The University of Connecticut and scientific instrument maker FEI Co. sign an agreement to develop a cutting-edge center for microscopy and materials science research.

Uconn Keramos Chapter hosted Microscopy Contest

Construction of Artificial Organs with 3D Printers

New Eyes, New Insights

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Warm greetings to the faculty, students, alumni, and friends of UConn IMS! This is the second edition of the IMS Annual Newsletter, and this year has brought many exciting changes to IMS and UConn at large. The launch of groundbreaking Next Generation Connecticut legislation, a $1.5 billion investment in UConn’s STEM program, will establish hundreds of new research and teaching faculty positions in the STEM disciplines, increase enrollment of STEM undergraduates, and lead to the construction of cutting-edge new equipment, teaching laboratories, research facilities, STEM dormitories, and other infrastructure expected to make UConn one of the top research institutions in the nation. Bioscience Connecticut, a program similar to Next Generation CT, will develop the biological sciences at UConn with $200 million of funding. The Innovation Partnership Building (IPB), the first facility of the UConn Technology Park and a $172 million venture, is set to break ground any day now with an expected completion date of 2017. IMS faculty, students, and researchers will play a strong role in the future of the IPB, with particular emphasis on the Advanced Characterization Laboratory (ACL). The recent partnership announced between UConn and scientific instrument maker FEI Co. will develop a $25 million world-class Center of Electron Microscopy on the UConn campus, complete with state-of-the-art electron microscopy equipment, a grant program, graduate fellowships, and technical positions under the stewardship of IMS.

Many ongoing initiatives continue to transform IMS. Our new website, ims.uconn.edu, provides comprehensive information on all aspects of our academic programs, research, and industry outreach. The three major programs in Materials Science, Materials Science and Engineering, and Polymer Science and Engineering continue to grow and flourish, supplemented by classrooms equipped with new audiovisual equipment. The IMS External Advisory Board has greatly expanded and has markedly helped shape changes in IMS. The Industrial Affiliates Program also continues to grow, as does the Electrical Insulation Research Center under the new leadership of Dr. Yang Cao. We are proud to welcome two new faculty members who joined IMS this past August: Dr. Seok-Woo Lee of the Materials Science and Engineering Department (mechanical behavior of materials at multiple length scales, dislocation mechanics, in-situ nano-mechanical testing, and rapid solidification and processing) and Dr. Kelly Burke of the Chemical and Biomolecular Engineering Department (natural and synthetic biomaterials).

Inside this newsletter you will find articles detailing the achievements and accomplishments of our hard-working faculty members, staff members, graduate students, and alumni. IMS derives its strength from its commitment to collaborative, interdisciplinary research, and we continue to develop new research programs true to this mission. We love to hear about what is going on in the lives of our IMS alumni and continually update our alumni database. Please send along any information you would like shared with the IMS community and we will feature you in an upcoming newsletter. Wishing you all a healthy and prosperous year!

Sincerely yours,

Steven L. Suib
Director, Institute of Materials Science
The University of Connecticut and scientific instrument maker FEI Co. have signed an agreement to develop a cutting-edge center for microscopy and materials science research. The center, which will be housed in the new Innovation Partnership Building at UConn’s Tech Park, will feature some of the most advanced commercially available electron microscopes.

“The new center at the UConn Tech Park will be the foremost microscopy facility in the world,” says Mun Choi, UConn’s Provost. “The transmission, scanning, and ion beam instruments will enable our faculty and students to manipulate and analyze materials at atomic scales. Their ability to create new applications for energy, electronics, and biomolecular sectors will be unparalleled.”

The center will focus on the advanced characterization of materials, which has nearly limitless applications, ranging from clean energy and alternative fuels to advanced manufacturing technology; semiconductors; vaccine development; and the development of medical devices.

The center will open its doors in mid-2015, with the arrival of the first three microscopes from FEI. These instruments will be housed in UConn’s Institute of Materials Science. The center will move to its permanent home in Tech Park’s Innovation Partnership Building when construction is complete, which is currently scheduled for 2017.

Funding for the center is being provided in roughly equal amounts by both UConn and Hillsboro, Ore.-based FEI, and is expected to exceed $25 million over a 15-year period.

When complete, the center will house a total of seven instruments from FEI, including the flagship microscope, Titan Themis TEM, which is capable of more than one-hundred million times magnification, allowing scientists to see the individual atoms that materials are made of, determine their arrangement, and measure the electrical and magnetic forces they exert on one another.

In addition to the acquisition of the instruments, the agreement includes research funding and support for an electron microscopy scientist and numerous graduate student fellowships. The new microscopy center may also draw researchers from peer academic institutions and industry to the facility to take advantage of its advanced materials characterization capabilities.

“Developing industry partnerships focused on innovative, cutting-edge research is an important goal of the UConn Tech Park,” says Choi, “and this center represents an important step in realizing this goal.”

FEI’s flagship microscope, Titan Themis TEM, is capable of more than one-hundred million times magnification, allowing scientists to see the individual atoms that materials are made of, determine their arrangement, and measure the electrical and magnetic forces they exert on one another. The Titan Themis will be one of the instruments housed at a new cutting-edge center for microscopy and materials science research to be located at UConn’s Tech Park.
At the University of Connecticut, 3D printing is drastically enhancing research and leading to inventive solutions.

Joining UConn as assistant professor in August 2011, Dr. Anson Ma is the head of the Complex Fluids Laboratory and a faculty member in both the IMS Polymer Program and the Chemical Engineering Program. Interested in foams, emulsions, biological fluids, and fluids containing nanoparticles, the Complex Fluids Laboratory’s mission is to develop novel, scalable techniques for processing complex fluids into multifunctional, high-performance articles. Dr. Ma’s group is particularly interested in inkjet and 3D printing. He recently led two teams of senior chemical engineering students in collaboration with the ACT Group, based in Cromwell, Connecticut, to design and 3D print an artificial kidney.

