Hosted by the Institute for Materials Research (IMR) and its Materials and Manufacturing for Sustainability (M&MS) Discovery Theme focus area

Tuesday, May 7th - Thursday, May 9th
Organized by the Institute for Materials Research (IMR) and the Materials and Manufacturing for Sustainability (M&MS) Discovery Theme focus area

The Institute for Materials Research provides vision, coordination and support to advance multi-college excellence and impact in materials-allied research. IMR is the gateway to materials-allied research at The Ohio State University.

**IMR SUPPORTS OHIO STATE’S MATERIALS COMMUNITY THROUGH:**

- Strategic leadership
- Intercollege coordination
- Multi-university relations
- Management of major research facilities
- Seed funding and facility access funding
- Promotion of industry partnerships
- Infrastructure support and development
- Development and administration of major research programs and centers
- Scientific educational programs and annual conference
- Faculty recruitment

**IMR IS GRATEFUL TO THE FOLLOWING FOR THEIR GENEROUS SUPPORT TOWARD 2019 OSU MATERIALS WEEK:**

- Ohio State Energy Partners: ENGIE and Axium Infrastructure
- Center for Emergent Materials (CEM), an NSF Materials Research Science and Engineering Center (MRSEC)
- L3 Space & Sensors

*Find IMR online at imr.osu.edu*
On behalf of the Institute for Materials Research, I’d like to welcome you to 2019 OSU Materials Week, our 11th annual showcase of materials-allied research at The Ohio State University!

OSU Materials Week is a very special event, as it is both a technical conference in which researchers share the latest in innovative materials-allied research, and a celebration of Ohio State’s materials community and all of its accomplishments.

This year we are honored to welcome our 2019 IMR Keynote Speaker, Dr. Tatjana Curcic, from the Defense Advanced Research Projects Agency (DARPA). At DARPA, she is program manager at the Defense Sciences Office. Prior to this, she was a program officer at the Air Force Office of Scientific Research for the Quantum Information Science and Atomic and Molecular Physics programs. Her interests are in driving toward the acceleration of quantum information technologies from materials and information processing. Her presentation, entitled “From Basic Research to Quantum Technologies: Challenges and Opportunities,” will discuss various opportunities linked to the development of quantum technologies, as well as some challenges. Along with this, Dr. Curcic will summarize Quantum Information Processing (QIP) approaches and their applications.

The keynote will be preceded by a welcome reception and the first of our cross-cutting sessions: Materials for Quantum Science. The reception will include a welcome from Ohio State’s Senior Vice President for Research Morley Stone.

The three-day conference continues with multiple cross-cutting and focus sessions, featuring talks on a variety of topics that demonstrate the depth and breadth of materials research. A cross-cutting session will be held each morning, featuring speakers from academia, industry and government labs. Two focus sessions on both Tuesday and Wednesday will feature researchers from a variety of U.S. institutions of higher education.

Food and drinks will be available during the evening receptions at 5 p.m. on Tuesday and Wednesday. On Tuesday, the Three Minute Thesis at 5:15 p.m. will challenge master’s and doctoral students to describe their research within three minutes to a general audience. Our Student Poster Sessions, always a highlight of Materials Week, take place Tuesday and Wednesday evenings, beginning at 6 p.m. These sessions present an opportunity to socialize amongst colleagues. Finally, we wrap up Thursday with lunch, featuring an awards ceremony for our student poster winners and recognitions of achievement among faculty.

We are very grateful for the generous sponsorship from L3 Space and Sensors and our partners at Ohio State: Ohio State Energy Partners - Engie and Axium Infrastructure and the Center for Emergent Materials. Many thanks also to our outstanding Organizing Committee and Technical Program Committee volunteers (listed on pages 48 and 49) for all of their contributions and assistance in the production of this year’s conference, helping to ensure its success.

Welcome!

Dr. Steven A. Ringel
Distinguished University Professor
Neal A. Smith Professor of Electrical Engineering
Associate Vice President for Research, and
Executive Director, Institute for Materials Research

Dr. Steven A. Ringel
## Tuesday, May 7

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<tr>
<th>Time</th>
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<tbody>
<tr>
<td>7:30 AM</td>
<td>Pfahl Lobby</td>
<td>Registration/Coffee</td>
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<tr>
<td>8:00 AM</td>
<td>140 Pfahl</td>
<td>Welcome &amp; Introductions: Morley Stone, Ohio State Sr. VP for Research</td>
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<tr>
<td></td>
<td>140 Pfahl</td>
<td>Cross-cutting Session 1: Materials for Quantum Science</td>
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<tr>
<td>8:30 AM</td>
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<td>Daniel Gauthier, <em>The Ohio State University</em></td>
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<tr>
<td>9:00 AM</td>
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<td>David Awschalom, <em>University of Chicago</em></td>
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<td>9:45 AM</td>
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<td>Minh Nguyen, <em>HRL Laboratories</em></td>
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<tr>
<td>10:30 AM</td>
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<td><strong>KEYNOTE SPEAKER</strong> Dr. Tatjana Curcic - DARPA, Defense Sciences Office</td>
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<tr>
<td>11:30 AM</td>
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<td>Keynote Reception</td>
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<tr>
<td>12:00 – 1:00 PM</td>
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<td>LUNCH on your own</td>
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<tr>
<td></td>
<td>140 Pfahl</td>
<td>Focus Session 1: Materials for Biofabrication</td>
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<tr>
<td></td>
<td>302 Pfahl</td>
<td>Focus Session 2: Next-generation Functional Materials</td>
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<tr>
<td>1:00 PM</td>
<td></td>
<td>Matt Becker, <em>U. of Akron</em></td>
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<tr>
<td>1:45 PM</td>
<td></td>
<td>Jan Stegemann, <em>U. of Michigan</em></td>
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<td>2:30 PM</td>
<td></td>
<td><strong>BREAK</strong></td>
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<tr>
<td>2:45 PM</td>
<td></td>
<td>Jennifer Leight, <em>OSU</em></td>
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<tr>
<td>3:15 PM</td>
<td></td>
<td>Jessica Winter, <em>OSU</em></td>
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<tr>
<td>3:45 PM</td>
<td></td>
<td>Katelyn Swindle-Reilly, <em>OSU</em></td>
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<tr>
<td>4:15 PM</td>
<td></td>
<td>Discussion Panel</td>
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<td>5:00 - 8:00 PM</td>
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<td><strong>Three Minute Thesis, Student Posters and Evening Reception</strong></td>
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<td>Three Minute Thesis (3MT®) Finals 140 Pfahl (5:15-6 PM)</td>
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<td>Student Poster Session Blackwell Ballroom (6-8 PM)</td>
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<td><em>Food and drinks are served throughout the Evening Reception on the Blackwell Patio (5-8 PM)</em></td>
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## Wednesday, May 8

**Pfahl Lobby**
- **8:00 AM**: Registration/Coffee

**140 Pfahl**
### Cross-cutting Session 2: Data Science for Advanced Manufacturing
- **8:30 AM**: Benji Maruyama, *Air Force Research Laboratory (AFRL)*
- **9:10 AM**: Charlie Bouman, *Purdue University*
- **9:50 AM**: BREAK
- **10:10 AM**: Edward Herderick, *The Ohio State University*
- **10:30 AM**: David Hoelzle, *The Ohio State University*
- **11:00 AM**: Matthew Jacobsen, *Air Force Research Laboratory (AFRL)*
- **11:30 AM – 1 PM**: LUNCH on your own

### Focus Session 3: Wide Bandgap Materials and Ionizing Radiation
- **1:00 PM**: James Edgar, *Kansas State U.*
- **1:45 PM**: Robert Nemanich, *Arizona State U.*
- **2:30 PM**: BREAK
- **2:45 PM**: Marat Khafizov, *OSU*
- **3:15 PM**: Yang Liu, *OSU*
- **3:45 PM**: Jinsong Huang, *UNC at Chapel Hill*
- **4:15 PM**: Discussion Panel

### Focus Session 4: Elastomers and Other Polymers for Improved Sustainability
- **1:00 PM**: Julie Kornfield, *California Institute of Tech.*
- **1:45 PM**: Liming Dai, *Case Western Reserve U.*
- **2:30 PM**: BREAK
- **2:45 PM**: Robert Nemanich, *Arizona State U.*
- **3:15 PM**: Yang Liu, *OSU*
- **3:45 PM**: Jinsong Huang, *UNC at Chapel Hill*
- **4:15 PM**: Discussion Panel

**302 Pfahl**
- **5:00 - 8:00 PM**: Student Posters and Evening Reception

**Student Poster Session** Blackwell Ballroom (6-8 PM)

*Food and drinks are served throughout the Evening Reception on the Blackwell Patio (5-8 PM)*
## Thursday, May 9

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<th>Time</th>
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<tr>
<td>8:00 AM</td>
<td>Pfahl Lobby</td>
<td>Registration/Coffee</td>
</tr>
<tr>
<td>8:30 AM</td>
<td>140 Pfahl</td>
<td>Cross-cutting Session 3: Materials in Energy Applications for a Carbon Sustainable World</td>
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<tr>
<td>8:45 AM</td>
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<td>Welcome and Perspective: Ardeshir Contractor, The Ohio State University</td>
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<td>9:25 AM</td>
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<td>Michael Webber, ENGIE Lab Crigen</td>
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<td>10:05 AM</td>
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<td>Ramteen Sioshansi, The Ohio State University</td>
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<td>10:45 AM</td>
<td></td>
<td>Joel Agner, Honda R&amp;D Americas</td>
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<tr>
<td>11:30 AM</td>
<td>Blackwell Patio</td>
<td>Yiying Wu, The Ohio State University</td>
</tr>
<tr>
<td>11:30 AM</td>
<td>Blackwell Patio</td>
<td>Awards Ceremony &amp; Lunch</td>
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</table>
Richard Feynman has famously and prophetically said in 1981 “Nature isn’t classical, dammit, and if you want to make a simulation of Nature, you’d better make it quantum mechanical, and by golly it’s a wonderful problem, because it doesn’t look so easy”. However, it wasn’t until Peter Shor discovered the quantum factoring algorithm in 1994 that the power of quantum mechanics for information processing was widely recognized. Since then, we have witnessed vigorous and growing Quantum Information Science (QIS) research around the world that has resulted in a plethora of significant scientific advances. Over the past few years, we have also seen a substantial interest in quantum technologies from the commercial sector, and various national quantum R&D programs have sprung up around the globe. It is an exciting time to be working in this field, whether as an academic or industrial researcher, or as a policy maker.

