Innovations in Materials Research

Newsletter of the OSU Institute for Materials Research

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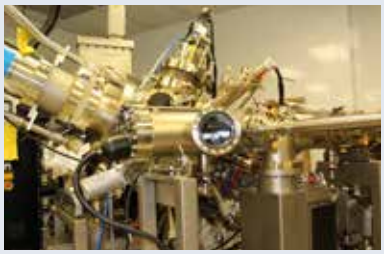
IMR SEALs the Deal With Newly Supported Research Facility



This Fall, the OSU Institute for Materials Research added another campus research facility to its cadre of IMR-supported core materials facilities, the Semiconductor Epitaxy and Analysis Laboratory (SEAL). Located in the basement of Dreese Laboratories, SEAL houses world-class facilities for research based on molecular beam epitaxy (MBE), a thin film deposition technique that maintains atomic crystal structure. The work done at SEAL is focused on MBE-grown III-V materials and devices, including both III-AsP and III-N compounds, and also III-V/Si integration and a variety of 2-D, 1-D and 0-D nanostructures. Research conducted at SEAL spans basic physics, chemistry, material science and electrical engineering, to produce unique material combinations and electrical properties. These innovative materials have real world device applications in optoelectronics (lasers and LEDs), alternative energy (solar cells), high power, high speed and high frequency devices. The SEAL facility includes a cleanroom with five MBE systems - three of which (for III-AsP and III-AsP/SiGe) are interlocked with an in-situ XPS analytic chamber, while the other two are dedicated for GaN and related materials. The lab also includes a wide range of advanced, state-of-the-art materials characterization tools to support advanced epitaxy and forefront advances in electronic materials.

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Faculty Spotlight: Alan Luo, Advanced Materials and Manufacturing

Professor Alan Luo discusses experimental work with graduate student Andrew Klarner

Dr. Alan Luo joined The Ohio State University as Professor of Materials Science and Engineering and Professor of Integrated Systems Engineering in July 2013. Before joining Ohio State, Dr. Luo worked most recently with General Motors Research and Development Center in Warren, Michigan, where he was a GM Technical Fellow on light metals and manufacturing. At OSU, Prof. Luo directs the Light Metals and Manufacturing Research Laboratory with more than 10 members, including graduate and undergraduate students and Postdoctoral Researchers. As a Principal Investigator, Prof. Luo maintains a current research portfolio with funding from the National Science Foundation, the US Department of Energy, and industrial sponsors. He is one of the core faculty for the Center for Simulation Innovation and Modeling (SIMCenter), leading manufacturing process simulation research. Prof. Luo is also a technical leader of the American Lightweight Materials Manufacturing Innovation Institute (ALMMII), a $148 million new manufacturing research institute co-founded by EWI, OSU and the University of Michigan.

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The Ohio State University

IMR
Institute For Materials Research

Director's Note

Dear Colleagues,

Welcome to the Fall 2014 edition of IMR's newsletter, Innovations in Materials Research! Innovation this Autumn has been everywhere and has been amplified tremendously with the recent announcement of the awarded Discovery Theme program "Translational Materials and Innovation: Accelerating Global Sustainability," led by a cross-cutting team of IMR's core faculty members. This Discovery Theme plan centers on the integration of science, technology, manufacturing, policy and business innovation and includes the creation of a new entity, the Materials Innovation Greenhouse, a construct designed to create a mixing bowl for shared university-interactions across disciplines, academia and industry. Discovery Theme hiring will build on and leverage existing strengths and assets, such as the Center for Emergent Materials and the Center for Electron Microscopy and Analysis; it will strategically fill gaps; it will aim to advance recent relevant strategic investments such as the Center for Design and Manufacturing Excellence, and, most importantly, it will target directions where transformative impact can be achieved leading OSU from excellence to eminence in materials and sustainability with a goal to deploy our innovations. We are very proud of this important achievement and now the real work is beginning! You can read more details inside.

Professors Alan Luo and Maryam Ghazisaeidi, both of whom joined the Department of Materials Science and Engineering in 2013, are featured in our Faculty Spotlight section. Alan's research on Light Metals and Manufacturing is a central area for one of the core topics within the Discovery Theme and he is working across multiple boundaries and centers already. Maryam's research focus on computational materials is also multidisciplinary and a great asset to our community. Not only do we welcome them both but we are eager to have you learn more about them inside. In addition, we welcome the newest addition to the constellation of IMR core facilities – the Semiconductor Epitaxy and Analysis Lab (SEAL), we have numerous updates to other core facilities, and an extensive set of member news in this issue!

Finally, I hope to see you all May 12-15, 2015 for this year's OSU Materials Week conference in which we are focusing the conference's technical sessions on the seven areas within our Discovery Theme plans – Design and Manufacturing, Emergent Materials, Lightweighting and High Performance Materials, Energy Efficient Systems, Energy Harvesting and Storage, Cradle-to-Cradle, and Policy, Awareness, and Globalization. This is a great opportunity to see what the Discovery Theme Initiative is all about and to become even further engaged in this strategic investment!