“3D printing is what we call an additive manufacturing method,” Dr. Ma says. “You add things drop by drop or layer by layer to construct 3D objects. This approach presents a unique opportunity for creating structurally or chemically complex objects that require a high level of customization.”

“The kidney project started with the idea to challenge our students to apply engineering principles that they have learned at UConn to solve a problem and make a difference. The kidney is a good place to start,” Dr. Ma says. “According to the National Kidney Foundation, about 100,000 people are currently on the waitlist for a kidney, and last year only 17,000 kidney-transplant operations were performed. On average, about 12 people die per day waiting for one.”

The artificial kidney that Dr. Ma’s group constructed is an early prototype, and there are still a lot of technical challenges yet to be overcome. “The long-term vision is to incorporate cells, for example stem cells from the patients, thereby creating fully functional and compatible organs,” Dr. Ma says.

As more and more scientists and engineers from different disciplines are joining forces in research, Dr. Ma is hopeful that clinical trials will be possible in the near future.

After completion of the initial project, Dr. Ma’s group was contacted by Google to showcase the kidney prototypes at one of their events in New York City.

“My research team and I now focus on the reliability and resolution of 3D printing,” Dr. Ma says. “Currently, we can print parts with resolutions on the order of the diameter of human hair. We need a resolution higher than that to realize the full potential of 3D printing for biomedical applications like dentin regeneration and bone scaffold.”

UConn researchers are also working with different cells to create tissue on non-degradable plastics. Collaborating with the leading provider of 3D content-to-print sources, the ACT Group, faculty and students at the UConn Institute for Regenerative Engineering are conducting research in the new wave of 3D printing technology.

UConn researchers start with a computer model and then click on the icon for build. After four hours, a model of a patient’s jaw is finished and that product can help a doctor determine how to remove cancerous dark spots from a patient’s mouth. The material’s mechanical properties mimic the mechanical properties of human bone.

Dr. Ma’s research has recently been featured on the front page of The Chronicle (newspaper) and Channel 8 News. He is also leading a major UConn initiative to create a center of excellence for additive manufacturing of soft materials. The new center’s mission is to accelerate technology transfers to the industry and to provide an important training ground for future workforce in advanced manufacturing.
Kelly Burke, who joined UConn in 2014 under the Eminent Faculty Initiative as Assistant Professor in the Chemical and Biomolecular Engineering Department, has exhibited an inextinguishable interest in chemistry and engineering since her childhood.

“Though an extensive childhood collection of LEGOs would have suggested that I would become a civil engineer, I decided to study chemical engineering,” she says. “During my undergraduate years, I developed a fascination with polymer research in particular because it combined my love of chemistry, physics, and engineering.”

Dr. Burke completed her undergraduate degree at UConn before going on to earn her Ph.D. at Case Western Reserve University in 2010. Her expertise lies in protein modification strategies, tissue engineering, structure-property relationships of liquid crystals, and biocompatible multifunctional polymeric materials.

With the goal of focusing her research career on developing new responsive materials and exploring biological applications for materials, Dr. Burke conducted postdoctoral research in protein-based biomaterials at Tufts University, investigating both synthetic strategies to add functional behavior to the material as well as studying human adult stem cell and immune cell behavior in 2D and 3D constructs. Her research on silk fibroin produced by the domesticated silkworm Bombyx mori sparked her enthusiasm for biodegradable and biocompatible materials.

“These experiences not only taught me how to work with cells and materials together, but also taught me how materials can influence cellular responses,” Dr. Burke states. “There is a great need for materials-based solutions to problems in medicine and one aspect of my research seeks to address this by leveraging material-cell interactions to achieve desired responses.”

At UConn, Dr. Burke’s research projects focus on bio-derived polymers and stimuli-responsive materials that can be applied as advanced drug and cellular delivery devices, soft actuators, bio-composites, and implantable biomaterials.

“Our approach recognizes that not all of these functional properties can be found in existing polymers, so we design, synthesize, and characterize new materials with these desired properties,” Dr. Burke says. “We work on both natural, protein-based materials as well as synthetic polymers, and we seek to understand the underlying relationships between the physical and chemical structure of the polymers and the properties that result.”

Dr. Burke says that in order to meet the targeted applications, polymers may need to have different functional behaviors, such as programmable degradation profiles, the ability to change shape on demand, or the ability to influence biological responses.

“While we prepare and characterize our materials using traditional polymer techniques to understand these structure-property relationships, we also study the responses of human cells to our materials,” Dr. Burke says. “Ultimately, combining the knowledge from both material and biological characterization techniques provides enhanced insight into the design of future materials.”

One of Dr. Burke’s current projects involves liquid crystalline (LC) polymers, focusing on advanced materials for medical, composite, and green technologies. LC polymers consist of rigid molecules called meso-
gens that are capable of forming ordered phases. Under certain conditions, the mesogens can potentially trigger to transition from an ordered phase to a disordered phase.

“The materials we work with are typically crosslinked networks of LC polymers because the molecular-scale order of the mesogen is directly coupled to the macroscopic behavior of the material,” Dr. Burke says. “An important example of this is actuation, the reversible extension and contraction of a material when cycled under stress. We are very interested in exploring the application of these materials in the field of delivery, smart implantable materials, and as soft actuators for robotics applications.”

Though Dr. Burke and her colleagues have several ideas about where to take their research next, one avenue that she looks forward to pursuing in the future highlights the design and development of materials to interact with chronically-inflamed environments to promote healing.

Seok-Woo Lee was welcomed by the Department of Materials Science and Engineering at the University of Connecticut in July 2014 as Pratt & Whitney Assistant Professor.