Numerous scientific advances over the past couple of decades have laid foundations for new quantum technologies. In this talk, I will discuss challenges and opportunities accompanying the development of quantum technologies. Opportunities are abundant, from precision electric and magnetic field sensors and timekeeping devices, to information security and novel network applications, to a powerful new way of computing and simulating Nature. An overview of various Quantum Information Processing (QIP) approaches and their potential uses will be presented. I will also briefly discuss a particular tantalizing opportunity in QIP with Noisy Intermediate-Scale Quantum (NISQ) devices.

**BIOGRAPHY**

Dr. Tatjana Curcic joined DARPA as a program manager in the Defense Sciences Office in 2018. Her interests are in accelerating the development of quantum information technologies and discovering new applications in a range of areas from sensing to information processing with noisy qubits. Prior to joining DARPA, Tatjana was a program officer at the Air Force Office of Scientific Research (AFOSR) for the Quantum Information Science and Atomic and Molecular Physics programs. She managed a portfolio that supported basic research on five continents. She has served on a number of government panels and boards, including the White House Office of Science and Technology Policy (OSTP) Quantum Information Science (QIS) Working Group. In 2017, Tatjana served as the founding director of Quantum Valley Ideas Laboratories, a not-for-profit applied-research organization for the development of quantum technologies in Waterloo, Ontario. Earlier in her career, she worked as a science and technology consultant to DARPA. Tatjana received her Ph.D. in physics from Cornell University, and her B.S. in physics from the University of Belgrade in Serbia.
The benefits of growing algae to help mitigate numerous environmental concerns are well known in the academic and scientific communities. For example, using algal technologies as a solution to reduce excessive nutrients in waste streams is gaining credibility, with several full-scale municipal and industrial applications already in construction. Recently though, there has been a growing interest in the potential use of algal production to help reduce CO\textsubscript{2} emissions, and even potentially turning the algae into value-added materials, such as plastics, oils, and fertilizers.

This talk will feature a project by Honda R&D Americas, Inc. to recycle CO\textsubscript{2} emissions at its Ohio Center outside Columbus. Part of a potentially larger program, this initial phase focused on demonstrating how algal production can be a viable component of a corporate objective to become carbon neutral, with a target cost of less than $100 per ton of CO\textsubscript{2} consumed. The discussion will focus on the program’s overall objectives, methodologies employed, results obtained, and what products can be produced from the biomass, all of which factor into the most important aspect of this approach: the economics.

BIOGRAPHY

Joel Agner is an engineer for Powersports products at Honda R&D Americas, Inc. (HRA). Agner is responsible for exhaust and evaporative emissions regulation compliance, drivability, start-ability, and fuel system component testing for Honda side-by-sides and all-terrain vehicles (ATVs). Agner joined Honda in 2006, with a focus on Powersports product research, later becoming a test group project leader before assuming his current role. In addition to that work, in the summer of 2018, Agner and two of his colleagues led the construction and operation of a 2,000-liter algae photo-bioreactor at HRA’s Ohio Center. The project was a proof-of-concept to determine the feasibility of carbon capture and waste remediation using micro-algae. Biomass utilization was also a focus area of the project, including research in energy generation, bio-fertilizers, and automotive product applications from algal-based materials.

Agner is a co-inventor on three patents pending from his work at HRA in CO\textsubscript{2} reduction and waste remediation. Agner graduated from the University of Northwestern Ohio with an associate’s degree in automotive and alternative fuels technology. He also has more than 10 years of experience in biodiesel production and alternative energy research.
Selective conversion of alkanes to higher value species using heterogeneous catalysts is of great interest with the increasing availability of light alkanes from shale fracking. We have used a combination of temperature programmed reaction spectroscopy (TPRS) and density functional theory (DFT) to demonstrate that the stoichiometric terminated IrO$_2$(110) surface can activate methane and ethane below room temperatures, and furthermore, that this surface can be selective towards ethane dehydrogenation to ethylene. For ethane, DFT shows that adsorption and initial C-H bond cleavage to surface bound C$_2$H$_4^*$ is facile and the selectivity step occurs between further C-H bond breaking leading to complete oxidation versus ethylene desorption. The reactivity of this surface is mediated by the presence of undercoordinated Ir (Ircus) and adjacent bridge O atoms (Obr). Using the combination of TPRS and DFT we find that pre-hydrogenating the IrO$_2$(110) surface results in the formation of HO$_{br}$ sites that increases the selectivity towards ethylene by increasing the barrier to C-H bond cleavage for C$_2$H$_4^*$ and decreasing the desorption energy of C$_2$H$_4^*$. We will discuss efforts to use DFT-based microkinetic modeling to explore doping strategies to promote selectivity towards ethylene formation under reaction conditions.

**BIOGRAPHY**

Dr. Aravind Asthagiri obtained his B.S. in Chemical Engineering with a minor in Mathematics (1998) from The Ohio State University, and a Ph.D. in Chemical Engineering from Carnegie Mellon University (2003). His research involves the application of first-principles based simulations to understand and rationally design novel catalysts for energy applications. He has co-edited a book titled “Computational Catalysis: Recent Advances in Methods and Applications” published in 2014 by the Royal Society of Chemistry. He has also served as the organizer for the Low Pressure group at the AIChE National Meetings and a co-chair of the executive committee for the 23rd North American Catalysis Meeting.
Our technological preference for perfection can only lead us so far. As traditional transistor-based electronics rapidly approach the atomic-scale, small amounts of disorder begin to have outsized negative effects. Surprisingly, a promising pathway out of this conundrum may emerge from recent efforts to embrace defects and construct quantum systems to enable new information technologies based on the quantum nature of the electron. Individual defects in materials possess an electronic spin state for manipulating, communicating, and storing quantum information at the level of single electrons and nuclei. We describe recent developments in controlling and linking spins in diamond, silicon carbide, and hybrid structures. These include opportunities to implement quantum gates, pathways towards high-fidelity information processing within wafer-scale materials, and schemes to ‘wire’ spins using magnons and phonons.

BIOGRAPHY
David Awschalom is the Liew Family Professor and Deputy Director of the Institute for Molecular Engineering at the University of Chicago, and a Senior Scientist at Argonne National Laboratory. Before arriving in Chicago, he was the Director of the California NanoSystems Institute and Professor of Physics, Electrical and Computer Engineering.
The known crystal structures of solids often correspond to the most thermodynamically stable arrangement of atoms. Yet, oftentimes there exist a richly diverse set of alternative structural arrangements that lie at only slightly higher energies and can be stabilized under specific constraints (temperature, pressure, alloying, point defects). Such metastable phase space holds opportunities for non-equilibrium structural motifs and distinctive chemical bonding and ultimately for the realization of novel function. I will discuss the challenges with the prediction, stabilization, and utilization of metastable polymorphs. Using two canonical early transition-metal oxides, HfO$_2$ and V$_2$O$_5$, as illustrative examples where emerging synthetic strategies have unveiled novel polymorphs, I will highlight the tunability of electronic structure, the potential richness of energy landscapes, and the implications for functional properties. In recent work, we have explored the intriguing electronic phase diagrams of low-dimensional ternary vanadium oxides with the formula M$_x$V$_2$O$_5$, where M is an intercalating cation and $x$ is its stoichiometry. Several of these compounds show colossal metal—insulator transitions and charge ordering phenomena. The talk will focus on mechanistic understanding of these transitions and their implications for the design of new “brain-like” vectors for computing. If composition does not have to be structural destiny, a powerful new palette becomes available for tuning material properties. I will demonstrate the application of this M$_x$V$_2$O$_5$ palette to two specific problems: (a) the design of cathode materials for multivalent insertion batteries; and (b) the design of photocatalysts for the water oxidation reaction.

**BIOGRAPHY**

Sarbajit Banerjee is the Davidson Professor of Chemistry and Professor of Materials Science & Engineering at Texas A&M University. Sarbajit is a graduate of St. Stephen’s College (B.Sc.) and the State University of New York at Stony Brook (Ph.D.). He was a post-doctoral research scientist at the Department of Applied Physics and Applied Mathematics at Columbia University prior to starting his independent career at the University at Buffalo in 2007. He moved to Texas A&M University in 2014. He was awarded a National Science Foundation CAREER award in 2009; the American Chemical Society ExxonMobil Solid-State-Chemistry Fellowship in 2010; the Cottrell Scholar Award in 2011; the Minerals, Metals, and Materials Society Young Leader Award in 2013; the American Chemical Society Journal of Physical Chemistry Lectureship in 2013; the Scialog Innovation Fellowship in 2013; the IOM3 Rosenhain Medal and Prize in 2015; and the Royal Society of Chemistry/IOM3 Beilby Medal in 2016. He is a Fellow of the Royal Society of Chemistry and the Institute of Physics. In 2012, MIT Technology Review named Sarbajit to its global list of “Top 35 innovators under the age of 35” for the discovery of dynamically switchable smart window technologies that promise a dramatic reduction in the energy footprint of buildings. His research interests are focused on solid-state chemistry, electron correlated materials, mechanisms of electrochemical energy storage, heavy oil processing, and functional coatings.
Despite significant advances in software and hardware for additive manufacturing, the availability of resorbable resins is extremely limited. Motivated by traumatic injuries experienced by warfighters, we are developing novel materials and devices designed to repair segmental bone defect and achieve limb salvage. Biomimetic approaches based on polymers derivatized with adhesive receptor-binding peptides, glycoproteins and tethered growth factors have been shown to enhance interactions at the biotic-synthetic interface. Further advances in both synthetic methodology and additive manufacturing are needed to drive these efforts forward. This presentation will describe the use of several translationally relevant chemistries, resorbable polymer resins and functionalization strategies that are impacting the practice of medicine and how physicians are planning for future therapies using additive manufacturing that were not possible previously.