With warm regards,

Steven A. Ringel, Ph.D.
Neal A. Smith Chair Professor
Executive Director, The Ohio State University Institute for Materials Research

Faculty Spotlight: Maryam Ghazisaeidi, Materials Science and Engineering

Maryam Ghazisaeidi joined the Ohio State University as an Assistant Professor of Materials Science and Engineering in September 2013. She received her Bachelors and Masters degrees from Sharif University of Technology, Tehran, Iran and a Ph.D. in Theoretical and Applied Mechanics from University of Illinois at Urbana-Champaign. Before coming to OSU, she was a Postdoctoral Research Associate at Brown University.

Dr. Ghazisaeidi conducts research at the intersection of materials science, physics and mechanics. The focus of her group is to understand the connection between microscopic physical phenomena and macroscopic behavior of engineering materials by state-of the art computational methods.

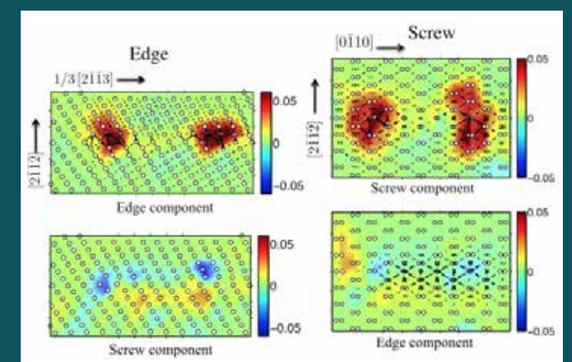


Figure 1: Core structure of edge and screw <c+a> dislocations computed from density functional theory. Color coding shows the Nye tensor distribution.

Shortly before joining OSU, Dr. Ghazisaeidi received a NSF-GOALI grant as a Co-PI (with Prof. Sharvan Kumar, Brown University and L. G. Hector, GM) to understand how alloying can tune deformation mechanisms in Mg alloys. The room temperature formability of Mg alloys is poor due to an anisotropic deformation response caused by the hexagonal-close-packed crystal structure: the non basal deformation modes require much higher stress levels to activate than the dominant basal mode. Dr. Ghazisaeidi's group seeks to solve this problem by finding a favorable element from the periodic table that reduces the critical stress differential between various deformation modes of Mg. This requires first principles modeling of dislocation cores and their interactions with solutes (Figure 1).

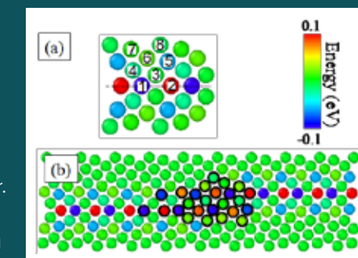


Figure 2: Twin/solute interaction energy map for Al solutes in Mg: (a) energies at geometrically unique sites in and around the coherent twin boundary; (b) twin dislocation structure and the solute interaction energies computed by direct substitution of Al in bold sites.

In addition to this work, Dr. Ghazisaeidi leads an effort (along with Prof. Michael Mills, MSE) funded by the Department of Energy's Office of Basic Energy Sciences to understand twinning mechanisms in hexagonal-close-packed (HCP) systems. Twinning is an important deformation mode in HCP systems but various HCP metals show different levels of propensity to twinning in the presence of the same alloying element. For example, twinning is readily observed in Mg-Al alloys but is severely suppressed in Ti-Al alloys. Dr. Ghazisaeidi and her group are working to quantify the effect of changes in chemistry on the different responses of two systems of the same crystal structure (Mg and Ti) to the presence of the same alloying element (Al). The research on twinning in Mg (Figure 2) has been published in *Acta Materialia [Acta Mater, 80, 278-287 (2014)]*.

Another aspect of Dr. Ghazisaeidi's research involves the development of new computational tools. A current focus is the development of a new method that extends the applicability of density functional theory calculations to modeling dislocation core structures in random, compositionally complex alloys.

For more information on Maryam Ghazisaiedi's research, visit her group's website at https://u.osu.edu/ghazisaeidi.1/

IMR Lecture Hosts General Motors Director Mark Verbrugge

The OSU Institute for Materials Research hosted its first IMR Distinguished Lecture of the 2014-2015 academic year on October 14, given by Dr. Mark W. Verbrugge, the Director of General Motors R&D's Chemical and Materials Systems Laboratory. Dr. Verbrugge's lecture, "The Automotive Industry, Vehicle Electrification, and Industrial Research," was given in front of a packed room of OSU faculty, staff, and students. The lecture first provided an overview of the need for energy sustainability in all areas of manufacturing and transportation before discussing specifics on the electrochemistry of lithium-ion batteries and the effects of different surface coatings on battery life. Dr. Verbrugge also discussed specific GM models such as the Chevy Volt and the new Spark EV, and his industry's attempts to double fuel efficiency by 2025.