After receiving his bachelor’s and master’s degrees in materials science and engineering from Korea University in Seoul, South Korea, Dr. Lee earned his Ph.D. in materials science and engineering at Stanford University in 2011. While attending Stanford, Dr. Lee completed his dissertation on “The Plasticity of Metals at the Sub-micron Scale and Dislocation Dynamics in a Thin Film” with his advisor, Dr. William D. Nix. As a Kavli Nanoscience Institute Postdoc Fellow at California Institute of Technology, he researched the development of an in-situ cryogenic nano-mechanical testing system, which was collaborative work with Jet Propulsion Laboratory of NASA.

At UConn, Dr. Lee’s current research interests include the development of in-situ nanomechanical measurement systems working at different temperatures and the study of nanomechanical properties of novel complex metallic materials such as intermetallic compounds and quasi-crystals.

“We fabricate both nano-sized and bulk-sized samples, measure their mechanical properties, and try to understand deformation mechanisms with advanced microscopy techniques such as scanning electron microscopy (SEM) and transmission electron microscopy (TEM),” Dr. Lee says. “Based on the experimental data, we try to find a way to control micro-/nano-structures to achieve superior mechanical properties at smaller length scales.”

Dr. Lee states that in order to design any reliable mechanical device, it is crucial to understand the mechanical behavior of materials. The use of materials with inappropriate mechanical properties could result in significant device failure.

“Imagine that someone is using a fragile glass hammer that will shatter once they hit a small metallic pin,” Dr. Lee says. “Especially for small mechanical systems such as micro-electro-mechanical systems (MEMS) and nano-electro-mechanical system (NEMS), the fundamental understanding of materials at small length scales is very critical. The interaction between defects and free surface brings out the emergence of new deformation mechanisms, which is scientifically interesting and important in order to apply the knowledge to the development of mechanical devices.”

Using his work in MEMS/NEMS, coating technology, thin film technology, and lightweight structural materi-
als, Dr. Lee applies his research to the real world so that it can later be implemented by industry partners. “Materials strength gets higher at the nanoscale,” Dr. Lee says. “If we create an architectural structure that consists of nanoscale members, it is possible to reduce the density without sacrificing material strength. This is one way to develop a nanolattice, which is known to be an ultra-light metallic material.”

In the future, Dr. Lee says that he looks forward to exploring nanomechanical studies on novel metallic systems within different environments.

“I am interested in studying different temperatures or different chemical environments at the nanoscale,” Dr. Lee says. “Even though you change only one environmental parameter, you can see very different mechanical behaviors of materials, which would have never been expected at bulk scale.” He is excited to study environmental effects at the nanoscale from both scientific and practical perspectives.

**NEW EYES, NEW INSIGHTS**

Michael Pettes joined the University of Connecticut as Assistant Professor in the Department of Mechanical Engineering in 2013.

Prior to earning his master’s degree and Ph.D. in Mechanical Engineering from the University of Texas at Austin, Dr. Pettes served as an infantry officer with the 1st Marine Division of the United States Marine Corps.

“With well-publicized requirements for a sustainable path to the growth in global demand for energy, I see the need for advanced scientific research of materials for energy conversion applications,” Dr. Pettes says. “This has led to my commitment and career in developing fundamental knowledge of transport phenomena in materials for energy and applying that knowledge to designing systems which can benefit society.”

At UConn, Dr. Pettes researches micro and nano-scale energy transport with the help of his Ph.D. and undergraduate students. With the world’s ever-increasing need for sustainable energy growth, his lab plays a major role in developing essential knowledge of transport phenomena in materials for energy, which can be used to design more efficient systems that benefit society as a whole.

“Strong capabilities in materials synthesis and structural characterization with a focus on transmission electron microscopy, micro-nano heat transfer theory, and micro-fabrication have allowed me and my students to design experiments to gain insight into the fundamental mechanisms leading to observed properties in individual nanomaterials,” Dr. Pettes says.
According to Dr. Pettes, his research is broken down into three separate concentrations: multi-property measurements on individual nanomaterials, engineering transport properties through material design, and development of synthesis techniques and structure-property relationships of bulk nanostructured materials.

Through funds provided by the State of Connecticut, Dr. Pettes has had the opportunity to grow materials in ultra-high vacuum conditions and use Institute of Materials Science facilities to characterize them. Through techniques such as multi-energy Raman, which experimentally collects phonon dispersion data of nanostructured materials, he has implemented methods to synthesize and characterize thermoelectric and piezoelectric materials.

The research in Dr. Pettes’ labs consists of two major real-world application areas. “First, our work on carbon nanomaterials is geared towards making impacts in thermal management applications mainly in microelectronics,” he says. “Secondly, our research into solid state energy conversion materials has applications in Peltier cooling and thermoelectric power generation from low-quality waste heat.”

In collaboration with Dr. Morgan Stefik, Assistant Professor of Chemistry at the University of South Carolina, Dr. Pettes develops mesoporous polymer materials to be used in inorganic material templating in the lab, which can exhibit sub-10 nm feature sizes.

Over the course of the next five to ten years, Dr. Pettes says that his laboratory will expand its research to include in-situ transmission electron microscopy and the development of a new piezoelectric micro-actuator device capable of measuring thermal conductivity of low-dimensional materials in the presence of elastic strain.

“This challenging work will be the next step in investigations of the structure-electrical-thermal property relationships in individual nanomaterials that my colleagues and I have carried out over the last decade,” Dr. Pettes says.

His lab also works to develop interactive software, which will be used by UConn’s engineering students to aid in their understanding of complex physical phenomena. Dr. Pettes plans to introduce this software in his nanoscale thermal transport course and his heat transfer and thermodynamics courses.

Luyi Sun joined the Institute of Materials Science during the fall of 2013 as Associate Professor in the Department of Chemical and Biomolecular Engineering.