BIOGRAPHY
Matthew L. Becker is the W. Gerald Austen Endowed Chair of Polymer Science and Engineering at The University of Akron. His multidisciplinary research team is focused on developing bioactive polymers for regenerative medicine and addressing unmet medical needs at the interface of chemistry, materials and medicine. His group has published more than 140 papers, has 50 patents issued or pending and is the founder of three start-up companies. Professor Becker was recently awarded the Carl S. Marvel Award in Creative Polymer Chemistry. He is a Kavli Fellow and a Fellow of the Royal Society of Chemistry, the PMSE Division of the American Chemical Society and the American Institute for Medical and Biological Engineering. In August of 2019, Dr. Becker and his research team will join the Departments of Chemistry, Mechanical Engineering and Material Science and Orthopaedic Surgery at Duke University.
Machine learning (ML) and AI promise to bring the next wave of change and innovation to every corner of society. But how will it change the endeavors of science and material science in particular? This talk explores a number of important recent directions in the integration of AI with materials science problems, and also speculates on some directions these innovations might take in the future. First, we discuss methods for integrating what we argue are the three major types of models: a) sensor models, b) data models, and c) physics models in order to make accurate observations using the available sparse, incomplete, and noisy data. Second, we discuss methods for using intelligent models to improve the quality and speed of observations by dynamically and autonomously acquiring information. Third, we discuss methods for reducing computation by supplementing or replacing traditional physics-based models with ML based methods. Throughout the talk, we present state-of-the-art examples using imaging modalities including computed tomography (CT), transmission electron microscopy (STEM), synchrotron beam imaging, optical sensing, scanning electron microscopy (SEM), and ultrasound imaging. In each of these examples, key advantages result from the integration of sensor, data, and physics models using emerging ML methods.

**BIOGRAPHY**

Charles A. Bouman is the Showalter Professor of Electrical and Computer Engineering and Biomedical Engineering at Purdue University. He received his B.S.E.E. degree from the University of Pennsylvania, M.S. degree from the University of California at Berkeley, and Ph.D. from Princeton University in 1989. Professor Bouman’s research is in the fields of electronic and computational imaging in applications ranging from medical to scientific and consumer imaging. His research resulted in the first commercial model-based iterative reconstruction (MBIR) system for medical X-ray computed tomography (CT), and he is co-inventor on over 50 issued patents that have been licensed and used in millions of consumer imaging products. Prof. Bouman is member of the National Academy of Inventors, a Fellow of the IEEE, AIMBE, IS&T, and SPIE. He has served as the IEEE Signal Processing Society’s Vice President of Technical Directions, Editor-in-Chief of the IEEE Transactions on Image Processing, Vice President of Publications for the IS&T Society and was the 2014 recipient of the Electronic Imaging Scientist of the Year award.
With the recent rapid progress in flexible and wearable electronics, there is an ever increasing demand in developing flexible and stretchable energy devices as power sources. Consequently, elastomers based on conductive polymers and carbon nanomaterials are emerging as a promising candidate for such applications. However, conventional conductive polymers and carbon nanomaterials, including intrinsically conducting conjugated polymers, carbon nanotubes, and graphene, fail to satisfy the stringent requirement for the development of flexible and stretchable devices for sustainable energy conversion and storage. By starting with highly processable rubber-like polymers (e.g., 1,4-trans-polyisoprene), stretchable intrinsically conducting polymer fibers and films with the potential to increase conductivity in response to increasing strain could be developed through iodine-induced conjugation to produce intrinsically conductive elastomers consisting of interspersed conjugated and non-conjugated polydiene segments.

Having conjugated all-carbon structures, carbon nanomaterials, including carbon nanotubes (CNTs) and graphene, also possess certain similar optoelectronic characteristics as conjugated macromolecules, apart from their unique multidimensional molecular structures (e.g., 1D CNTs, 2D graphene, 3D graphene foams). The combination of the unique multidimensional structures of CNTs, graphene and the associated hybrids with comparable optoelectronic properties of appropriate conjugated macromolecules has yielded some interesting synergetic effects attractive for the development of flexible and stretchable energy devices, including supercapacitors and batteries, form multidimensional and multifunctional carbon nanomaterials. Therefore, considerable efforts have recently been made to utilize graphitic carbon nanomaterials, along with elastomers based on conducting polymers and carbon nanomaterials for flexible and stretchable energy devices for sustainable energy conversion and storage.

In this talk, I will summarize our work on rational design and development of multi-dimensional intrinsically conjugated polymers and graphitic carbon nanomaterials for flexible and stretchable energy devices for sustainable energy conversion and storage. A brief overview of this exciting field, along with some challenges and opportunities, will also be presented.
Wood, Concrete, or Steel? This is often the first question asked by a structural engineer when a project begins. Architects interested in advanced materials are more frequently replying, “Let’s try plastic!” Enter composites. As a class of materials, glass-fiber reinforced polymer (GFRP) composites are widely used in other industries but still uncommon in architecture. Yet uncommon is not the same as entirely unknown. Since the 1950s, a number of experimental projects have been realized to explore the architectural potential of structural plastics. Today’s cutting-edge buildings also increasingly employ composites, seeking a combination of structural performance, formal flexibility and, unexpectedly, sustainable attributes. This talk will highlight the key ways architects are using plastic to make innovative components for buildings. These components are often exceptionally large and lightweight compared with traditional construction materials. Several design projects by Prof. Diles will be shown to illustrate how architects combine the most recent advances in fabrication technologies with polymers. The sustainable opportunities afforded by plastic parts relative to conventional building materials will be presented. The current resistance to the adoption of bio-derived polymers and reinforcements will also be discussed along with the future prospects for using recycled and non-petroleum derived plastics in architecture.

BIOGRAPHY

Justin Diles is an Assistant Professor of Architecture at The Knowlton School with a joint-appointment in the Materials Science & Engineering (MSE) Department. His current research and design work centers on the architectural effects of patterned assemblies made from lightweight but strong materials. Drawing on historical construction methods, contemporary digital design and fabrication processes, and advanced composite materials, Diles' research and teaching promote architecture that is visually animated and innovatively constructed.
A key challenge in development of safer, sustainable Li-ion batteries is the replacement of liquid electrolytes with inorganic solid-state electrolytes that have longer cycle life and are also chemically stable across a wider temperature and voltage range. Cells with liquid electrolytes have issues with flammability and release of gases, which contribute to mechanical and chemical instability and, ultimately, failure. The challenges for designing and engineering safer batteries require scalable materials synthesis and identification of decomposition dynamics of inorganic solid electrolytes for Li-ion as well as Naion batteries. Identifying the local structure within the solid electrolyte will allow us to map structure-property relations with ionic conductivity and chemical stability within the electrolyte as well as at the electrode interfaces. In this talk, I will present rapid and single crystal synthesis methodology for production of next generation of solid electrolytes for energy storage. I will discuss challenges for cross-correlating structural characterization across length scales as well as across multiple techniques. The objectives of this discussion are to seed strategies for controlled synthesis of next generation of smart, functional materials.

**BIOGRAPHY**

Vicky Doan-Nguyen is an Assistant Professor in the Departments of Materials Science & Engineering and Mechanical & Aerospace Engineering. She joined OSU as part of the Discovery Themes’ Materials and Manufacturing for Sustainability Initiative. Vicky joined OSU in August of 2017. Prior to OSU, she was concurrently a University of California President’s Postdoctoral Fellow and Elings Prize Fellow at the University of California, Santa Barbara (Ram Seshadri Group) and the University of California, Los Angeles (Bruce Dunn Group). As part of OSU’s Center for Electron Microscopy and Analysis (CEMAS), her cross-cutting research includes synthesis, in-situ structural characterization, and functional testing of smart materials as well as advanced materials for energy storage and conversion. Prof. Doan-Nguyen earned a B.S. in Chemistry and Women’s and Gender Studies from Yale University and an M.S. and a Ph.D. in Materials Science and Engineering from the University of Pennsylvania (Christopher Murray Group). She has been recognized by the American Crystallographic Association with the Margaret C. Etter Lecturer Award and the Oak Ridge Associated Universities Ralph E. Powe Junior Faculty Enhancement Award.
Single crystal hexagonal boron nitride is being developed for electronic, optoelectronic, and nanophotonic devices, including neutron detectors, ultraviolet light emitters and detectors, and hyperlensing. One of its limitations has been that it is difficult to alter hBN’s properties by stand techniques such as impurity doping. Here neutron transmutation doping was explored as a far from thermal equilibrium approach to altering its properties. When subjected to thermal neutrons, the boron-10 isotope is transmutates into Li-7. To separate the effects of neutron and gamma irradiation, in this study, monoisotopic B-10 and B-11 hBN single crystals were studied. The crystals were produced from molten nickel-chromium solutions at atmospheric pressure using isotopically pure boron sources. The B-10 crystals changed from colorless to red. Two new Raman peaks at 480 cm\(^{-1}\) and 1300 cm\(^{-1}\) were created in the B-10 hBN crystals, but not in the B-11 hBN crystals. Irradiation decreased the thermal conductivity of the B-10 single crystals by a factor of more than 50. Results from photoluminescence and electron resonance spectroscopy will also be presented.

BIOGRAPHY

James H. Edgar is in his tenth year as head of chemical engineering at Kansas State University. His department has 300 undergraduate students, 25 PhD students, 13 faculty and 4 staff. Edgar is an active researcher, who applies chemical engineering principles to improve the quality of semiconductor materials, to enable new types of electronic devices. Edgar has received more than $9 million in research funding from the National Science Foundation, U.S. Department of Defense, U.S. Department of Energy, and other federal and private funding agencies. This funding has supported 21 PhD and 8 MS students to the completion of their degrees. He has co-authored more than 150 papers in published in scientific journals, edited two books and has presented numerous national and international lectures. He has most frequently taught material science and engineering and chemical engineering thermodynamics.

Edgar earned his bachelor’s degree from the University of Kansas in 1981 and his doctorate from the University of Florida in 1987, both degrees in chemical engineering. He joined Kansas State University in 1988 as an assistant professor, rose through the ranks of associate (1993) and full (1997) professor, and was named a University Distinguished Professor in 2013.
I introduce some of the basic concepts of quantum information science to place the later talks of this session in context. The primary topics of the field include quantum computing, simulation, communication, and sensing. I then discuss some of the efforts on campus in the area of materials development for future quantum information science applications and opportunities for team building.

