials	GE Greenville, SC
Niven Monsegue	Aning	Solid State Synthesis of Bulk Amorphous Ni-50 a% Ti Alloy	Ph.D. Program MSE-VT
Chris Story	K Lu / Reynolds	Shape Memory Alloy / Glass Composite Seal for Solid Oxide Fuel Cells	Plansee Austria
Michael Willemann	Guido	Polymer-Supported Bridges for Multi-Finger AlGaN/GaN Heterojunction Field Effect Transistors (HFETs)	Ph.D. Program Cornell University
Michael Wooddell	Pickrell	Increased Functionality Porous Optical Fiber Structures	Arcelor Mittal Steel Harrisonburg, PA
Master of Engineering			
Megan Enzinna	G-Q Lu		ITT Roanoke
Kai Zhang	Aning		Norfolk State University

Alumni News

MSE Alumnus Charles P. Blankenship was inducted into the Academy of Engineering of Virginia Tech's College of Engineering in 2007. Charles received a bachelor's and a master's degree in metallurgical engineering in 1960 and 1962, respectively. He spent more than three decades with NASA, moving to NASA's Langley Research Center in Hampton, Virginia in 1980. Charles held a variety of positions, becoming NASA's Director of the Advanced Subsonic Technology Program Office with operations at three of the NASA centers — Lewis in Cleveland, Ohio, Ames at Moffett Field, California, and Langley in Hampton, Virginia in 1996, a year before his retirement. Charles lives in Poquoson, Va. and is the father of Charles "Chip" Blankenship, Jr who currently serves as an MSE Advisory Board member.

Virginia Tech's College of Engineering has honored ten of its most distinguished alumni with induction into its Academy of Engineering. Membership in the academy is reserved in general for individuals holding an engineering degree from Virginia Tech's College of Engineering and who have made sustained and meritorious engineering and/or leadership contributions during their careers. Only 71 alumni out of more than 45,000 living engineering graduates are members of this select group. The Academy was created in 1998 by the College of Engineering's Advisory Board in collaboration with the college administration. ❄

MSE LOSES a DEAR FRIEND: A Tribute to Alfred Knobler (CERE '38)

MSE says farewell to A**lfred E. Knobler (CERE'38)**, one of the department's most beloved alumni, who passed away peacefully on November 21. He was 92.

Alf Knobler, the founder and CEO of Pilgrim Glass Corporation and Knobler International Ltd. and a Virginia Tech 1938 alumnus in Ceramic Engineering, has made a special connection with the MSE family. He has served on the MSE Advisory Board, and he was also a member of the College of Engineering Committee of 100. In 2000, Mr. Knobler was inducted into the College of Engineering Academy of Engineering Excellence.

The Knobler Scholarship

Concern for others has been a way of life for Knobler. "I've always been an advocate of poor people--my purpose even now is to serve people." One of the many ways he serves is through the endowment of scholarships in both English and Materials Science and Engineering here at Virginia Tech.

In November 2003, Mr. Knobler made a generous donation to the university that is being shared between the Department of Materials Science and Engineering and the Department of English. The purpose of this gift was to support graduate education through the establishment of Knobler Fellowships. Knobler scholars will mesh across the two departments to exchange ideas and skills.

From Top: Alfred Knobler with Undergraduate Knobler Scholarship recipient Betsy (Hubbard) Barry (B.S. 2004) and MSE Graduate Knobler Scholar Dara Fleming (M.S. 2004); A portion of the the MSE Pilgrim Glass Collection; Peter Knobler, Alf KNobler and Dr. David Clark

The Pilgrim Glass MSE Exhibit

In 1997, Alf Knobler and the Pilgrim Glass Corporation donated several pieces of cameo glass for the department to keep and exhibit. Cameo glass is one of the most highly esteemed types of glass. It can be traced back to ancient Rome between 25 B.C. and A.D. 50 and was a cherished possession of emperors and patricians. The revival of the cameo technique in glass making was spearheaded by the Pilgrim Glass Corporation. This exhibit includes several pieces of American cameo glass, as well as cranberry, cobalt, and other glassware for which Pilgrim Glass has become internationally known. Currently, there are 72 pieces in the exhibit.