Dr. Sun received his bachelor’s degree in Chemical Engineering from South China University of Technology and his Ph.D. in Chemistry from the University of Alabama, where he was awarded with the Outstanding Dissertation Award of College of Arts and Sciences in 2005. After working as an Assistant Research Engineer at Texas A&M University, Dr. Sun became a Senior Research Engineer at TOTAL Petrochemicals USA, Inc. As Assistant Professor in the Department of Chemistry and Biochemistry at Texas State University, he received the Presidential Award for Excellence in Scholarly and Creative Activities in 2011.

With an extensive background in the plastics industry, Dr. Sun’s knowledge in green science has been transferred to his research at UConn. One of the main objectives of his lab at UConn is to design multifunctional nanostructured materials for structural, environmental, and energy related applications like packaging and catalysis.

“After moving to academia and reading more literature, I realized that our research can help the environment,” Dr. Sun says. “It is always nice to find a niche application of our work, particularly when the application can bring direct benefits to the society.”
Dr. Sun’s research team, a group of IMS students, material scientists, and engineers, are engaged in various green science projects that synthesize, isolate, and derive valuable materials from biomass, such as harvesting nanostructured silica and lignocellulose from rice husks. The research group uses bio-based surfactants to help store methane in water to release upon proper treatment. Both nanostructured silica and lignocellulose can potentially lead to widespread application.

The four areas of materials research that his research group is engaged in include multi-functional nanostructured materials, solid state chemistry, green science and polymeric materials, and polymer processing. The group actively applies knowledge gained to solving practical problems such as developing the barrier properties for packaging applications through the creation of nanocoatings.

“In most cases, the structural design and control are the keys to the high performance of these materials,” Dr. Sun says. “Because our research targets specific applications, we hope our work can help solve problems and improve life.”

Few developments in manufacturing have made splashes the way 3D printing or additive manufacturing (AM) has in the past year or two. Since additive manufacturing with metallic materials currently focuses on aerospace and biomedical applications, Connecticut has seen strong developments toward an industrial additive manufacturing or 3D print base. Three trends will shape additive manufacturing this year.

The rapid pace of machine improvements and novel machine features will continue this year. Higher throughput and larger build volumes will be available with the next generation of metal machines that will be revealed over the next months. The improvements will be achieved with high-powered lasers and multi-laser set-ups. More commercial build themes—the machine settings to use specific materials—will become available than currently on the market, which will enable a
wider range of material choices. Additive manufacturing machines will have increasing in-process monitoring abilities to capture part temperatures or defects that might develop during the manufacturing process within parts. It remains to be seen if the market can sustain the number of manufacturers for laser-based equipment or if consolidation will occur. But it is also conceivable that new companies come to market with new ideas and machines. Parallel to the development of additive manufacturing machines, the powder materials used for additive manufacturing have attracted the attention of material producers, including start-ups. Research projects aim at new technologies that would enable powder processing at reduced cost. While it is not clear if these new technologies will be able to compete with the existing ones, the competition on the powder market equals the competition on the machine manufacturer level.

Can Connecticut businesses take advantage of additive manufacturing, in particular with metallic materials? 2015 will see new service providers for additive manufacturing in Connecticut and an increasing number of companies adopting additive technologies. Throughout the country, companies try to fill a void for highly qualified additive manufacturing service providers. Connecticut is no exception and either new start-up companies or existing manufacturing companies extending into additive manufacturing will establish themselves in ’15 as capable service providers. Some of the questions to consider over the next 12 months is if the market can support the growing number of additive manufacturing service provider companies that offer additive manufacturing services, the level of progress that will be made in mastering the many challenges that additive manufacturing poses, and if there is enough demand to even specialize in niche applications or materials with additive manufacturing. A common thread among additive manufacturing service providers is the hope to enter the supply chain for large corporations and for full scale production of additively made parts. It is difficult to predict when the transition from prototype parts to a full scale production might occur, but continuous improvements in the ability to understand processing details will be required to transition toward additive manufacturing of production parts.

Many challenges and opportunities in additive manufacturing are technical in nature, but equal challenges and opportunities exist for the workforce development. Few engineers are currently trained in operating the rather complex additive manufacturing machines. Moreover, with additive manufacturing technology development still in its infancy, there is a need for a highly skilled workforce capable of not only operating equipment, but of understanding the underlying engineering issues. Not surprisingly, many companies turn to universities, UConn in particular, searching for master’s and PhD-level engineers for their additive manufacturing activities. The State of Connecticut has invested and continues to invest substantially into additive manufacturing research at UConn to help speed the transition of this emerging field within the State. Engineering faculty not only embark on additive manufacturing research projects that will yield graduates with additive manufacturing skills over the next years; educational programs are furthermore being developed that will benefit engineers in the State and beyond who want to develop specialized skills in additive manufacturing.

After an initial phase of sometimes overly optimistic expectations for additive manufacturing, a far more realistic ground has been reached that bodes well for a long-term success. Immediate steps to enable long-term success should focus on two areas: prevention of processing-specific defects and a reduction in the variations of part properties. Both areas play into the key challenge of part qualification, which is the primary concern for stakeholders such as OEMs or government agencies. One solution approach to the qualification challenge is to generate large amounts of data that can be used to develop predictive models. Another approach—currently pursued by IMS faculty members Alpay, Dongare, Ladani, Hancock, and Hebert in collaboration with Pratt & Whitney—is to use computational materials science combined with selected experiments to establish physics-based answers to the qualification problem. Connecticut is well positioned to lead AM with its combination of large OEMs, a small and medium sized supply basis, and UConn supporting the necessary research and workforce development needs for additive manufacturing.
Seize the unique opportunity to become a Senior Design industry partner and tap into the exceptional student talent, distinguished faculty, and state-of-the-art materials processing and characterization laboratory equipment that the UConn Department of Materials Science and Engineering has to offer!