**BIOGRAPHY**

Daniel J. Gauthier is a Professor of Physics and Electrical and Computer Engineering at The Ohio State University. He received the B.S., M.S., and Ph.D. degrees from the University of Rochester, Rochester, NY, in 1982, 1983, and 1989, respectively. His Ph.D. research was supervised by Prof. R.W. Boyd. From 1989 to 1991, he developed the first CW two-photon optical laser as a Post-Doctoral Research Associate under the mentorship of Prof. T.W. Mossberg at the University of Oregon. In 1991, he joined the faculty of Duke University, Durham, NC, as an Assistant Professor of Physics and was named a Young Investigator of the U.S. Army Research Office in 1992 and the National Science Foundation in 1993. He was the Robert C. Richardson Professor of Physics at Duke from 2011-2015, chair of the Duke Physics Department from 2005–2011, and interim chair in spring 2015. He moved to The Ohio State University in 2016. His research interests include high-rate quantum communication, nonlinear quantum optics, and reservoir computing using complex networks in complex electronic and optical systems. Prof. Gauthier is a Fellow of the Optical Society of America and the American Physical Society.
This presentation will focus on cellulose acetate (CA), a derivative of natural polymer cellulose. Processing of CA by means of electrospinning has resulted in fibrous mats that are water-repellant, yet they are highly oleophilic. Superior oil sorbents were manufactured in this way by our research group. The effects of the processing on the chemistry, structure and properties of these mats will be discussed. Furthermore, the use of CA fibrous mats as supports of amyloid fibers composites has opened the pathway for a universal filtration tool, that is potentially able to remediate even produced water from unconventional energy processes, such as fracking effluents. Finally, use of these CA mats as templates for the processing of ceramic photocatalysts will be reported. The latter is known as the Nanogrids™ materials technology, a breakthrough nanotechnology used for the photochemical oxidation of hydrocarbons and for water splitting.

**BIOGRAPHY**

Dr. Pelagia-Irene (Perena) Gouma is currently the Edward Orton Jr., Chair in Ceramic Engineering at The Ohio State University. Her previous appointment was with the Institute of Predictive Performance Methodologies (IPPM) and with the MSE Dept. (tenured Full Professor) at the University of Texas-Arlington. Before that, for 16 years, she was a Professor at the State University of New York in Stony Brook, and the Founder and Director of the Center for Nanomaterials and Sensor Development (CNSD). She holds a B.Sc. degree in Applied Physics from the Aristotelian University in Thessaloniki Greece; a M.Sc. (Eng) degree in Materials from the University of Liverpool, UK and a M.Phil in Organizational Management from the same Institution. She received her Ph.D. in Materials Science and Engineering from The University of Birmingham in the UK. Dr. Gouma’s research activities involve the synthesis and characterization of nanomaterials for bio-/chemical sensors and biotechnology as well as the development of artificial olfaction systems (breath analyzers, electronic noses and tongues). Dr. Gouma has established novel and highly successful programs on nanomedicine, with emphasis on the development of non-invasive breath and skin-based diagnostic tools. Other areas of her research include photocatalysts and sorbents for remediating water from fracking operations and self-supported photocatalytic blankets that float on water and produce energy from photochemical water splitting. She has been featured as an expert in nanomaterials, ceramics, sensors, and photocatalysts in numerous press releases (Science Nation, IOP, Science press, NPR, NBC news, Fox news, Fast Company, etc.). She has published over 140 peer-reviewed articles, 18 book chapters and editorials, and a monograph. She also holds 18 patents (both US and International). She is a member of the National Academy of Inventors, she was a Fulbright Scholar to UNICAMP in Brazil, and she has received the prestigious Richard M. Fulrath award of The American Ceramic Society. She was the sole Chair of the 2011 ISOEN Conference. Dr. Gouma can be reached at: gouma.2@osu.edu. Website: https://acrl.osu.edu
Over the past 30 years additive manufacturing has matured from a handful of lab scale prototyping technologies to a full blown suite of production hardened manufacturing methods. This talk will cover some of the early history for metals additive manufacturing and provide context for similarities and differences between additive and traditional subtractive metallurgical manufacturing. It will also include an overview of AM activities in the OSU Center for Design and Manufacturing Excellence (CDME) including multiple laser powder bed fusion, in-situ monitoring, and reverse engineering. Views on the current state of the technology as well as considerations for qualification and certification will be presented.

**BIOGRAPHY**

Dr. Edward D. Herderick is the Director of Additive at The Ohio State University Center for Design and Manufacturing Excellence (CDME). His role is to build a robust, industrially focused additive manufacturing program at CDME. The guiding thread across his career has been a focus on implementing complex manufacturing technology solutions for industrial customers in aerospace, power generation, oil & gas, and transportation. Previously he has held leadership positions at GE, EWI, and additive startup rp+m.
Powder bed fusion (PBF) is the additive manufacturing (AM) process that has arguably the highest potential for the elevation of AM from rapid prototyping tools to the use in the manufacture of final products. The initial success of PBF has been in spite of the fact that the part temperature during the process, hence microstructure and defect modes, is controlled in open-loop by heuristic methods. This presentation details an exploratory study of one enabling control tool in the system of tools required for closed-loop control of the thermal management problem: state estimation of temperature states inside the part from measurements of surface temperatures. We pose the fundamental physics of PBF with the variational calculus of the finite element method (FEM), and then repose FEM as a state-space model for controller and observer synthesis. From the state-space model, we define a temperature state estimator and corresponding observability criteria. The significant outcomes of this study are the first definition of a state estimator for PBF temperature fields and the successful estimation of the temperature evolution of several simulated test parts. The presentation concludes with potential future directions, which include the use of the temperature state estimates in advanced certification and qualification, state feedback control, and observer-based process fault detection.
The research of halide perovskite solar cells continues to boom with device energy conversion efficiency approaching that of single crystal silicon solar cells. Many unique properties have been discovered in halide perovskites. I will present the advance in understanding the optoelectronic properties and their application in radiation detection, which includes application of perovskites as sensitive photodetectors, scintillators and semiconductor detectors. Our progress of material and device engineering of perovskite detectors will be presented and scaling up for commercialization will be briefed.

BIOGRAPHY

Jinsong Huang received his PhD degree in Material Science and Engineering from the University of California-Los Angeles in 2007. After working in Agiltron Inc. as a research scientist for two years, he joined the University of Nebraska-Lincoln in 2009 as an assistant professor in the Department of Mechanical and Materials Engineering, and was promoted to associate professor with tenure in 2014, and professor in 2016. He joined the faculty in the department of Applied Physical Sciences of University of North Carolina at Chapel Hill in 2017. His current research interests include solution processed electronic materials for applications in sensing, energy and consumer electronics.
Great strides have been made recently in the ICMSE community with the widespread adoption of flexible, poly-structured databases, common development frameworks, and best practice Application Programming Interfaces (APIs). As a result, a tremendous amount of connectivity has been enabled between dozens of systems representing as many organizations. In spite of these achievements, a significant barrier to fully achieving “FAIR” principles – findable, accessible, interoperable, reusable – persists in the creation of data and schemas that are adequately described and self-contained. Numerous failure effects have been observed when two or more systems are initially connected and data are transferred, stemming from a lack of any useful structure, description, or relation, beyond the original intent of the data creator, which is rarely sufficient for long-term consumption.

In response to these challenges, the Air Force Research Laboratory (AFRL) in Dayton, Ohio, has created a software platform called HyperThought™ that goes beyond the traditional features found in many Laboratory Information Management Systems (LIMS). HyperThought™ allows end users to create formal data structures and schemas for both concept definition (a mechanical test, for example) and provenance definition (“Sample X was characterized using EBSD”). These structures and schemas are community-curated and rely on many existing standards (RDF, OWL, QUDT, Prov-O, and others) to ensure consistency and quality as the vocabularies and taxonomies take shape. The result of these activities is data and process definition (including schemas) that fully comply with FAIR principles. This presentation will show the benefits of this approach by examining use cases in Additive Manufacturing, Machining, and Microscopy.

BIOGRAPHY

Mr. Matthew Jacobsen is a software engineering technical lead in the Materials and Manufacturing Directorate of the Air Force Research Laboratory, where he manages efforts in data and value stream management, process optimization, and cyber-physical vulnerabilities analysis. Mr. Jacobsen’s current focus is concerned with the modernization of Air Force laboratory and supply chain IT capabilities, in order to address emerging issues in Big Data Analytics, Cloud Services, and Internet of Things (IoT) technology. To this end, Mr. Jacobsen is leading an internationally recognized cyberinfrastructure development program within the area of Integrated Computation Materials Science and Engineering (ICMSE). This Air Force-trademarked cyberinfrastructure, called HyperThought™, employs state-of-the-art technologies to provide a complete suite of data management and machine integration capabilities to research and manufacturing organizations around the United States.
Current approaches to exploring materials and manufacturing (or processing) design spaces in pursuit of new/improved engineered structural materials continue to rely heavily on extensive experimentation, which typically demand inordinate investments in both time and effort. Although tremendous progress has been made in the development and validation of a wide range of simulation toolsets capturing the multiscale phenomena controlling the material properties and performance characteristics of interest to advanced technologies, their systematic insertion into the materials innovation efforts has encountered several hurdles. The ongoing efforts in my research group are aimed at accelerating materials innovation through the development of (i) a new mathematical framework that allows a systematic and consistent parametrization of the extremely large spaces in the representations of the material hierarchical structure (spanning multiple length/structure scales) and governing physics across a broad range of materials classes and phenomena, (ii) a new formalism that evaluates all available next steps in a given materials innovation effort (i.e., various multiscale experiments and simulations) and rank-orders them based on their likelihood to produce the desired knowledge (expressed as PSP linkages), and (iii) novel higher-throughput experimental assays that are specifically designed to produce the critically needed fundamental materials data for calibrating the numerous parameters typically present in multiscale materials models. I will present and discuss ongoing research activities in my group.