IMR Distinguished Lecturer Mark Verbrugge (center) with IMR Director Steve Ringel and OSU Professor and Ohio Eminent Scholar Joseph Heremans

Each year, the Institute for Materials Research Distinguished Lecture Series brings world renowned materials researchers to The Ohio State University campus to share the latest developments in materials-allied fields and discuss their research with OSU students, faculty, and staff. IMR Distinguished Lecturers include the top scientists in their fields, and these lectures are advertised via campus mail, IMR listservers, and IMR's website. For more information on past lectures, visit http://imr.osu.edu/seminarsandevents/imr-distinguished-lecture-series/

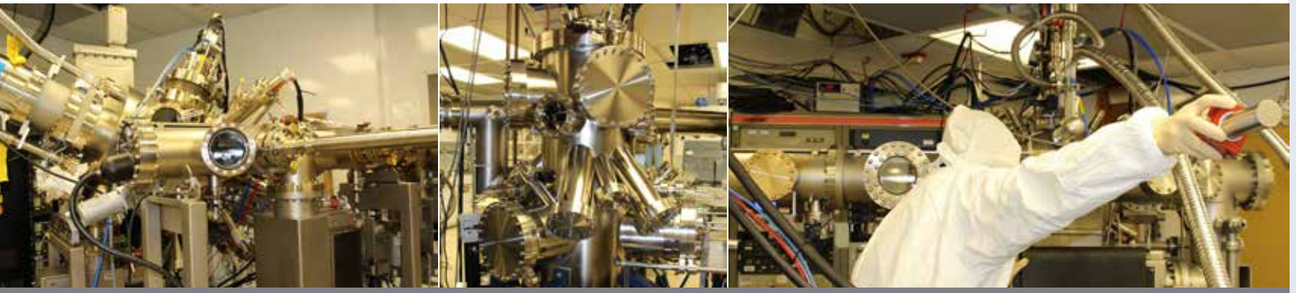
IMR SEALs the Deal With Newly Supported Research Facility (continued from page 1)

SEAL Laboratory Manager Mark Brenner has worked in this facility for many years, starting as an undergraduate student user and later becoming its full-time Lab Manager in 2002. His patient demeanor is essential to the operations of the lab, where Brenner estimates the average set-up time for a new project to be between two and 2 ½ hours, and new users must undergo an extensive, six-month training process just to get started. "We have very intricate equipment," explained Brenner, "You need to be very dedicated and attentive to be trained as a regular user of a lab this complex." While a unique, one-off experiment may last just a couple of hours, Brenner estimates that a typical growth day is closer to 5-6 hours of machine time while extreme growths can last as long as 18 hours. In addition to the time to properly set-up and grow a sample, this highly specialized and sensitive equipment needs routine repairs and service which can be followed by 3-4 weeks of calibration time. Brenner's oversight of the lab includes not only this regular maintenance of the instrumentation, but his full-time expertise is also used to train users, consult with researchers on their project goals and scope, liaison with industry and academic customers, and regularly conduct one-time experiments for clients as well.

The work done at SEAL also complements that conducted at IMR's Nanotech West Lab, and Brenner works closely with Dr. John Carlin on chemical vapor deposition (CVD) projects and with Aimee Price on electron beam lithography research needs. Materials are often grown to specifications at SEAL, then transported to Nanotech West for material processing to make devices. "Very often we grow crystals here at SEAL, then bring them to Nanotech West to process and analyze," said Brenner as he explained the full-range of services offered through these two IMR-supported facilities in close coordination.

SEAL joins three other materials-allied research facilities on campus receiving ongoing, direct support from IMR – Nanotech West Laboratory, NanoSystems Laboratory, and the Center for Electron Microscopy and Analysis.

For more information about the Semiconductor Epitaxy and Analysis Laboratory (SEAL), contact Lab Manager Mark Brenner at brenner.34@osu.edu or visit their website: http://emdl.ece.ohio-state.edu/seal.html

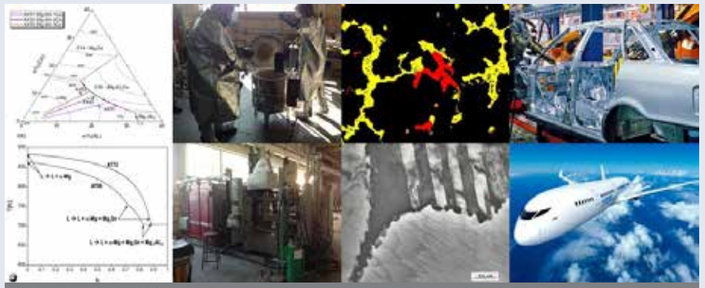


A look at some of the five MBE systems found in SEAL, with Lab Manager Mark Brenner loading a sample into the ultra-high vacuum chamber

In his October 17 announcement to IMR members, IMR Executive Director Steven A. Ringel noted, "As part of its mission, the Institute for Materials Research coordinates and strengthens the activities of major campus materials-related instrumentation centers, laboratories, and facilities. IMR does this through providing support for technical staff and other resources in key materials research facilities on The Ohio State University's Columbus campus [...] SEAL researchers are focused on III-V compound semiconductor materials and devices grown by MBE, and include materials from gallium arsenide and indium phosphide to gallium nitride and many related alloys. Ongoing projects range from advanced solar cells and optoelectronic devices, to transistors, fundamentals of epitaxial growth, nanostructures, nanoelectronics, wide bandgap semiconductors and III-V on Si integration. Many of these topics are already central to a number of IMR-supported seed programs, industry collaborations and research center efforts."