Fusion of Art and Engineering

Alf Knobler could not have chosen a better place to exhibit a perfect combination of art and engineering but the Materials Science and Engineering Department. A perfect cameo glass is equal parts engineering technique and artistic

precision. Traditionally, the term 'cameo' refers to a technique of layering one material over another, so that a raised motif emerges as the artist carves away surrounding material, exposing the background layer. However, in cameo glass, two or more layers of glass of similar compositions are cast together while still molten. The outer layer is carved to leave a design in relief with the effect depending upon the extent and depth to which the outer color is removed. Because of the layering of glass over glass, thermal expansion and stress factors must be carefully matched because even a tiny defect in the process can result in explosion.

For the engineer, cameo glass represents an amazing pheonmena from the standpoint of the stresses that can build up between the glass layers. Molten glass can be compared to hot lava, capable of chewing its way through anything in its path. The facilities required to produce this glass must be insulated against the high temperatures needed for processing. When the cameo blank is cooled and ready to carve, artisans must wear protective clothing and work in specially designed room. This increases the difficulty of trying to carve intricate detail into the glass, thus making the completed product even more of a marvel.

The product is a piece that comes alive with a spectrum of color and three-dimensionality, and which powerfully conveys the mood of the artist to the viewer appreciating it. More so, the product is affirmation of the connections between ceramic art forms and the science and engineering of glass making.

We Will Miss You, Alf !

Like the cameo glass, with his life and work, Alf Knobler has given the world a spectrum of inspiration through hard work, precision, creativity, kindness, and endless generosity. He is survived by two children, Peter, a writer, and Joanna, a doctor;their spouses, Jane Knobler and Ira Kawaller; and three grandchildren. *Alf Knobler, MSE's friend and benefactor, will truly be missed.*

Alfred T. Knobler, CERE '38

by Lee Ann Ellis Reprinted from ***It's A Materials World 1997***

When **Alfred Knobler** arrived at the Virginia Agricultureand Mechanical College (Virginia Tech) in 1934, Julian A.Burruss was the President, Earle Norris was the Dean of Engineering, and John Whittemore was the department head for Ceramic Engineering. Louis O'Shaughnessy was teaching Applied Mechanics and Samuel Pritchard was a professor in Electrical Engineering. The Huckleberry line was still in operation, and women were a fairly novel sight on campus.

Mr. Knobler recalls the culture shock of being a young Jewish northerner arriving in a small southern town, where, for example, the food was definitely not kosher. The son of Polish immigrants, Mr. Knobler grew up in the Bronx with two brothers and two sisters. Love and hope surrounded his childhood. He can remember his mother opening her home to two strangers newly arrived in New York during the Depression. "That's what working class people do for each other—they help people." He recalls his grandfather telling him at an early age, "You serve God by serving people." These memories have been a guide for him throughout his life.

Very early, he became aware of inequality and how money and power were used to keep average men and women down. He recalls the poll tax that prevented lower income citizens from voting. He remembers walking down Main Street in Blacksburg as an 18-year-old student and being surprised when a black couple stepped out into the street, leaving the sidewalk for him. This was one of many incidents that made an impression on him as a young man preparing to face the world.

A 1938 graduate of Virginia Tech, Mr. Knobler came of age during a dark time in our nation's history. He saw first hand the deep scars that resulted from the Depression. Fresh out of college with a degree in Ceramic Engineering, he was eager to try his wings. However, he faced failure and discouragement along with tho sands of other Americans who were unable to find work. At one point, he hitchhiked from his home in the Bronx all the way to Chattanooga, Tennessee because he heard rumors that work could be found there. On his return trip, after finding no job, he was advised by his traveling companion to consider a career in sales. He insisted that he was not interested in sales, that he was trained to be an engineer.