BIOGRAPHY
Surya Kalidindi is a Professor in the Woodruff School of Mechanical Engineering at Georgia Institute of Technology, Georgia, USA with joint appointments in the School of Materials Science and Engineering as well as the School of Computational Science and Engineering. Surya earned a Ph.D. in Mechanical Engineering from Massachusetts Institute of Technology in 1992, and joined the Department of Materials Science and Engineering at Drexel University as an Assistant Professor. After twenty years at Drexel University, Surya moved into his current position at Georgia Tech. Surya's research efforts have made seminal contributions to the fields of crystal plasticity, microstructure design, and materials informatics. Surya has been elected a Fellow of ASM International, TMS, and ASME. In 2016, he and his group members have been awarded the top prize as well as one of the runner-up prizes in the national Materials Science and Engineering Data Challenge sponsored by the Air Force Research Lab in partnership with the National Institute of Standards and Technology and the U.S. National Science Foundation. He has also been awarded the Alexander von Humboldt Research Award, the Vannever Bush Faculty Fellow, the Government of India’s Vajra Faculty Award, and the Khan International Award.
A number of semiconducting and insulating materials are attractive for nuclear energy applications as structural, optical and radiofrequency windows and sensor materials. Their high temperature mechanical stability, chemical inertness and radiation resistance is owed to ionic or covalent nature of atomic bonding and their crystalline structure. In this presentation, experimental work aiming at characterizing the impact of radiation damage on physical properties of silicon carbide (SiC), alumina (Al₂O₃), cerium oxide (CeO₂), uranium dioxide (UO₂) and aluminum nitride (AlN) important for nuclear fusion and fission applications. First, utilization of femtosecond laser to measure reduction of thermal conductivity in SiC, Al₂O₃, UO₂ and CeO₂ upon irradiation with energetic ions will be discussed. The reduction of thermal conductivity is analyzed using phonon mediated thermal transport models based on microstructure characterization revealed by a combination of Raman Spectroscopy, X-ray diffraction and electron microscopy methods. Second, implementation of surface acoustic waves to probe the impact of radiation damage on piezoelectric, dielectric and elastic properties of piezoelectric materials such as AlN using interdigitated transducer configuration will be presented. Lastly, a new approach to probe grain microstructure in polycrystalline ceramics in 3D will be introduced. The approach is called time domain Brillouin scattering and relies on utilization of femtosecond laser which allows excitation and monitoring of ultrasonic wave propagation with spatial resolution comparable to grain size of polycrystalline materials. This method has implications for nondestructive evaluation of microstructure in-situ and development of hard ceramics.

**BIOGRAPHY**

Prof. Marat Khafizov is an assistant professor in the Department of Mechanical & Aerospace Engineering and Nuclear Engineering program at The Ohio State University. He directs Thermal properties of Materials for Extreme environments (TME) laboratory. Dr. Khafizov is Phonon Transport Thrust lead for the Center for Thermal Energy Transport under Irradiation, an Energy Frontiers Research Center funded by Basic Energy Science, Department of Energy. His research interests are in developing experimental methods for measuring material's physical properties, investigating impact of radiation damage on properties of materials, and development of sensors for extreme environments. Dr. Khafizov holds a Ph. D. degree in Physics from University of Rochester. Prior to joining OSU, he was a research scientist at Idaho National Laboratory.
Poly(L-lactide) (PLLA) is the structural material of the first clinically-approved bioresorbable vascular scaffold (BVS), a promising alternative to permanent metal stents for treatment of coronary heart disease. BVSs are transient implants that support the occluded artery for 6 mo and are completely resorbed in 2 years, leaving behind a regenerated artery. Clinical trials of BVS’s report restoration of arterial vasomotion and elimination of serious complications of metal stents that occur 5 to 7 yr after implantation. It is remarkable that a scaffold made from PLLA, known as a brittle polymer, does not fracture when crimped onto a balloon catheter or during deployment in the artery. We used X-ray microdiffraction to discover how PLLA acquired ductile character and found that the crimping process creates localized regions of extreme anisotropy. The degree and direction of orientation and crystallinity change on micron-scale distances. The distinct morphologies in the crimped scaffold work in tandem to enable a low-stress response during deployment, which avoids fracture of the PLLA hoops and leaves them with the strength needed to support the artery. After deployment, the highly oriented morphology created at points of stress localization during crimping confer resistance to hydrolysis precisely where it is needed for the scaffold to retain strength even after 9 mo of hydrolysis. Thus, the ability to use processing to access non-equilibrium microstructures in the semicrystalline PLLA are essential to the clinically-approved BVS and open the way to thinner resorbable scaffolds in the future.

**BIOGRAPHY**

Julia A. Kornfield, Professor of Chemical Engineering at the California Institute of Technology (Caltech), is an expert in polymer science, particularly how polymers influence and are influenced by flow. She has applied small angle neutron and x-ray scattering to diverse systems, including end-associative polymers for aviation safety and security (Wei et al., *Science* 2015), flow-induced crystallization of polymers (e.g., *Science* 2007) and the effects of flow on polymer self-assembly (e.g., *Science* 1997). Since she joined the Caltech faculty in 1990, Kornfield has received the Dillon Medal of the American Physical Society, been elected Fellow of the American Physical Society and the American Association for the Advancement of Science, and received the Bingham Medal of the Society of Rheology, among other honors. She holds 29 patents and is a cofounder of RxSight (formerly Calhoun Vision), which uses polymers developed at Caltech to customize vision by noninvasively optimizing a lens after it is implanted into a patients’ eye. Thus, her work spans from fundamental research on the molecular basis of polymer structure and properties, to commercialization of polymers that improve health and safety.
Synthetic hydrogels are often utilized in tissue engineering applications and are designed to be responsive to the body’s endogenous, enzymatic remodeling processes. A key characteristic of these biomaterials is the ability to be degraded at a controlled rate, thus facilitating time-dependent local tissue regeneration. These properties can be modulated using different peptide sequences to crosslink the hydrogels. However, these degradable sequences are often characterized in solution with recombinant enzymes at arbitrary concentrations, which is not reflective of the actual cell-mediated proteolysis. To measure and predict this cell-mediated degradation, there is a need for new methods. We have developed a unique approach in which 3D hydrogel cell culture platforms are functionalized with degradable fluorogenic substrates to enable measurement and visualization of material degradation in space and time. There is also a need to identify the specific cell-secreted enzymes that cleave these degradable moieties in order to develop materials with well-defined degradation rates. To interrogate this cell-peptide interaction we have developed a modified SDS-PAGE technique in which fluorescently labeled substrates, corresponding to sequences used for degradable materials, are covalently attached to the polyacrylamide gel structure. Sensitivity analysis demonstrated that use of peptide functionalized gels could surpass detection limits of current techniques. Analysis of conditioned media from cultured cells resulted in the appearance of several proteolytic bands, some of which were undetectable by standard gelatin zymography. These methods will enable better rational design of degradable biomaterials for biological studies as well as tissue engineering and drug delivery applications.

BIOGRAPHY
Jennifer L. Leight, Ph.D., is an assistant professor in the Biomedical Engineering Department and a member of the James Comprehensive Cancer Center at the Ohio State University. Dr. Leight was awarded a National Science Foundation Graduate Fellowship in 2005, and earned her Ph.D. in Bioengineering in 2011 from the University of Pennsylvania. Following graduation, Dr. Leight continued her training as a Howard Hughes post-doctoral research associate at the University of Colorado Boulder. Since joining OSU in 2014, the Leight lab seeks to understand how properties of the tumor microenvironment (matrix rigidity, cell-cell interactions, growth factor signaling) affect cancer cell function and treatment responsiveness. To achieve this goal, the lab develops new biomaterials and fluorogenic sensors that enable careful tuning of microenvironmental properties and easy measurements of cancer cell function. In addition to her research accomplishments, Dr. Leight received the Biomedical Engineering Department’s Herman R. Weed Excellence in Teaching Award in 2018 in recognition of her outstanding teaching accomplishments.
Development of wide bandgap GaN radiation detectors is reported. Current mode GaN detectors with diameter of 20-50mm were developed by using large area semi-insulating GaN single crystal as its sensitive medium. The characteristics of the detector were tested such as the I-V curve, the responsibility and sensitivity to γ-rays, the charge collection efficiency, and the time response to pulsed X-rays. The test results showed that a low resistance ohmic contact formed between the crystal and the metal electrode. The dark current was lower than 400pA at voltage of 600V, the charge collection efficiency was greater than 40%, and the time response to pulsed X-rays was at nanosecond order. We also develop GaN detectors with PIN structure, the dark current was lower than 10nA at voltage of 20V, difference about the detector performance before and after 14MeV neutron radiation was studied, the results show the neutron radiation influence the carrier transport characteristics evidently under low bias. We also study radiation damage mechanics of GaN material under proton and neutron irradiation of $10^{15}$ cm$^{-2}$ fluence, results show that GaN material has high resistance to proton radiation, proton radiation generates Ga vacancies or complex defects related to Ga vacancy in material which lead to yellow luminescence and blue luminescence change. HVPE has high resistance to neutron radiation, neutron radiation generates V$_{Ga}$ defects which combine O$_{n}$ to form stable complex V$_{Ga}$ - O$_{n}$, leading to the increase of yellow luminescence.

**BIOGRAPHY**

Yang Liu, Associate Professor, North China Electric Power University. My major research interest focus on radiation detection and applied radiation physics, including radiation detector development and pulsed radiation detection technology based on wide band-gap semiconductor materials such as GaN and SiC, low flux neutron and soft X-ray detection technology based on scintillating material, advanced measurement methods of neutron and X-ray energy spectrum, simulation of ionizing radiation interactions with materials, and quantum physics of measurement mechanics in dual system. I have authored/co-authored 50 papers in peer-reviewed journal articles and conference proceedings, and given more than 30 invited presentation at conferences and workshops. And also serve as referee for SCI journals, such as Chinese Science Bulletin, Science China PM&A, International Journal of Theoretical Physics and Communications in Theoretical Physics.
The optimization of elastomeric materials for sustainability requires the successful navigation of durability constraints, which in turn require knowledge of how material behavior and operating conditions may limit durability. Endurica has developed a systematic framework for characterizing materials and simulating their performance in applications. The characterization includes cyclic stress-strain behavior, strength, fatigue crack growth, crack nucleation, strain-crystallization, crack precursor size, etc. This information is then used, in combination with simulation results generated via Finite Element Analysis, with one of Endurica’s durability solvers to compute product durability under realistic operating conditions. To illustrate, characterization and simulation results are shown for a tire and for an automotive transmission mount, including information about sensitivity to various material behaviors. The approach opens the possibility of rapidly prototyping durability behavior of prospective materials relative to their actual end-use.