Faculty Spotlight: Alan Luo, Advanced Materials and Manufacturing (continued from page 1)

Among Prof. Luo's many honors, he has won two John M. Campbell Awards for his fundamental research and three Charles L. McCuen Awards for research applications at GM; is an elected Fellow of the American Society of Metals (ASM) International; and received The Minerals, Metals & Materials Society (TMS) Brimacombe Medalist Award and the Society for Automotive Engineers (SAE) International Forest R. McFarland Award in 2013, the United States Council for Automotive Research (USCAR) Special Recognition Award in 2009, and the ASM Materials Science Research Silver Medal in 2008. Prof. Luo also holds 16 patents and has authored more than 200 technical publications in advanced materials, manufacturing and applications. Prof. Luo's research is also recognized by several Best Paper awards from TMS, SAE and AFS (American Foundry Society), and he is the vice chair of TMS Light Metals Division and SAE Materials Engineering Activity Division.



Integrated computational materials engineering (ICME) for automotive and aerospace applications

Prof. Luo's research generally focuses on the following three areas:

Advanced metallic materials

Prof. Luo's group designs and develops new lightweight alloys (Al, Mg, Ti and advanced high strength steels) using computational thermodynamics and CALPHAD (CALculation of PHAse Diagrams) tools coupled with critical experimental validation. This approach was proven very effective in developing new magnesium alloys for automotive applications in Dr. Luo's previous work at GM. Current research at OSU funded by NSF and DOE will expand the research to include new aluminum and titanium alloys.

Innovative manufacturing processes

Prof. Luo's lab is developing new and/or improved manufacturing processes (casting, forming and multi-material manufacturing), aided by process simulation and multi-scale microstructure modeling. In collaboration with ISE Associate Professor Jerald Brevick, Prof. Luo's team adapted a new magnesium furnace and melt transfer system to the aluminum die casting machine to conduct the first successful magnesium die casting trial at OSU. This integrated die casting cell capable of manufacturing net-shape magnesium and aluminum is the first of its kind at any U.S. university. This technology is crucial for making lightweight metals for transportation applications, and will soon be made available for industrial development and academic research. Prof. Luo also pioneered the development of overcasting technology, which combines the excellent castability of light metals with the high strength/stiffness of advanced high-strength steels, opening an important window for multi-material manufacturing.

Integrated computational materials engineering (ICME)

ICME is defined as the integration of materials information, captured in computational tools, with engineering product performance analysis and manufacturing-process simulation. Several major National Academy studies have documented the importance of ICME and the substantial economic payoff to the manufacturing industry and to the nation. In collaboration with several other IMR researchers at OSU and external industrial and academic partners, Prof. Luo's group is developing ICME tools, and more importantly, working on lightweight structural designs and multi-material solutions using these advanced tools.

For more information on Alan Luo's research, visit his personal and group websites: http://mse.osu.edu/people/luo.445 and http://u.osu.edu/lmml/.

IMR-Led Proposal Funded Through OSU Discovery Themes Initiative

Translational Materials and Innovation: Accelerating Global Sustainability, an IMR-led project, was one of six proposals selected for funding this August through The Ohio State University's Discovery Themes Initiative.

The Ohio State University's Discovery Themes Initiative is a significant investment in three thematic areas in which the university will make a global impact: Energy and the Environment, Food Production and Security, and Health and Wellness. As the nation's most comprehensive university and one of the top institutions for industry-sponsored research, Ohio State is able to develop solutions that will transform our world.

Currently the implementation plans of each Discovery Theme program are being developed, and IMR leadership is working closely with a core team of representatives from throughout the OSU materials community. Below is a brief overview of the IMR-led initiative, its goals and objectives.

Discovery Theme Initiative: Materials for a Sustainable World
Translational Materials and Innovation: Accelerating Global Sustainability

Challenge:

Global sustainability is a holistic issue requiring a holistic solution. This challenge presents great opportunity for materials innovation, because materials production, processing and manufacturing are dominant energy consumers, using approximately 30 percent of U.S. energy. At the same time, materials innovation provides the solution as it is the foundation for the advanced technologies needed for sustainability in manufacturing, clean/renewable energy, energy-efficient macro- and micro-systems and bioproducts. The societal and industrial needs and challenges span the realms of regional, national and international, and solutions must be "cradle to cradle," making products that have a net positive impact on the environment through the entire cycle of manufacturing and use. In addition, materials innovation will require design and manufacturing; emergent materials; lightweighting; energy efficient systems; energy harvesting and storage; and policy, awareness and globalization.

Big idea:

To accelerate sustainable materials solutions, we will bring together stakeholders from materials science, engineering, business, design and policy for discovery, education and training and the end game – deployment.