After sending out letters to every conceivable ceramics company, he was hired by Trenton Potteries in New Jersey, where he ultimately tried his hand at sales and discovered a new talent. The company, which manufactured porcelain bathroom fixtures, also designed high fire ceramics for the florist industry. When they gave some of these items to Mr. Knobler, he sold them out on the street for a nice profit. In no time he was earning a commanding salary of $8400 a year and was able to purchase a new Plymouth automobile for $600.

During World War II, he worked for the War Department as an inspector, traveling to various factories and writing reports. After the war, he decided it was time to take a chance on going into business for himself. With his talent for sales, he began buying and selling glass and pottery.

In 1949 he purchased a small factory in West Virginia called Tri-State Glass Manufactur-

Alf Knobler continued in page 16

Research Spotlight continued from page 1

Semiconductor (or diode) lasers have been a fundamental device in optoelectronics and photonics. These electrically-injected lasers present strategically important light sources for a wide range of civilian and military applications, such as telecommunications (Internet, high speed fiber networks and mobile phone networks), optical data storage and recording, optical pumping of solid-state lasers, free-space and satellite communications, chemical and biological sensing and spectroscopy, and materials processing and manufacturing technologies. CD players, laser printers and laser pointers contain examples of everyday use of diode lasers.

Due to the quantum-size effect, reducing dimensionality of the active region has been a tool for improving the semiconductor laser performance. The idea was initially applied to quantum well (QW) lasers, which successfully replaced the bulk active-region lasers in most commercial applications. The radical, qualitative improvement is anticipated from QD lasers – lasers with zero-dimensional active region. The discrete carrier spectrum in QDs appears ideally suitable for lasing generation. Thus the semiconductor QD lasers form a novel class of injection lasers that promise radically enhanced operating characteristics. The use of QDs as an active medium in injection lasers is a dramatic example of nanotechnology applied to devices of high commercial interest.

The principal advantages of an idealized QD laser over the contemporary QW lasers can be summarized as follows: significantly lower threshold current (current, at which the lasing starts) and its higher temperature-stability (ideally, temperature-insensitive threshold), superior opportunity for tuning the gain spectrum width and the emission wavelength (color of light), low chirp (shift of the lasing wavelength with injection current), more linear light-current characteristic and higher output optical powers.

A breakthrough in fabricating QD lasers came with the use of self-organizing effects in heteroepitaxial systems. Commercial perspectives of QD lasers have led to a significant progress in the fabrication technology. Using different material systems, it became possible to vary the lasing wavelength in the wide spectral range from the visible to mid-infrared, including 1.3 μm and 1.55 μm, most desirable for telecommunication applications.

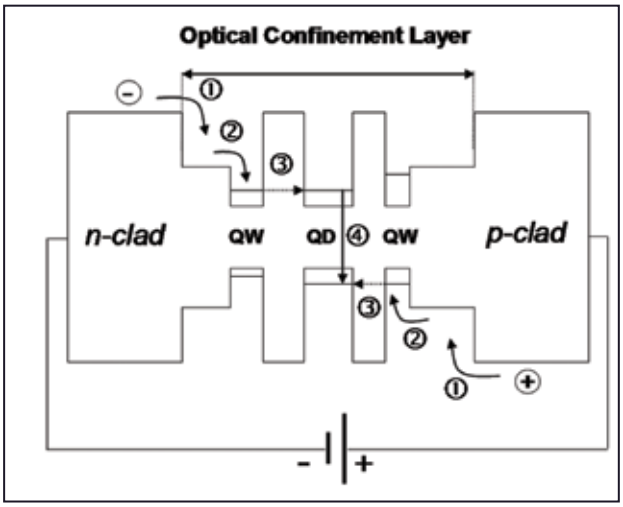


Fig. 1. Energy band diagram of a tunneling-injection QD laser.