**BIOGRAPHY**

Dr. Will Mars is an international leader in the failure mechanics of rubber. The comprehensive testing and simulation tools Endurica has developed under his direction help companies across the world to speed their product development process and compete on durability. He has received several awards for his scientific contributions and innovations, including the 2017 Rubber Division ACS Arnold Smith Special Service Award, the 2007 Sparks Thomas award of ACS Rubber Division, and the 1999 Henry Fuchs award of the SAE Fatigue Design & Evaluation committee.

Dr. Mars is the editor of the journal Rubber Chemistry & Technology, and past editor of Tire Science & Technology with 50+ peer-reviewed publications and three patents. His experiences and contributions span a topic range including material characterization, product evaluation, constitutive modeling, crack nucleation, fracture mechanics and fatigue life prediction methods. He has nearly 30 years’ experience developing testing and simulation methods in the rubber industry. Dr. Mars’ professional activity has focused generally on applying experimental and computational mechanics in pursuit of better-performing rubber products. He has been an invited lecturer in numerous international venues. Dr. Mars earned his Honors BSME with Polymer Specialization at the University of Akron, and his MS and Ph.D. degrees at the University of Toledo.
The properties of diamond that contribute to its value in radiation detection include large bandgap, high electron and hole mobilities, high breakdown field, and high displacement damage threshold. These properties combine to enable radiation hard, low background, and efficient particle detectors. Research at ASU has developed and demonstrated diamond p-i-n particle detectors based on epitaxial growth of n-type, phosphorus doped diamond, p-type, boron doped diamond, and high purity undoped (intrinsic) diamond. The detector i-layer thickness has been adjusted to match the penetration depth of designated alpha particles, which minimizes background due to gamma radiation and high energy particles. Moreover, the detectors operate in pulse mode with a bias of only a few volts. The unique properties of the p-i-n diode led to the development of a new method to mitigate the effects due to the accumulation of trapped charge in the diamond. Recognizing these advantages led us to propose the development of an efficient thermal neutron detector through the integration of a boron nitride neutron absorption layer and an optimized diamond p-i-n detector. Like diamond, boron nitride is a hard, high temperature material that is expected to survive in extreme environments. A number of BN/diamond pin neutron detectors have been fabricated at ASU and tested at the Ohio State University Reactor Laboratory, and the results will be detailed for the first time during this presentation.

Acknowledgement: we gratefully acknowledge the OSU Reactor Laboratory team, and research support by ARPA-E through the SWITCHES program.
Quantum computation is a very dynamic playground with participation from all research and development sectors: academia, start-ups, research laboratories and industry. Realizing quantum computation platforms is extremely challenging as it requires both deep fundamental science research and scalable engineering development. Multidisciplinary collaboration can leverage each institution’s unique strengths and help guide a practical development roadmap that requires participation and transition across different sectors. In addition, the expanding non-academic job market raises the need for new skills and expertise from prospective graduates who could potentially benefit from exposure to an industrial perspective. In the light of promoting collaboration, I will present an overview on HRL Laboratories, LLC (as well as its opening opportunities), and its activities in quantum computation materials. HRL has been working on a number of scalable technologies that have long term - beyond the Noisy Intermediate Scale Quantum (NISQ) era - promise for fault-tolerant qubits: quantum photonics for the potential of room temperature operation, Silicon-based qubits that leverage highly scalable Silicon technology, and topological qubits with extremely high fidelity. Example of the quantum spin Hall InAs/GaSb material system for topological qubits will be discussed in details.

BIOGRAPHY

Minh Nguyen is a Senior Research Scientist in the Sensors and Electronics Laboratory at HRL Laboratories. Prior to joining HRL in 2014, he received his PhD in Electrical Engineering from Northwestern University and held positions in diverse research environment such as Research Assistant Professor at Northwestern University, technical director of a small business, director’s postdoctoral fellow at Los Alamos National Lab. Nguyen has over 14 years of experience in developing and managing multiples research projects on Antimonide–based materials for infrared detection and topological quantum computation. His expertise encompasses the areas of device modeling/design, epitaxial growth, device fabrication and testing. He is also involved in nanoscale epitaxy and nanofabrication of III-V and Ge/Si semiconductors for applications including solar cells, field effect transistors and quantum computation. Nguyen has authored/co-authored six book chapters, more than 80 technical papers with over 2800 citations and an h-index of 33.
Despite demonstrated economic and environmental benefits, the remanufacturing industry surprisingly remains largely underdeveloped with significant opportunities for growth. Specifically, many companies are hesitant to enter the remanufacturing market because of concerns of cannibalization of new sales, competition from current remanufacturers, and the willingness of consumers to purchase remanufactured products. In this presentation, we survey research on this topic and highlight directions for future academic studies.

**BIOGRAPHY**

Ramteen Sioshansi is a professor in and associate department chair of the Department of Integrated Systems Engineering and an associate fellow in the Center for Automotive Research at The Ohio State University. His research focuses on the integration of advanced energy technologies, including renewables, energy storage, and electric transportation, into energy systems. He also works in energy policy and electricity market design, especially as they pertain to advanced energy technologies. He is a member of the Electricity Advisory Committee of the U.S. Department of Energy and is chair of its Energy Storage Subcommittee.
There have been two relatively successful approaches to preparing reactive epoxidized seed oils emanating from the Soucek group. The first is a technology based on industrial product. The norbornylization of seed oils was first developed by Cargill for use with linseed oil. We used a similar norbornylization approach with soybean oil (NSO), and successfully optimized its usage in tire formulations and a replacement for aromatic oils. Both the norbornylized linseed (NLO) and soybean oils (NSO) were epoxidized by the Soucek Group. The NLO was more reactive and was, as a consequence, carried forward into further academic and industrial research resulting in one funded SBIR for composite matrix development to replace styrene-unsaturated polyesters, and is presently the subject of a SBIR which would result in the scaling and manufacturing of NLO. A second approach to creating a new reactive epoxide is based upon hetero unreported reaction of GMA with tung oil. The reaction results in a Diels-Alder adduct that has pendent glycidyl ester group available for crosslinking. Both the NLO and GMA seed oil adducts are good candidates as BPA replacements for food contact can coatings.

BIOGRAPHY

In 1983, Dr. Soucek obtained his B.S. in Chemistry from Eastern Illinois University, and a M.S. from Illinois State University in 1986. In 1990, he obtained his Ph.D. from University of Texas at Austin. From 1990 to 1993, he was a NRC Post-Doctoral Fellow at NASA-Langley Research Center. From 1993 through 2001, Dr. Soucek was an Assistant and then Associate Professor at North Dakota State University in the Department of Polymers & Coatings focusing his research on Coatings Science. In 2001, Dr. Soucek joined the Polymer Engineering Department at the University of Akron and while at UA being promoted to full Professor. Dr. Soucek also has relations with the University de Maine in LeMans France, appointed as guest professor at Wuhan University of Technology, Adjunct Professor at Beijing University of Chemical Technology, and University Ljubljana/PoliMat in Slovenia.

Since started his academic career in 1993, and has won many awards in the coating field including Tess award for Coatings, 3 Roon awards, an UV-innovation award, a Gordon award, and a SSPC Editor’s award and 2016 ACS Tess award for Coatings. He has run many coating symposium including three SOS at the University of Akron. He has served as President, Vice-President, and Treasurer of the Cleveland Coating Society. Dr. Soucek has also run and participated in a number of symposium for the ACS and is currently a PMSE member. He presently has >180 research papers published all in coating science. He was awarded with the Sundar Aggarwal Endowed Research Chair in 2018.
A wide variety of materials have been adapted and developed for biomanufacturing. For the purposes of creating engineered tissues containing living cells, protein-based materials offer unique opportunities, but also involve significant constraints. Natural proteins provide instructive cues through specific cell-matrix interactions that are difficult to reproduce in synthetic materials. Cells can recognize, bind to, degrade, produce and remodel protein matrices in ways that lead to tissue-specific structure and function. However, use of protein-based materials with living cells in biomanufacturing also places limitations on the temperature, pH, osmolarity, and chemical modification that can be used during fabrication and processing. This talk will focus on the use of pure and composite protein-based materials for the biomanufacturing of living tissues. Examples of producing modular engineered tissues and their use in orthopaedic and vascular applications will be presented. Biofabrication using simple mixing, centrifugation, and molding will be discussed, along with more complex patterning and assembly techniques such as 3D bioprinting. Materials manufactured from proteins and cells have great potential in treating a range of pathologies. The challenges and opportunities inherent in understanding and controlling cell-matrix interactions and resulting tissue function in these dynamically complex materials is an exciting area of current and future research.

BIOGRAPHY

Jan Stegemann is Professor and Associate Chair for Master’s Programs in the Department of Biomedical Engineering at the University of Michigan in Ann Arbor. He received BS and MS degrees in Chemical Engineering from the University of Toronto. Prior to earning his PhD in Biomedical Engineering from the Georgia Institute of Technology, Dr. Stegemann worked for five years at Boston-based W.R. Grace & Co., where his research focused on cell-based bioartificial organs. Dr. Stegemann’s research focuses on the use of extracellular environments to control cell function, as applied to the biofabrication of engineered tissues. In particular, his laboratory develops materials for tissue engineering by creating composites of natural polymers. Dr. Stegemann is highly active in several professional societies related to biomaterials and regenerative medicine, including BMES, SFB, and TERMIS. Dr. Stegemann serves on the Cellular, Tissue, and Gene Therapies (CTGT) Advisory Committee of the US-FDA, and is a Fellow of the American Institute of Medical and Biological Engineering (AIMBE) and a Fellow of the Biomedical Engineering Society (BMES).
Polymers and hydrogels have successfully been used in ophthalmology for decades, most notably in intraocular lenses and contact lenses. The properties of polymeric systems (e.g., biocompatibility, transparency, wettability) make them good candidates for biomimetic replacements of various ocular tissues. We design amphiphilic polymer films, injectable hydrogels, and electrospun materials for use in ophthalmic prosthesis and drug delivery. We are currently exploring the design of polymers to replace the crystalline lens after cataract surgery and vitreous humor after vitrectomy. One focus area of our research is exploring the impact of mechanical properties, surface chemistry, and surface topography on cellular response to polymeric materials designed for intraocular lenses. Our lab also studies the biochemical, mechanical, and optical properties of the vitreous humor to design biomimetic replacement materials. We are also using polymer processing techniques to fabricate intraocular drug delivery systems for sustained release of therapeutics to treat retinal diseases.