We will create a Materials Innovation Greenhouse to with five critical component areas: discovery, clean energy, sustainability, systems and social-behavioral sciences with energy-environmental policy. The greenhouse will serve as to internally integrate university disciplines, colleges, departments and centers for a singular focus, building on established strengths and assets. The Greenhouse also will coalesce not only university experts and researchers but also industry partners, global partnerships, and regional innovators for creative ideation, rapid prototyping and modeling along with technology integrators who can translate science and technology into deployed products. Examples of expected impacts for improving global sustainability include affordable solar energy, biocomposite structures, buildings from sustainable materials, energy-efficient power systems, non-degrading components, ultra-light vehicles and improved urban mining.

IMR Member News

Paul Berger, Professor, Electrical and Computer Engineering, received the Ohio Society of Professional Engineers 2014 Outstanding Engineering Educator Award. The award recognizes Berger's "teaching and professional expertise, selfless service to promoting excellence in engineering education and for his dedication to the students of The Ohio State University and the engineering profession."

Stuart Cooper, Professor, Chemical and Biomolecular Engineering, received the American Institute of Chemical Engineers (AIChE) 2014 Founders Award for Outstanding Contributions to the Field of Chemical Engineering, recognizing outstanding contributions to the profession in both technical and professional activities that have advanced the profession and made a significant impact on the field of chemical engineering. Cooper's fundamental work on phase separation in block polymers is responsible for the good mechanical properties of many widely-used polymers such as the polyurethanes used in the high-performance thermoplastic elastomer industry.

L.-S. Fan, C. John Easton Professor, Chemical and Biomolecular Engineering, was recognized at the R&D 100 Awards on November 7 in Las Vegas. Fan and his collaborators at Taiwan's ITRI (the Industrial Technology Research Institute) were celebrated for developing one of the 100 most innovative technologies introduced in 2013 for their work on high-efficiency calcium looping technology (HECLOT).

Gerald Frankel, DNV Designated Chair and Professor, Materials Science and Engineering, was awarded the Lee Hsun Lecture Award by the Institute of Metal Research in Shenyang, China. This award is given for "outstanding contribution in the field of Materials Science and Engineering" and Frankel presented a lecture titled Mechanism of Hydrogen Evolution on Dissolving Mg Surfaces.

W.S. Winston Ho, Distinguished Professor, Chemical and Biomolecular Engineering, was elected to membership in the Academia Sinica as an Academician in the Republic of China in Taiwan, the highest form of academic recognition in that country. Ho has made outstanding and sustained, pioneering contributions to novel separations, gas treating invention and commercialization, new membranes and novel applications for energy and the environment.

Christopher Jaroniec, Professor, Chemistry and Biochemistry, received the 2014 Founders' Medal from the International Council on Magnetic Resonance in Biological Systems (ICMRBS) during the 26th ICMRBS meeting in Dallas, Texas. The Founders' Medal recognizes exceptional contributions to the development and/or progress of the field of magnetic resonance spectroscopy in biological systems.

William Marras, Honda Chair Professor, Integrated Systems Engineering, has been elected as the next president of the Human Factors and Ergonomics Society (HFES), a multidisciplinary professional association of more than 4,500 members globally. Marras plans to sustain and enhance HFES' value to both the academic and applied membership by supporting multi-disciplinary research, reaching out to young potential members, and increasing interaction with practitioners, among other efforts.

Susan Olesik, Professor and Department Chair of Chemistry and Biochemistry, was honored at the American Chemical Society's annual meeting with two awards acknowledging her accomplishments in both high-impact research and extraordinary advocacy for public understanding of science. Dr. Olesik received the Award for Chromatography and the ACS Helen M. Free Award for Public Outreach, two premier honors conferred by the nation's largest professional society for chemists.

Jon Parquette, Professor, Chemistry and Biochemistry, was the recipient of the 2014 American Chemical Society Columbus Section Award, awarded every two years to an outstanding scientist in the field of chemical sciences, including chemistry, biochemistry, biomedical sciences, chemical engineering, materials sciences, and science education.

Kubilay Sertel, Assistant Professor of Electrical and Computer Engineering, was awarded the 2014 Early Career Innovator of the Year by The Ohio State University Office of Research. Sertel's research focuses on Terahertz-frequency sensing, imaging and communications and he developed and commercialized the first real-time, high sensitivity terahertz camera used for medical, communication and security applications. Sertel's camera has been commercialized by Traycer Systems Inc. and has immediate applications such as security screening through clothing, identification of explosive compounds and life-changing applications such as breast cancer detection.

New IMR Members

This semester we welcome ten new members to the OSU Institute for Materials Research. Below is a brief description of the areas of focus of their research.