Prof. Asryan builds a comprehensive theory of operating characteristics of QD lasers providing fundamental insights into them and practical recommendations for the realization of their advantages over the diode lasers currently in use. The work is performed in the following two directions: 'conventional' design of a QD laser, and tunneling-injection design.

The conventional design of a QD laser can be viewed as an analog of a QW laser — with the only difference being a layer with QDs (or multiple layers with QDs) replacing a QW (or multiple QWs). To investigate the limitations of such devices, we address all the major challenges in their development and major factors affecting their operating characteristics, such as internal optical loss, multiple transitions in QDs, multimode behavior above threshold, and nonradiative processes.

As an alternative approach to the conventional design of a QD laser, we consider tunneling injection of both electrons and holes into QDs (Fig. 1). The physical mechanisms, which potentially allow achieving virtually ideal performance in a tunneling-injection QD laser (with all the advantages listed above), are as follows: suppressed parasitic recombination outside QDs, suppressed effect of inhomogeneous broadening, suppressed effect of multiple levels in QD, and improved capture into QDs. Assuming an array of tunneling- injection QD lasers is used to produce the optical power, a considerably smaller number of lasers will be required to produce the same power as compared to conventional devices. This would significantly improve electrical-to-optical power conversion efficiency.

The theoretical work of Prof. Asryan's group in the area of electronic materials and devices in the MSE Department is complemented by the experimental work of Professor Louis Guido. The advanced experimental facilities, which are jointly operated by the MSE and ECE Departments, will allow them to synthesize novel p-n junction QD laser structures by metal-organic chemical vapor deposition, fabricate such material structures into working devices, and characterize the properties of these laser diodes for direct comparison with theoretical predictions and their final optimization.

You are invited to further learn about the research activities of Professor Asryan by contacting him directly at asryan@mse.vt.edu; (540) 231-7033) and/or visiting his webpage:

http://www.mse.vt.edu/people/faculty/Asryan.html ❄

Green Engineering continued from page 13

many students, this is first time they have considered some very basic questions regarding sustainability and materials such as:

- Where do the raw materials for this technology come from and what reserves exist?
- What are the environmental effects of raw materials' extraction?
- How much energy is required to transform the raw materials to usable form?
- Does the product or manufacturing process have environmental or health hazards?
- What happens to this product and its component materials when its useful life is over?

These are questions that most practicing materials scientists also do not generally consider in detail as they focus on improving technical performance or cost while the environmental issues are left to be handled by others.

In MSE 4055, Materials Selection and Design, the basic green engineering concepts are revisited as upper-level students focus on materials design considerations. A powerful materials design software package, Cambridge Engineering Selector (CES, Granta Design Limited), is used to show students examples and case-studies of how specific environmental constraints can be considered in materials selection. For example, students can consider the production energy of a material, that is, the amount of energy required to take raw materials and transform them into an engineering material like steel. This constraint can be balanced along with other traditional design constraints such as strength, modulus, fracture toughness, cost, or others as the specific case requires.

These courses represent the start of what Dr. McGinnis hopes is the full integration of green engineering concepts into the education of materials scientists. While these efforts are needed in all fields to address issues of sustainability, materials scientists and engineers are responsible for a significant fraction of all materials and materials processes used in modern society. Despite the strong connection between materials and environmental impacts, it is rare for materials science courses or curricula to address any environmental issues in a formal way, even though such content is now required in the ABET accreditation for engineering programs.

The Green Engineering Program is also working with MSE students in an NSF-funded interdisciplinary capstone design class. Unlike traditional capstone projects where upper-level students from the same department work in teams on a project, this new course mixes students from different disciplines to solve a complex project with sustainability implications. While it is widely held that this type of project experience will improve student skills and prepare them for real-world teams and problems, the methods for teaching in this challenging format and the student outcomes have not been studied in detail. Dr. McGinnis is collaborating with faculty from Engineering Education to consider these pedagogical issues in addition to teaching students about green engineering and sustainability on real-world challenging projects like water filtration for the developing world.