**BIOGRAPHY**

Katelyn Swindle-Reilly, Ph.D., completed a B.S. in Chemical Engineering at Georgia Institute of Technology in 2004. She then received her M.S. in Chemical Engineering in 2006 and Ph.D. in Energy, Environmental, and Chemical Engineering in 2008 from Washington University in St. Louis. Her dissertation research resulted in the development of an injectable, biomimetic vitreous substitute. She completed postdoctoral training in Biomedical Engineering at Saint Louis University where she developed biopolymer and electrospun scaffolds for peripheral nerve regeneration. After completing her postdoctoral training, Dr. Swindle-Reilly worked as a Senior Scientist at Rochal Industries LLC for over four years where she researched and developed several patented and FDA approved wound care products. She concurrently held an appointment as Adjunct Assistant Professor in Biomedical Engineering at The University of Texas at San Antonio from 2013-2015. She joined The Ohio State University as Assistant Professor in Biomedical Engineering and Chemical and Biomolecular Engineering in 2016. Her current research interests focus on the design of polymeric biomaterials for soft tissue repair and drug delivery with focused applications in ophthalmology and wound healing.
Based on his book and upcoming documentary series, this talk will give a global tour of energy to explain how it is hidden in plain sight, serving as the builder of human civilization and also its greatest threat. Energy is connected with water, food, transportation, wealth, cities and our national security. It underpins industry, innovation and even democracy. For better and worse, no other physical resource has had such a wide-ranging impact on our ecosystems, economy, public health, and personal liberties. Yet at the same time, the worldwide energy sector is going through dramatic shifts in energy demand, end-uses, and sources. Population growth and economic growth are driving up total demand. Industrialization, electrification and motorization are changing how we use energy. And a policy push for domestic, low-carbon and renewable fuels is changing our sources of energy. In parallel, we are entering an era where markets, technologies and policies are enabling dramatic increases in U.S. production of oil, gas, wind, solar and bioenergy that is affecting global economies, the environment, and our national security posture. Overlaid with those shifts are three technology trends of increasing efficiency, information intensity, and decentralized manufacturing and industrial processes. Meeting the global need to increase energy access while reducing environmental impact stands as the most pressing challenge for the 21st century. With entertaining insights and a big-picture overview of global energy trends mixed in with humorous anecdotes, historical snippets, and unexpected examples this talk will give a surprising look into the past and future of energy.

BIOGRAPHY

Dr. Michael E. Webber is based in Paris, France where he serves as the Chief Science and Technology Officer at ENGIE, a global energy & infrastructure services company. Webber is also the Josey Centennial Professor in Energy Resources, Author, and Professor of Mechanical Engineering, at the University of Texas at Austin where he trains the next generation of energy leaders through research and education at the convergence of engineering, policy, and commercialization. His first book, *Thirst for Power: Energy, Water and Human Survival*, which addresses the connection between earth’s most valuable resources and offers a hopeful approach toward a sustainable future, is receiving wide praise. His upcoming book *Power Trip: the Story of Energy* will be published May 7, 2019 with a 6-part companion series on PBS shortly afterwards. He was selected as a Fellow of ASME and as a member of the 4th class of the Presidential Leadership Scholars, which is a leadership training program organized by Presidents George W. Bush and William J. Clinton. Webber has authored more than 400 publications, holds 6 patents, and serves on the advisory board for Scientific American. A successful entrepreneur, Webber was one of three founders in 2015 for an educational technology startup, DISCO Learning Media, which was acquired in 2018 by Probility Media. Webber holds a B.S. and B.A. from UT Austin, and M.S. and Ph.D. in mechanical engineering from Stanford. He was honored as an American Fellow of the German Marshall Fund and an AT&T Industrial Ecology Fellow on four separate occasions by the University of Texas for exceptional teaching.
Mechanics of materials have long been recognized as critical components for success in tissue engineering and regenerative medicine. From the effects of mechanical strain on bone regeneration to the ability of stem cell differentiation to be influenced by the stiffness of their microenvironment, mechanics should be a critical component of any biomaterials design process. However, the primary characterization of biomaterials is the Elastic (or Young’s) Modulus, which principally describes linear elastic materials, yet many tissues and their mimetic biomaterials are viscoelastic in nature. Here, we describe two common biomaterials: hydrogels and electrospun fibers, that are used in advanced biofabrication processes to create complex structures. Using the brain as a model system, we will first evaluate brain mechanical properties using a variety of mechanical models and comparing responses to those of brain mimetic hydrogels. Next, we will evaluate the role of edge effects that originate from material interfaces with their supporting substrates (e.g., glass, plastic) in cell migration and spreading. Then, we will expand these results to electrospun fibers, discussing the role of edge effects and tension in cell spreading responses. These results clearly show that mechanical considerations beyond Elastic modulus influence cell behaviors and should be carefully considered in biomaterial design.

BIOGRAPHY
Jessica Winter is a Professor in the William G. Lowrie Department of Chemical and Biomolecular Engineering and the Department of Biomedical Engineering, Associate Director of the MRSEC Center for Emergent Materials at the Ohio State University, and appointee to the Chemical Engineering Technical Operating Council of the American Institute of Chemical Engineers. She received her PhD in Chemical Engineering from the University of Texas at Austin in 2004, and completed a postdoctoral fellowship at the Center for Innovative Visual Rehabilitation at the Boston VA Hospital in 2006. Her research interests include nanoparticles for cancer imaging, diagnostics, and drug delivery; and cell migration in the brain tumor microenvironment. She is a co-founder and Chief Scientific Officer of Core Quantum Technologies, a company commercializing nanoparticle reagents for leukemia diagnostics. She was named TechColumbus Innovator of the Year, Columbus Business First 40 under 40, and Columbus Business First 20 People to Know in Technology. In addition, she has received the American Chemical Society Rising Star Award and the Golden Mouse Trap Engineering Rising Star Award; she was named to Top 25 STEM professors in Ohio; and is a fellow of the AAAS, AIMBE, and senior member of the IEEE and AIChE.
Dr. Jason Wu is a research engineer at Ford Motor Company. He obtained his B.S. in Chemical Engineering at Purdue University in 2010 and earned his Ph.D. in Chemical and Biomolecular Engineering at the University of California - Berkeley under the tutelage of Prof. Alexis T. Bell. While a member of the Bell Group, he pursued fundamental catalysis research in the area of alkane dehydrogenation and was part of a collaboration with Haldor Topsøe in using environmental microscopy methods to characterize catalysts at work. He joined the Chemical Engineering Department at Ford Motor Company in 2015 to lead the development of next generation automotive catalysts. His research interests are in the use of supported metal nanoparticles for heterogeneous catalysis and developing structure-function relationships on the activity, selectivity and stability of catalysts.

**BIOGRAPHY**

Tightening emission regulations for internal combustion engines have led to the need for innovative catalytic materials to treat CO, hydrocarbons, and NOx. Traditional three-way catalysts typically compose of precious metals (Pt, Pd, Rh) supported on a metal oxide support. Research generally focuses on two areas: improving the light-off temperature at which species start to convert and tuning the oxygen storage capacity of the catalyst to better handle air-fuel ratio fluctuations. As the cost of precious metals can be high and volatile, adding more precious metal to the catalyst can be an inefficient solution. Instead, modifying support structures and incorporating trapping materials that can hold onto species under a certain temperature offer an advantage in enhancing catalyst performance. This talk will go over broadly some of the new types of materials that show promise and give an overview of the challenges that they face. Furthermore, recent work on the use of pyrochlore-type ceria-zirconia (CZO) as a high capacity oxygen storage material will be discussed. The tendency for pyrochlore to revert back to less-active fluorite phase under high temperature oxidizing condition is well-known and can be overcome with modifications to the catalyst. In addition, the synergistic interactions between precious metals and pyrochlore-CZO will be explored. While there is no one-stop-shop solution to drastically decrease emissions, a combination of a variety of new materials can help achieve the desired catalytic performance.
Yiying Wu received his B.S. in chemical physics from the University of Science and Technology of China in 1998, and his Ph.D. in chemistry from the University of California at Berkeley in 2003 with Prof. Peidong Yang. He then did his postdoctoral research with Prof. Galen D. Stucky at the University of California, Santa Barbara, and joined the chemistry faculty at The Ohio State University in the summer of 2005. He was promoted to associate professor with tenure in 2011 and to full professor in 2014. Since 2017, he has been appointed as the Leet Endowed Chair. He has been serving as an associate editor for ACS Applied Materials and Interfaces since 2013. His group focuses on materials chemistry and interface synthesis for energy conversion and storage. He is the inventor of the one-electron K-O2 battery and pioneered solar batteries that integrate solar harvesting with energy storage. He received Cottrell Scholar Award in 2008, NSF CAREER Award in 2010, CAPA Biomatik Distinguished Faculty Award in 2014, and Midwest Energy News “40 under 40” in 2015. His invention of K-air battery received DOE Clean Energy Prize in 2014.

BIOGRAPHY
In my talk, I will summarize the research capabilities and achievements from the OSU energy storage community. These includes material innovations from the cell level including new electrode and solid-state electrolytes for Li-ion batteries, new organic and polymeric electrodes for new flow batteries, innovative concepts in metal-oxygen batteries. OSU also has strong capabilities in in situ and in operando characterization of half cells and full cells. Capabilities such as neutron-depth profiling, ambient X-ray photoelectron spectroscopy, in situ Raman, and state-of-the-art transmission electron microscopy will be presented. Finally, innovations in system-level design will also be presented.
Simply put, our vision is to make innovation as strong as research, and the IMR Innovation Lab is the place where we make this happen. It is designed to allow people to collide while fostering their collaboration to maximize impact. It is a place where partners have access to the university and engage with both students and faculty. Building from the foundation of interdisciplinary materials research at Ohio State, we aspire to evolve the university’s culture and land-grant mission of advancing the well-being of the people of our community through the creation and dissemination of knowledge to include the translation of this knowledge and assets to solve the world’s most pressing problems in the 21st century. The IMR Innovation Lab is the interface that connects, creates and delivers impactful value derived from interdisciplinary research to meet the needs in the market through collaboration and strategic partnerships.