Nicholas Brunelli is an Assistant Professor in the William G. Lowrie Department of Chemical and Biomolecular Engineering. He leads the Catalytic Material Design Group, whose research focuses on achieving atomic level control of the catalytic active sites in heterogeneous materials by creating novel designs and using advanced synthetic methods. These materials are interrogated through spectroscopic techniques that enable improved design. Dr. Brunelli graduated from The Ohio State University William G. Lowrie Department of Chemical and Biomolecular Engineering with honors with an NSF Graduate Fellowship, earned his Ph.D. at the California Institute of Technology, and completed a postdoctoral fellowship at Georgia Institute of Technology prior to joining Ohio State.

John Clay is a Clinical Professor in the William G. Lowrie Department of Chemical and Biomolecular Engineering. In this role, he has two areas of focus. First, his primary emphasis is on undergraduate education. Second, Dr. Clay supervises the Unit Operations Laboratory, a capstone class for chemical engineers with twelve unique experiments and pilot scale equipment. Dr. Clay earned his M.S. and Ph.D. at The Ohio State University, focusing on biocompatible materials and rheology, and holds a joint appointment with Battelle, where he has been employed for seventeen years.

Liang Guo is an Assistant Professor of Electrical and Computer Engineering with a joint appointment in Neuroscience. His research takes place in the Laboratory for Biotronic Engineering, where his group studies the science and engineering of biological cyber-physical systems (bioCPS) at the intersection of circuits & systems engineering, tissue engineering, synthetic biology and neural prosthetics. His research has three goals: to develop bioCPS as implantable medical devices for treatment, restoration, and augmentation to body functions; to develop bioCPS as scientific tools to facilitate novel biomedical research; and to study biological principles, systems, and functions through the engineering of bioCPS models. Prior to joining OSU, he earned a Ph.D. degree in bioengineering from Georgia Institute of Technology and was a Postdoctoral Scholar in neural tissue engineering and regenerative medicine at the Massachusetts Institute of Technology. Dr. Guo has offered a new course during Fall 2014 semester, Neuroengineering and Neuroprosthetics (ECE5070).

Marat Khafizov is an Assistant Professor with the Nuclear Science and Engineering section of Mechanical and Aerospace Engineering. His research thermal properties of materials, materials science of nuclear fuel, radiation damage and its effect on materials properties, and laser-based, nondestructive evaluation methods. Prior to joining Ohio State, he was an Associate Scientist at Idaho National Laboratory and a Postdoctoral Research Associate at the University of Rochester, from which he received his Ph.D. in Physics.

Jennifer Leight is an Assistant Professor of Biomedical Engineering and is a member of the Molecular Biology and Cancer Genetics research program at the OSU Comprehensive Cancer Center. Her research interests include studying how the cellular microenvironment contributes to cancer progression and developing new biomaterials to systematically vary the microenvironment and measure cell function. The focus of research in her lab is to utilize cutting edge biomaterials techniques to precisely vary the spatial and temporal presentation of 3D extracellular cues as well as develop new sensors to measure activity of specific members of the matrix metalloproteinase (MMP) family. Using these novel materials, her group investigates fundamental questions regarding the regulation of MMP activity and cancer cell function and response to treatment. She joins us directly from a Postdoctoral Research Associate position at Howard Hughes Medical Institute at the University of Colorado, and she received her Ph.D. in Bioengineering from the University of Pennsylvania where she was awarded a National Science Foundation Graduate Research Fellowship.

Jonathan Song is an Assistant Professor of Mechanical and Aerospace Engineering and a member of the Solid Tumor Biology Program at OSU's Comprehensive Cancer Center. His Microsystems for Mechanobiology and Medicine Laboratory uses an integrated microsystems approach to study vascular biology and the tumor microenvironment. One of his research interests is understanding how the determinants of tumor blood flow such as elevated interstitial flow guide angiogenesis. Another research topic is dissecting the role of stromal fibroblasts in potentiating angiogenesis across multiple scales from secreted molecules, to multi-cellular morphogenesis, to tissue-matrix remodeling. Dr. Song is also interested in deploying these engineered microsystems for large-scale, high-throughput platforms for pre-clinical screening of multi-target anti-angiogenesis therapy. Prior to arriving at OSU, he earned his Ph.D. in Biomedical Engineering from the University of Michigan and was a Postdoctoral Fellow in the Edwin L. Steele Laboratory for Tumor Biology at Massachusetts General Hospital and Harvard Medical School.

Mingju Zhang is a Professor of Biomedical Engineering. His research interests focus on the study of biologically derived and inspired nanoadhesive and nanoparticles and how we can learn from biological systems in nature, especially in micro/nano-scale, to engineer biocompatible nanomaterials, and develop devices and systems for interfacing with molecular and cellular systems for therapeutics and tissue engineering. Dr. Zhang's group has discovered and derived several naturally occurring nanoparticles and adhesives, including ivy nanoparticles, fungus nanoparticles, tea nanoparticles, sundew nano-scaffolds, ivy and sundew adhesives. Through understanding molecular mechanisms of these nanomaterials, they are developing bio-inspired nanoparticles and nanoadhesives for drug delivery, wound healing, tissue engineering and cancer therapy. Before joining OSU's faculty, he was an Associate Professor of Mechanical, Aerospace and Biomedical Engineering at the University of Tennessee and a scientist with Agilent Technologies' Life Science and Chemical Analysis Division, where his work focused on bio-chip fabrication, lab-on-a-chip molecular diagnosis and bio-instrumentation.