Our MSE program was established to meet the high local demand for materials engineering professionals. Our students enjoy a 100% job placement rate, a choice of five academic concentrations (biomaterials, energy materials, nanomaterials, metallurgy, and electronic materials), first-rate faculty instruction, and hands-on laboratory experience and research opportunities. UConn MSE is the number one public MSE program in the Northeast, boasting a student-to-faculty ratio of 13 to 1, industry co-ops, internships, and departmental scholarships.

The UConn MSE experience culminates with Senior Design, a two-semester project that provides students with exposure to real-world engineering problems, stimulating design challenges, collaboration with local companies, and potential future employment opportunities.

As an industry partner, you can expect collaborative impact with UConn MSE and the Institute of Materials Science, project updates and documentation, secure proprietary information, and the opportunity to hire skilled, engaged engineering students. Visit our Senior Design webpage for more information!
Dr. S. Pamir Alpay received his Ph.D. in materials science and engineering in 1999 from the University of Maryland. He served as a post-doctoral research associate at the Materials Research Center at the University of Maryland until 2001 before joining the University of Connecticut Department of Materials Science and Engineering (MSE) in 2001 as an assistant professor. Dr. Alpay is currently serving as department head of MSE. His research focuses on materials for electromagnetic applications and materials modeling. He is a Fellow of the American Physical Society, an elected member of the Connecticut Academy of Science and Engineering (CASE), an editor for the Journal of Materials Science, and recipient of the NSF-CAREER Award in 2001 and the UConn School of Engineering Outstanding Junior Faculty Award in 2004. Dr. Alpay is the author of more than 130 publications in peer-reviewed journals, 20 peer-reviewed conference proceedings, four invited book chapters, and an invited book on compositionally graded ferroelectric materials. He has delivered more than 70 invited talks and seminars at academic institutions, international meetings, national laboratories, and industry.

We sat down with Dr. Alpay to discuss his research, role as department head, and vision for UConn MSE.

**When did you first become interested in materials science?**
When I was a senior in high school.

**What courses do you teach in the department?**
I am currently teaching an introductory materials engineering class at the graduate level. I was also the instructor for MSE 4001/5317, Electrical and Magnetic properties of Materials, and MSE 5305, Phase Transformations in Solids.

**What is typical day like for you as department head?**
The one constant is that it is always busy! In addition to research and teaching, a significant portion of my time is spent working on the management aspects of the department.

**What do you find most fulfilling about your position?**
Working with outstanding students, staff, and colleagues.

**What are your research interests and current research projects?**
My research interests include materials theory, computational materials science, and multiscale materials modeling. I am particularly interested in materials for electrothermal energy conversion. I most recently published a paper in the December 2014 MRS Bulletin. I am also going back to my metallurgy roots. Here is a list of my current research projects:

- Mesoporous Ferromagnetic Materials for Antenna Applications, Rogers Corp. (co-PI, with S. L. Suib, 02/15/2014-02/14/2015, $84,159).
- Metals and Alloys for Electrical Circuit Breaker Contacts, GE Industrial Solutions (PI, with M. Aindow, 01/01/2013-01/01/2015, $581,753).
- MOCVD of High Performance Complex Oxide Films for Switchable Film Bulk Acoustic Resonators, subcontract from SMI Inc., NJ via Department of Defense, Army Research Office STTR, $284,895 with $172,937 UConn matching, 05/27/2013-08/31/2015.
Phase II (PI, 02/01/2013-01/31/2015, $120,000).

What positive changes have you facilitated in MSE since taking on the role of department head?
I have worked to hone in on the necessary resources and staff members required for our department’s development and expansion. We have facilitated a greater than fifty percent increase in undergraduate enrollment since 2011 made possible by the active involvement of our undergraduate student chapters, faculty, and new promotional videos and emails. With the help of laboratory manager Adam Wentworth, we raised over $120,000 and oversaw the renovation of MSE undergraduate teaching labs. We also initiated three online, long-distance mode graduate courses for MSE MENG offered each semester. Furthermore, I helped to recruit faculty members Dr. Avinash Dongare, Serge Nakhmanson, and Seok-Woo Lee, in addition to staff members Ms. Lorri Lafontaine (professional staff/administrative services), Ms. Heike Brueckner (web/graphic design), and Ms. Giorgina Paiella (written communications specialist). We overhauled the MSE website and developed new promotional material for MSE in the form of booklets, newsletters, etc. with Ms. Heike Brueckner. We also established an active Industrial Advisory Board of eight highly reputable industry partners. With the outstanding work of Dr. Hal Brody, we received ABET certification.

What is your vision for the MSE department in the coming years?
Our main goal is to ascend into the top 10 MSE programs. This involves targeting key research areas that we want to focus on, which departments and institutions are best in class and why, and establishing the necessary resources to achieve our goals as we look ahead to UConn MSE in two, five, and ten years into the future.

IMS Professors Publish “Rational Design of All Organic Polymer Dielectrics” in Nature Communications

Professor Dr. Rampi Ramprasad (MSE/IMS) and colleagues Dr. Greg Sotzing (CHEM/IMS) and Dr. Steve Boggs (IMS), along with their research group members and collaborators, have published an article titled “Rational Design of All Organic Polymer Dielectrics” in Nature Communications, a prestigious and multidisciplinary natural sciences journal.

In the paper, the group details their development of a five-step rational design strategy aimed at the production of promising polymer dielectrics for electrostatic (capacitive) energy storage applications. The computationally driven approach combines quantum mechanical calculations, force-field simulations, and property and structure prediction schemes to explore the chemical and configurational spaces of polymers with the goal of identifying potentially useful dielectrics. The approach is validated by synergistic research in synthetic and electrical characterization.