The Materials Innovation Lab is where students wanting real-world, experiential learning are connected with companies wanting better access to the university and undergraduates through externship opportunities. Externships, in this context, are a unique type of internship defined as on-campus partnerships between students, the university, and potential employers that formally integrate students’ academic study with work during a weekend INNOVATE-O-thon. These INNOVATE-O-thons are the result of a strong collaboration with the Center for Innovation and Entrepreneurship, industry partners, and the broader Ohio State community that allow students to participate in a unique, community-engaged learning environment where the focus is on talent, skills and inclusiveness.
Materials and Manufacturing For Sustainability Discovery Theme

The Materials and Manufacturing for Sustainability (M&MS) Discovery Themes Initiative at The Ohio State University enables faculty, students and staff to focus on translational innovation and research in technology, science and manufacturing as they apply to future energy systems and sustainability from the nano-scale to the macro-scale.

With the goal to become preeminent in the field of advanced materials and technologies for sustainability, the program connects, creates and delivers value to solve the world’s most pressing problems in the 21st century.

M&MS builds on the foundation of discovery in the Institute for Materials Research, hiring faculty to advance materials discoveries, developing strategic industrial and global relationships, and accelerating the research process to enable a paradigm of discovery-to-deployment at Ohio State.

INVESTMENTS ARE OCCURRING IN THREE CLUSTER AREAS SPANNING FROM SCIENCE TO MANUFACTURING

- Energy harvesting, storage and systems
- High-performance materials and structures
- Materials for sustainable information processing

These three primary clusters are supported by targeted investment in strategic assets, including a focus on business, policy, and awareness, all of which will connect within the IMR Innovation Lab, which serves as an innovation collaboration model translating knowledge and assets to solve problems in industry with regional, national and global partners. The 24 faculty members hired through the M&MS program are highlighted on page 42.
The M&MS Discovery Theme program is advancing a new vision for innovation through investments in select faculty dedicated to the value of interdisciplinary research at Ohio State. Our strategic recruitment of faculty members has focused on three discovery areas: energy harvesting, storage and systems; high-performance materials and structures; and materials for sustainable information processing. This year, IMR completed the recruitment process with our 24th and final faculty member set to join Ohio State early next year, in the Department of Physics, jointly with the Translational Data Analytics Institute, another Ohio State Discovery Theme program. With our first wave of new professors joining the university in Fall 2015, the cohort now span many departments across 4 colleges – Engineering, Arts and Sciences, Business and Public Policy, addressing the breadth of materials science, advanced technologies, applications and manufacturing toward achieving a sustainable world.

Meet the New M&MS Faculty

Anant Agarwal
Professor, Electrical and Computer Engineering

Carolin Fink
Assistant Professor, Materials Science and Engineering

Shamsul Arafin
Assistant Professor, Department of Electrical and Computer Engineering

Pelagia-Iren (Perena) Gouma
Orton Jr. Chair in Ceramic Engineering; Professor, Materials Science and Engineering

Ashley Bigham
Assistant Professor, Austin E. Knowlton School of Architecture

Michael Groeber
Associate Professor, Department of Integrated Systems Engineering

Christian Blanco
Assistant Professor, Operations Management Fisher College of Business

Ayonga Hereid
Assistant Professor, Mechanical and Aerospace Engineering

Marc Bockrath
Professor, Physics

Ned Hill
Professor, John Glenn Dean's Office; Professor, Knowlton School of Architecture

Vicky Doan-Nguyen
Assistant Professor, Materials Science and Engineering and Mechanical and Aerospace Engineering

John Horack
Senior Assoc. Dean, College of Engineering; Prof., Armstrong Chair, Mechanical and Aerospace Engineering; Prof., John Glenn Dean's Office
The Center for Emergent Materials is a National Science Foundation funded Materials Research Science and Engineering Center (MRSEC). The MRSEC program funds teams of researchers from different disciplines to work collaboratively on materials research in order to address fundamental problems in science and engineering. By working in teams, called Interdisciplinary Research Groups (IRG), the researchers at CEM tackle scientific problems that are too large and complex for a scientist working alone to solve. There are three IRGs at the Center for Emergent Materials.

Current Research Activities

IRG-1: Spin-orbit coupling in correlated materials: novel phases and phenomena

This long running collaboration is establishing the fundamentals for understanding and prediction in this rich field. The ultimate aim is to design a new class of tailored quantum materials with tunable magnetic and electric properties that would impact technology and society.

IRG-2: Control of 2D electronic structure by surface chemistry and proximity effects

This team of leading experts in the creation and manipulation of single-atom sheets is using the flexibility of these new materials to discover new science and enable broader applications in science and technology including new opportunities in materials by design, platforms for chemical sensing and information processing.

IRG-3: Spin flux through engineered magnetic textures: thermal, resonant and coherent phenomena

This multidisciplinary team brings together leadership in experimental and theoretical aspects of spin dynamics and transport to uncover new phenomena and enable transformative technologies that move beyond current spintronics concepts and technologies.
CEM Education Human Resources and Development (EHRD) activities focus on programs with proven high impact that leverage participant expertise and interest, and address local needs. At the elementary level, the Center makes sustained and regular (approximately bi-weekly) visits to classrooms at a local inner-city school to work with teachers to provide their students with hands-on science experiences with OSU scientists. CEM seeks to integrate materials-related topics into the high school science curriculum by developing curricula and resources and supporting teachers across the state of Ohio in their use. CEM builds on local expertise in Physics Education Research to employ best-practices to develop, implement, and rigorously assess methods to improve STEM and materials education at the undergraduate and graduate levels through a set of guided group work sessions and iteratively designed advanced laboratory experiences.

**Education, Outreach, and Diversity**

CEM Education Human Resources and Development (EHRD) activities focus on programs with proven high impact that leverage participant expertise and interest, and address local needs. At the elementary level, the Center makes sustained and regular (approximately bi-weekly) visits to classrooms at a local inner-city school to work with teachers to provide their students with hands-on science experiences with OSU scientists. CEM seeks to integrate materials-related topics into the high school science curriculum by developing curricula and resources and supporting teachers across the state of Ohio in their use. CEM builds on local expertise in Physics Education Research to employ best-practices to develop, implement, and rigorously assess methods to improve STEM and materials education at the undergraduate and graduate levels through a set of guided group work sessions and iteratively designed advanced laboratory experiences.

**Shared Facilities, Collaborations and Partnerships**

CEM continually plays a vital role in strengthening materials research facilities at OSU. The NanoSystems Laboratory (NSL) is closely aligned with CEM, which provides partial staff support. CEM members have historically been instrumental in the acquisition of equipment through federal or internal OSU grants. The addition of these tools directly benefits CEM research, as well as the OSU materials and central Ohio community at large.

**SEED PROGRAM**

CEM interdisciplinary research is augmented by a vigorous seed program that supports new ideas with the goal of becoming the basis for effective multidisciplinary teams. The seed program is operated in partnership with the Institute for Materials Research and the Center for the Exploration of Novel Complex Materials. This partnership broadens the impact of all three centers in the OSU materials community and better leverages resources. Components of the current IRGs were incubated by the CEM seed program. The program strongly encourages proposals from junior and underrepresented faculty.

**COLLABORATIONS AND INDUSTRIAL INTERACTIONS**

Established collaborations with industrial partners and national laboratories add further breadth and diversity to CEM scientific endeavors and improve the productivity of center research activities. CEM continues to build relationships that provide industry support for graduate students and to provide resources to assist in moving technologies from the lab to the commercial sector and preparing students for this career option. A particularly dynamic center-to-center collaboration with the Leibniz Institute for Solid State Research in Dresden, Germany, continues to be fruitful.

P. Chris Hammel, Director
Hammel.7@osu.edu

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Columbus, OH 43210-1117
cem.osu.edu
AREA A
Buffalo Wild Wings
Table Service, American
614-291-2362
2151 N. High St.

Chipotle
Counter Service, Mexican
614-297-4794
2130 N. High St.

Chop Shop
Counter Service, Burger
614-458-1141
2118 N. High St.

Diaspora
Counter Service, Korean
614-458-1141
2118 N. High St.

Donatos
Table Service, Pizza
614-294-5371
2084 N. High St.

Moe’s
Counter Service, Mexican
614-928-9005
2040 N. High St.

Noodles & Company
Counter Service, Multi
614-453-1095
2124 N. High St.

Panda Express
Counter Service, Chinese
614-297-9860
2044 N. High St.

Poke Bros
Counter Service, Sushi
614-947-7859
2036 N. High St.

Rippers Roadstand
Counter Service, American
614-725-1200
2036 N. High St.

Starbucks
Counter Service, Cafe
614-299-9840
2004 N. High St.

AREA C
Apollo's
Counter Service, Greek
614-294-4006
1758 N. High St.

Bibibop
Counter Service, Korean
614-623-8792
1778 N. High St.

Blaze
Counter Service, Pizza
614-745-2167
1708 N. High St.

Chili’s
Counter Service, Mexican
614-291-0274
1726 N. High St.

La Plaza Mexican Grill
Counter Service, Mexican
614-725-3044
1812 N. High St.

Starbucks
Counter Service, Cafe
614-291-5692
1782 N. High St.

Waffle House
Table Service, American
614-297-8879
1712 N. High St.

AREA D
Blaze
Counter Service, Pizza
614-745-2167
1708 N. High St.

Chipotle
Counter Service, Mexican
614-291-0274
1726 N. High St.

Bistro 2110
(inside the Blackwell)
Table Service, American
614-247-4000
2110 Tuttle Park Place

Tommy’s
Counter Service, Italian
614-294-4669
174 W. Lane Ave.

Panera Bread
Counter Service, Sandwich
614-299-4400
300 W. Lane Ave.

Varsity Club
Table Service, American
614-291-5029
278 W. Lane Ave.

AREA E
Bistro 2110
(inside the Blackwell)
Table Service, American
614-247-4000
2110 Tuttle Park Place

Tommy’s
Counter Service, Italian
614-294-4669
174 W. Lane Ave.

Panera Bread
Counter Service, Sandwich
614-299-4400
300 W. Lane Ave.

Varsity Club
Table Service, American
614-291-5029
278 W. Lane Ave.

AREA F
Oxley’s Café
Counter Service, Cafe
2035 Millkin Road

Ohio Union
Woody’s Tavern
Table Service, American
1739 N. High St.

Sloopy’s Diner
Table Service, American
1739 N. High St.

Union Market
Counter Service, Multi
1739 N. High St.
A big thank you to the many faculty and staff who dedicated time to plan this year’s Materials Week conference!

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