David Nagib is an Assistant Professor of Chemistry and Biochemistry. The Nagib Laboratory seeks to bridge the gap between what is possible and practical in the realm of organic synthesis, with a goal to expand the synthetic toolbox by designing fundamentally new activation strategies and catalysts. Dr. Nagib's research aims to harness the untapped reactivity of cheap and abundant chemical feedstocks as well as enable the late-stage functionalization of complex natural products, working towards the invention of multi-faceted approaches for selective C-H and C-O activation using combinations of radical (1e-) and closed shell (2e-) processes. By emphasizing the design of novel dual-catalytic strategies (organometallic, organocatalytic, etc.) and a careful elucidation of their unique mechanisms, his group is developing useful methodologies to enable non-classical synthetic disconnections, with important applications in various interdisciplinary arenas, including the streamlined synthesis of improved medicines, materials, and biofuels. Ph.D. from Princeton University NIH Postdoctoral Scholar with Prof. F. Dean Toste at the University of California, Berkeley, David continued developing new C-H activation strategies by harnessing selective, oxidative gold mechanisms.

Hannah Shafaat, Assistant Professor of Chemistry and Biochemistry joined Fall 2013 Ph.D. in Physical Chemistry from the University of California, San Diego. After earning her Ph.D., Hannah moved across the ocean to Germany to study hydrogenase proteins and learn advanced EPR techniques as a Humboldt Foundation Postdoctoral Fellow working under Director Wolfgang Lubitz at the Max Planck Institute for Chemical Energy Conversion (formerly Bioinorganic Chemistry). Our research centers on the study of metalloenzymes that carry out valuable reactions relevant to alternative energy sources and clean energy storage. Using nature as inspiration, we seek to harness the advantages of bioinorganic platforms while overcoming the limitations of fragile multimeric protein systems. Our projects utilize a diverse array of scientific tools, from wet chemistry— molecular biology, chemical synthesis, and metalloprotein design—to spectroscopy—steady state and time-resolved optical techniques along with visible and ultraviolet resonance Raman spectroscopy—to quantum chemical calculations. Obtaining molecular-level insight into the mechanisms of catalysis will guide our design of increasingly efficient and robust catalysts for application.

Ajay Shah, Assistant Professor, Food, Agricultural and Biological Engineering based on Wooster campus received Ph.D. in Agricultural and Biosystems Engineering from Iowa State University Ajay Shah is an Assistant Professor in the department of Food, Agricultural and Biological Engineering. He holds a bachelor's degree in Mechanical Engineering from Tribhuvan University in Nepal, a master's degree in Biological Engineering from Mississippi State University, and a doctoral degree in Agricultural and Biosystems Engineering from Iowa State University. Dr. Shah leads the Biobased Systems Analysis Lab, which focuses primarily on research of sustainable agricultural production and bioprocess/systems engineering. His work includes feedstock production, handling and supply logistics for biobased and agricultural industries, and systems analysis to assess techno-economics and life cycle environmental impacts of biobased processes and systems.

Materials Facilities Updates

In each issue of our newsletter, IMR provides relevant updates from some of our core materials research facilities - the NanoSystems Laboratory (NSL), Nanotech West Laboratory, the Center for Electron Microscopy and Analysis (CEMAS), and our newest addition, the Semiconductor Epitaxy and Analysis Laboratory (SEAL). More information on these facilities and over a dozen other open user materials research facilities on OSU's Columbus campus, visit our website at: imr.osu.edu/research/facilities.

Nanotech West Laboratory – nanotech.osu.edu

OSSIP Developments – New Process and New Cleanroom Tool

Scanning electron micrograph of thick (>10 micron) AZ9620 photoresist cross-sectional profile

A team led by Jay DeLombard and Dave Hollingshead, engineers at Nanotech West Lab working on the Ohio Third Frontier/Ohio Development Services Agency Program-funded Ohio Sensor and Semiconductor Innovation Platform (OSSIP), developed a thick (>10 microns) photoresist process. The AZ9620 process will be useful to those needing very thick resists for deep dry etches, planarization of surfaces, and other processes such as thick electroplating.

A new tube furnace funded by the OSSIP program was recently installed and activated in Bay 4 of the Nanotech West cleanroom. The 150mm table-top furnace, capable of 1200° C and made by Across International, will be able to serve a wide variety of materials; tubes can easily be swapped in and out for users to have their own dedicated tube for their material or application.

Nanotech Staff Retirement

Dan Doubikin, Facilities and Laboratory Manager at Nanotech West for over 12 years, will retire at the end of November. Dan has provided outstanding service to our facility infrastructure, managing ongoing maintenance and building upgrades and often responding to alarms overnight and on weekends. As an example of his dedication to Ohio State, one of his first questions to OSU Human Resources about the retirement process was, "I can keep my season's tickets to OSU football after I retire, right?" He will be missed by Nanotech West staff and clients, and we wish him well in his retirement.