The complexity of the polymer morphology (left) and local regions of crystallinity (right). Both the overall morphology and the most likely crystal structures were identified in the published work for the screened polymers.
This research is closely aligned with the White House’s multi-agency Materials Genome Initiative (MGI). Edisonian approaches to the design and development of novel materials is a long and costly endeavor, requiring large investments, a painstaking trial and error testing process, and lengthy—yet often unsuccessful—investigations. This process is gradually being replaced by rational strategies that combine predictions from advanced computational screening with targeted experimental synthesis and validation. While materials development using such approaches still poses significant unresolved challenges, groundbreaking innovations in computational chemical physics, data-mining, and computer-processing power coupled with close collaboration between modeling and synthetic efforts, now make it possible for materials scientists to accelerate the design of new materials. The discoveries fostered by such rational approaches could lead to countless applications and breakthroughs, from lighter and stronger car frames to revolutionary clean-energy technologies. These new potential applications of enhanced materials discovery have led Materials Project co-founders Dr. Gerbrand Ceder and Dr. Kristen Persson to assert in a recent Scientific American article that we are entering “a golden age of materials design.” Professor Ramprasad adds that an initial investment in rational, computation-driven approaches can lead to substantial future cost, effort, and efficiency benefits.

Professor Ramprasad and his group intend for their initial design strategy to be extended to include other critical dielectric properties in the screening process, including degradation, loss, and breakdown. They also hope that emerging advances in data-driven and quantum mechanical methodologies will allow them to overcome current limitations on rapid, high fidelity property predictions and extended time and length-scale simulations. While the approach is currently aimed at high-energy capacitor dielectrics, Professor Ramprasad and his colleagues are currently working on applying these principles to other materials classes and application domains. These critical steps and further explorations will likely influence future material discoveries.

A schematic illustration of the group’s rational polymer dielectric design strategy. The strategy involves five consecutive steps: (1) Combinatorial chemical space exploration, using 1D polymer chains containing four independent blocks with periodic boundary conditions along the chain axis, (2) Promising repeat unit identification, by screening based on band gap and dielectric constant, (3) 3D structure/morphology predictions of polymers composed of the downselected repeat units, (4) Property predictions of the 3D systems. Finally, (5) synthesis, testing and validation.
Dr. Baikun Li, Al Geib Distinguished Associate Professor in the University of Connecticut Department of Civil and Environmental Engineering, leads her bioenergy lab group in researching sustainable environmental engineering and real-time environmental monitoring.

After completing her bachelor’s and master’s degrees in environmental engineering at Harbin Institute of Technology in China, Dr. Li received her Ph.D. in Environmental Engineering from the University of Cincinnati in 2002. She began her career in academia as an assistant professor at Penn State Harrisburg in 2003 and then joined the UConn faculty in 2006.

With expertise in environmental biotechnology, wastewater treatment, and bioenergy production, Dr. Li has worked among a wide range of research partners, both in the United States and internationally. She has successfully secured research grants from NSF, EPA, ONR, and USGS, and broadly collaborates with industry for scale-up engineering research. During her 10-year academic career, Dr. Li has supervised 10 Ph.D students and 10 master’s students, and has over 90 peer-reviewed journal publications.

Recognizing the global challenge behind the maintenance of clean water and soil, her lab group engages in multidisciplinary research of sustainable environmental engineering in order to understand the fundamental mechanisms of bioelectricity generation at both science and engineering levels. The group also works toward enhancing the conversion efficiency of wastes to electricity and scaling up self-sustainable cost-effective natural and engineering systems in real-world application.

Elucidating scientific principles and discovering new means of engineering operation, Dr. Li’s group has been active in real-time environmental monitoring technology, low-cost natural degradation processes, and cost-effective bioenergy production and harvest from wastes.

Dr. Li’s students have won a number of regional and national awards, including “Doctorate Research Fellowship, American Society of Electrochemistry”, “Outstanding Graduate Student (Environmental Engineering), “New England Water Environmental Association (NEWEA)”, and UConn’s “Outstanding Undergraduate Thesis Award (Environmental Engineering)”.

In addition to receiving the “Woman of Innovation Research Innovation and Leadership” award from the Connecticut Technology Council (CTC), and the “Top Cited Paper Award” by the Biochemical Engineering Journal, Dr. Li serves as associate editor for the Journal of Environmental Engineering, Water Journal, and CLEAN-Soil, Air and Water.
Biorasis, Inc. is a rapidly growing, privately held medical device start-up company co-founded by Dr. Fotios Papadimitrakopoulos, IMS Polymer Program faculty member and Professor of Chemistry and Dr. Faquir C. Jain, Professor of Electrical & Computer Engineering and member of IMS. Biorasis is currently headed by Dr. Sagar Vaddiraju, R&D Director and Interim CEO, a former Ph.D. graduate of the IMS Polymer Program.

Biorasis, Inc. is committed to developing a wireless, needle-implantable biosensor platform for continuous metabolite monitoring in real time. The company has gained a strong intellectual property (IP) portfolio, receiving a number of peer-reviewed state and federal grants.

Implementing a holistic approach toward the development of a continuous metabolic monitoring system, the company utilizes a rice-sized device called the Glucowizzard as its main source of technology. Intended for diabetes management and care, as well as metabolic monitoring, the ingeniously compact Glucowizzard sensor contains miniaturized power and telecommunication modules alongside multiple sensors and smart coatings to continuously sense numerous analytes, while preventing foreign body response naturally elicited to reject and isolate all implants. The latter technology entails work of multiple UConn professors with significant contributions from Dr. Diane J. Burgess, Professor of Pharmaceutics and member of IMS.

Unlike many current continuous glucose monitoring (CGM) devices, the Glucowizzard sensor offers a holistic approach on extending device lifespan up to a year and is small enough for needle-based implantation.

It is expected that the Glucowizzard will reach commercialization by 2017, changing the way in which diabetics track their sugar levels.

With over 20 years of experience in the areas of polymers, nano/bio-systems, and supramolecular assembly of nanostructures, Dr. Papadimitrakopoulos is a committee member for the State of Connecticut Nanotechnology Advisory Committee and is the co-founding member of Connecticut Nanotechnology Initiative.