It is Dr. McGinnis' strong belief that sustainability is one of the most pressing issues of our time – one that has the potential to significantly affect the quality of life for future generations. Engineers have a key role to play in addressing these issues, but will need to think and act differently to help solve issues including the environmental, economic, and health risks that result from society's current use of materials, chemicals, and fuels. A critical step in this process is one of awareness and education, and Dr. McGinnis believes that universities and departments have the opportunity to take a leadership role. ❄

Alf Knobler continued from page 13

ing Company. It has since grown into the internationally renowned Pilgrim Glass Corporation, where specialty glass wares are produced such as cobalt and cranberry and the latest creation of American Cameo Glass. Concern for others has been a way of life for Alfred Knobler. "I've always been an advocate of poor people— my purpose even now is to serve people." He recently "adopted" PS42, his former elementary school in the Bronx. He purchased a much needed piano, a baby grand, for the school, and he spends one day a week visiting with the students, who call him Grandpa Alfred. He has also funded two scholarships in the MSE Department that were awarded for the first time this year. At 82, Alfred Knobler is still going strong. As CEO for Pilgrim Glass, he maintains an active interest in running the company. He enjoys traveling and meeting people from all walks of life. He finds joy in serving others. "It's been a marvelous life." ❄

Exploring Materials at Virginia Tech

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Heads Up!

David Clark

MSE Department Head

This past year proved to be a banner year for us and one of significant growth. We have new initiatives, new faculty, a robust student body, and achievements to cap off the efforts of the past several years. The concerted efforts of our faculty, staff, students, advisory board and alumni have made all of these accomplishments possible.

After five years of planning and the ongoing support of the MSE Advisory Board, the new Nanocharacterization and Fabrication Laboratory (NCFL) was dedicated this year and is a showpiece of the new Institute for Critical Technology and Applied Science (ICTAS). During the dedication, Dean Benson specifically thanked MSE for its vision and dedicated effort to establish this state of the art facility. MSE especially thanks Professors. Bill Reynolds and Carlos Suchicital for their valuable assistance in this initiative.

This past year, we focused on two new initiatives. One of these is the implementation of two international collaborations for students and faculty with the University of Darmstadt in Germany and Tianjin University in China. Drs. Hendricks and GQ Lu have played leadership roles in developing these collaborations initiatives. The other initiative is the establishment of VT FIRE, the Virginia Tech Foundry Initiative for Research and Education. Significant progress is being made in two phases of the project: the educational program is being developed jointly with Industrial Systems Engineering and the research focus will be developed in a new building that will be discussed in more detail in the next newsletter. When completed, this initiative will provide expanded opportunities for our students and faculty in high tech metallurgical education and research.

We are very proud of the many recognitions received by our graduate and undergraduate students in their academic and service activities. Their participation in national activities such as 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, led by President Andrew Smith and a very dynamic crew of officers, continue to be among the most active in the College of Engineering. Although one of the smallest student groups in size, they won E-Week again this year! The JUMR is about to release Volume 3 and this certainly would make Alf Knobler, our dear friend and alumnus who passed away this year, very proud. Alf funded the inaugural issue of the JUMR and it truly has helped to fulfill his vision of joint MSE and English initiatives. We congratulate recent alumnus, Dr. Ben Poquette, who has been awarded the College of Engineering Outstanding Doctoral Student.

In December, two of our faculty moved on to other positions. Dr. Brian Love joined the faculty at the University of Michigan and Dr. Rick Claus retired from Virginia Tech to devote full time to developing his business venture. In May, we will say goodbye to Dr. Steve Kampe who is joining the faculty at Michigan Tech. As Associate Department Head for the past several years, Steve has played a critical role in the growth of MSE over the past couple of years and he will be missed. We welcomed two new faculty to MSE in Drs. Jeremiah Abiade and Shashank Priya; and one former faculty, Dr. Robert Hendricks, has rejoined MSE and will assume the role of Associate Department Head when Steve leaves.

As always, we thank our alumni for their continued support and loyalty. Please stay in touch!

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