Nanotech West Associate Director Dr. John Carlin posing with the new tube furnace

NanoSystems Laboratory (NSL) – ensl.osu.edu

New Cryostation Arriving Soon

NSL is happy to announce acquisition of a Cryostation fabricated by Montana Instruments Corporation (Bozeman, MT). The instrument is optimized for optical experiments at cryogenic temperatures as low as 2.8 K and in magnetic field as high as 1000 mT. The instrument is cryogen free with an ultra-low vibration arrangement with peak to peak vibrations less than 5nm, and RMS vibrations less than 0.25 nm. NSL staff estimate the instrument will be installed and commissioned in the middle of December 2014 and it is expected to become available to NSL users in the beginning of 2015.

NSL Staffing Updates

NSL Program Assistant Asnika Bajracharya

The OSU NanoSystems Laboratory (NSL) is pleased to announce a new addition to its staff. Asnika Bajracharya was hired as NSL's new Program Assistant to handle administrative and customer service functions for NSL in a role previously held by Laura Heyeck. Asnika is from Nepal, the land of Himalayas, and earned her Bachelors of Science in Environmental Studies and in Physics from Gettysburg College. She is also a member of Sigma Pi Sigma, the Physics Honors Society, and completed her senior thesis on the effects of fertilizer use in radioactive isotope concentration in soil using gamma spectroscopy. She also developed a computer simulation in MATLAB using the Monte Carlo method to compare the experimental and computational value of the efficiency of a High Purity Germanium detector. Apart from her interest in science, she also loves open water scuba diving. Please contact Asnika if you are interested in becoming an NSL user, need BuckID access to one of NSL's labs, or if you need to purchase PPMS accessories, cantilevers, or other lab supplies. Asnika is also the point of contact for all NSL billing questions and for any issues that may occur in the labs or with the website and online reservation system. Asnika's office is located in the kiosk on the second floor bridgeway on the south side of the Physics Research Building, and she can be reached at bajracharya.5@osu.edu or 614-688-1158.

Bob Wells, NSL Lab Coorinator, passed away in September at the age of 54

Finally, the NanoSystems Lab and the entire OSU materials community mourns the loss of Robert "Bob" David Wells, NSL Lab Coordinator, who passed away on September 16, 2014. Bob was a 25 year employee of The Ohio State University and a valuable member of the Physics staff, earning the 2011 Distinguished Staff Award and serving NSL faculty, staff, and student users for more than three years. Bob was a great coworker and friend and is missed by all.

IMR Shuttle Now Features PHEV Van Acquired Through Honda Partnership

The OSU/Honda Partnership recently purchased two 12-passenger vans through a collaborative research effort with the U.S. Department of Energy, the Electric Power Research Institute (EPRI) and VIA Motors. The College of Engineering coordinated the purchase of two GM 12-passenger vans that have been converted to plug-in hybrid electric vehicle (PHEV) formats through the EPRI Plug-in Hybrid Medium-Duty Truck Demonstration and Evaluation Program. One PHEV van has generously been allotted to the IMR to use in its daily passenger service to west campus research facilities. The second van will be used by the College of Engineering for various business purposes throughout the year such as recruitment activities, moving equipment and supplies to regional campuses or high schools, transporting students to community projects or field work, and bringing student volunteers and engineering exhibits to important outreach events.

An artist rendering of the new IMR Shuttle Van. As of press time, the design was being finalized.

The vehicles are extended-range electric vans, which drive the first 35 miles in all-electric mode with near zero emissions, and have a full range of 400 miles on a single fill-up. The vans average over 100 mpg in typical local daily driving, allowing IMR to realize considerable savings while continuing to run its normal shuttle schedule, at the same time practicing the "green" sustainability approach to which many of its researchers have devoted their efforts. PHEV charging stations were installed in two dedicated parking spaces in the Northwest Garage to ensure the vehicles could be easily recharged overnight.

While the IMR shuttle transports passengers to research facilities, the new vehicle itself will be part of a research project. The vans are equipped with data collection devices which automatically send data related to driving vehicle and efficiency to EPRI, which in turn uses this data to recommend modifications to their PHEV converted vehicles in the future.

For more information about the IMR shuttle service, including its daily schedule and route, visit http://imr.osu.edu/resources/imr-shuttle/

Institute For Materials Research

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Save the Date

2015 OSU MATERIALS WEEK

at the Blackwell on OSU's Columbus Campus

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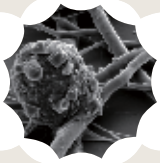
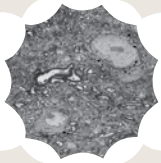
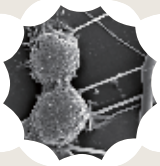
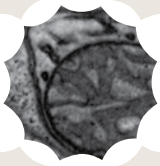
- Cradle-to-Cradle
- Design and Manufacturing
- Emergent Materials
- Lightweighting
- Energy Efficient Systems
- Energy Harvesting and Storage
- Policy, Awareness and Globalization

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