Dr. Sagar Vaddiraju has over nine years of R&D expertise in the field of implantable devices, with experience translating laboratory research into working prototypes. Specializing in polymer science, electrochemistry, and optoelectronic devices, he currently leads a number of R&D projects toward commercialization.

Biorasis, Inc. is comprised of a well-acclaimed team of industry professionals with backgrounds in electrochemical sensors, drug-delivery coatings, analog, and mixed signal circuits, semiconductor packaging, and quality control. Along with its collaborators, the company has published several papers that emphasize core technology, performance, and competency.

To find out additional information about Biorasis, Inc., visit www.bio-orasis.com.
Dr. Menka Jain, Associate Professor of Physics in the Institute of Materials Science, encourages her students to cultivate a well-rounded perspective of science.

Growing up with a father who was a technical officer in Materials Science Program at the Indian Institute of Technology Kanpur, India, Dr. Jain was exposed to an advanced research environment at a young age.

“In school, I realized from the very beginning that I was passionate about science, especially physics,” Dr. Jain says.

After receiving her master’s degree in Physics at Shri Sahu Ji Maharaj University in Kanpur, India, Dr. Jain worked on a research project at the Indian Institute of Technology centered around examining biological and gem stones using Raman and fluorescence spectroscopy. She always wanted to pursue an academic career. Graduating from the University of Puerto Rico in 2004 with a Ph.D. in Chemical Physics, Dr. Jain went on to conduct interdisciplinary research as a director-funded postdoctoral fellow in the Materials Physics and Applications Division at the Los Alamos National Laboratory from 2005 until 2008.

“While most of my post-doc colleagues worked on specific projects, being a director-funded postdoctoral fellow, I had freedom to conduct research in any area of my choice at the Los Alamos National Lab,” Dr. Jain says. “I worked on an extension of my Ph.D. research work on improving the ferroelectric and voltage tunable properties of ferroelectric materials along with exploring the multiferroic and colossal magnetoresistive properties of various functional materials.”

At UConn, Dr. Jain’s research is in the area of condensed matter physics. She leads both graduate and undergraduate students in her research group. Synthesizing a variety of functional/multifunctional metal-oxide thin films, powders, nanoparticles, heterostructures, and nanocomposites using diverse solution techniques, the group examines the fundamental physical properties of these materials to understand their structure-property relations. The physical properties of various metal-oxides, such as oxides with perovskite structure, largely originate from the underlying atomic/crystal structures such as cationizations in the lattice, geometric coordination, bond lengths, and bond angles. Structural distortions, either by chemical doping or strain engineering, can lead to variation in their physical properties.

“Overall, there is an immense need to enhance our understanding of various parameters contributing to the electrical or magnetic order in the functional/multifunctional oxide materials, which leads to identification of materials with desired sets of properties,” Dr. Jain says.

For many device applications, biphasic nanocomposites, also studied in her group, offer superior physical properties as compared to single-phase materials. “The materials that we study in my group have potential for applications in various device such as transducers, transformers, actuators,
tunable microwave devices, filters, phase shifter, memory, data storage, magnetic field (AC/DC) sensors, and magnetic-read heads,” Dr. Jain says.

Examining applied materials allows her students to gain perspective on the relation between their scientific research and real world applications.

By stressing to her students the significance of conducting research work utilizing state-of-the-art techniques available in the national labs, Dr. Jain connects her students to Los Alamos National Lab in New Mexico, Argonne National Lab in Illinois, and Oak Ridge National Lab in Tennessee.

“As a graduate student I worked with the National Aeronautics and Space Administration (NASA), but never actually got to go there,” Dr. Jain says. “Working at Los Alamos National Lab made me realize that it is very important for graduate students to see the working environment of national labs and interact with staff scientists there.”

The students from her group travel to the national labs to conduct experiments and work closely with scientists. One of her graduate students has also received a fellowship to work at a national lab.

Captivated by the functional and multifunctional properties of ferroelectric, ferromagnetic, multiferroic, magnetocaloric, and thermoelectric materials that could be very useful in technological advancements, Dr. Jain’s research interests lie in not only enhancing our fundamental understanding of the structure-property relations of various materials, but also identifying/engineering materials with desired properties for novel device applications.

As an overarching goal, Dr. Jain hopes to motivate her students to develop a ”bigger picture” view of their scientific research. Students are initially exposed to two-three different ongoing scientific research projects.

“By collaborating with theorists in IMS and in Los Alamos National Lab, we have recently started our efforts to understand the experimentally observed properties of materials and creating a data base that could lead to the identification of stable materials with preferred set of properties and prediction of the characteristics of the new materials,” Dr. Jain says, “I want my students to get a broader perspective of their scientific research and related technology, something that will help them in choosing their future career paths.”

Versatility of solution technique to grow functional materials

Precursor solution

Adjust viscosity
Spin-coat to make thin films or heterostructures
Dip coat to make nanorods
Dry and thermal treatment

Draw fibers

Nanoparticles
Ceramics
Institute of Materials Science  |  2015

Dr. Yang Cao, director of the University of Connecticut Electrical Insulation Research Center and Associate Professor of Electrical and Computer Engineering, applies his passion for electrical engineering to his ambitious lab group objectives.

“IMS houses organizations for interdisciplinary research, which makes it a very interesting and unique place,” Dr. Cao says. “Within the IMS program, students have the opportunity to work in a centralized research facility while building up their curriculum, taking courses from different departments, and getting exposed to a wide variety of research projects.”

After receiving his Ph.D. from UConn in 2002, Dr. Cao was hired as a Senior Electrical Engineer in the Power and Materials divisions at the General Electric (GE) Global Research Center. “My training and research at IMS got me well prepared for my research at GE on electromagnetic field interactions with materials and devices, high voltage engineering for power, and medical devices.” At GE, he has received many awards for excellence in innovation, including the 2013 GE Global Research Technical Career Award.

“I rejoined UConn at an exciting moment, as UConn is emerging as one of the nation’s leading institutes in Micro-Grid research for efficient distributed power generation and renewable integration,” Dr. Cao says. “What we are doing is not only fun, but also a critical enabler for carbon neutral future.” For example, with the newly developed pulsed-electroacoustic apparatus, one can now “hear” the acoustic emission of electric charges within a dielectric material excited by nanosecond high voltage pulses and derive the information of charge distribution and dynamics. Surprisingly, packet-type charge transport was observed above certain threshold field. This interesting mode of carrier transport is actually indicative of the onset of charge injection instability. More understanding of such underlying physics holds the promise of transformative technology for future power industry.

With a “healthy combination” of programs supported by the Department of Energy, the Department of Defense and industries like Exxon-Mobil, Dr. Cao’s research group designs and tailors material properties for field effect based devices.

“We’re still centered in high electrical field phenomena as an enabler for energy efficiency. It’s our focal area,” Dr. Cao says. “Our fundamental research gives us very clear paths to develop engineering based on those technologies.” “Same principle applies at device level and field effect devices based on quasi-permanent polarization can be developed into wearable sensors for health monitoring,” adds Dr. Cao.

With UConn being at the forefront of developing clean, alternative sources of renewable energy, Dr. Cao says that the UConn Storrs campus is an excellent example of combined heat and power that enables efficiency for power generation.

The UConn Depot Campus, which physically houses a number of research centers including the Center for Connecticut Clean Energy, is also
used as an experimental test lab for new developments, such as the CT Department of Energy and Environmental Protection (DEEP) funded Microgrid demonstration project.

Dr. Cao expects that his students’ exposure to conducting cutting-edge energy research will prepare them for future scientific challenges. “Solving a big problem based on fundamental understanding is essential for students to experience,” Dr. Cao says. “It’s a fulfilling feeling to solve a big engineering problem.”

One of Dr. Cao’s latest professional undertakings, a combined effort with GE and the Department of Energy, is the development of a electrification solution for subsea O&G. Inspired by Europe’s ambitiousness in regards to renewable energy resources, Dr. Cao is eager to develop next generation, high-voltage direct current (HVDC) power transmission technology.

“I would like to do more thorough fundamental research and bridge it to engineering,” Dr. Cao says. “Direct current power transmission was born in the United States and fully developed in Europe, and I hope we will regain the lead with game-changing technologies.”


The symposium was a result of a 2011 visit by IMS faculty to Fudan University, which also included a joint symposium. Five IMS faculty members (Douglas Adamson, Fotios Papadimitrakopoulos, Richard Parnas, Thomas Seery, and Yao Lin) traveled to Fudan University to establish a partnership with the university, one of China’s top materials science and polymer research universities and a fellow member of Universitas 21. Yao Lin, an alumnus of Fudan University, and Tom Seery taught a summer short course at Fudan in 2014. IMS and Fudan’s Macromolecular Science Department will sign an agreement on a summer student exchange program in 2015.

The symposium was made possible through the generous support of the Institute of Materials Science, the School of Engineering, CLAS, and the Office of Global Affairs.
A research team led by Dr. Pu-Xian Gao, Associate Professor of Materials Science and Engineering (MSE) at the Institute of Materials Science (IMS), has been awarded a $1.45 million grant from the Department of Energy (DOE) for their project: Metal Oxide Nano-Array Catalysts for Low Temperature Diesel Oxidation. This two-year project, a part of the Vehicle Technologies Incubator program at the DOE, intends to improve the U.S. transportation energy efficiency and fuel economy in the short term and focuses on the formulation and performance demonstration of a new type of nano-array based catalytic converters for fuel-efficient, low temperature diesel oxidation. Dr. Steven L. Suib, Professor of Chemistry at IMS, is one of four co-Principal Investigators in the project team that also includes leading researchers from Oak Ridge National Laboratory and industrial partners including Umicore and 3D Array Technology.

The patent pending, nano-array based catalytic converter technology was first envisioned by Dr. Gao back in 2007, when he won one of six Honda Initiation Grant Awards nationwide. Later, the technology was further developed by Dr. Gao and his research group through a sponsorship by the DOE for lean NOx emission control from 2009 to 2013. The current project will design and create a new nano-array catalyst formulation and assemble the catalyst system for practical performance demonstration. The research team attempts to utilize this high-risk, high-reward project to serve as a bridge to practical automotive industry application.

“This timely investment from the Department of Energy will provide a significant boost to push our nano-array based catalytic converter technology forward with a good recognition by the autocatalyst industry,” Dr. Gao says. “Our goal is simply to put this new catalytic converter technology on the autocatalyst technology map, so that it will enable the necessary catalyst activity needed at low temperatures for advanced fuel-efficient combustion and emission control.”

Dr. Gao considers the project to be a “natural extension” of his past research on metal oxide based nano-array catalysts, which was highlighted in the 18th Directions in Engine-Efficiency and Emission Research Conference in 2012.

“Back in 2012, we were able to successfully demonstrate that nanostructure arrays could be integrated within the commercially available honeycomb substrates used in catalytic converters,” Dr. Gao says. “Those unique and successful integrations showed good robustness and sustainabil-
The transportation energy is still globally dominated by fossil fuels, despite the encouraging progress of the electric car as a fashionable technology,” Dr. Gao says. “From a government perspective, improving gas mileage in transportation through implementing more efficient and cost-effective catalyst technologies would greatly enhance national energy efficiency and security. Meanwhile, reducing fossil fuel usage can be beneficial not only for the next generation automobile technologies, but for other energy technology purposes as well.”

Dr. Gao expects this project to provide new types of commercially viable catalytic converters to be used in the automobile industry.

“Overall, this technology has been in-the-making for seven years,” Dr. Gao says. “Besides the finished projects with Honda and DOE earlier, we started a Scalable Nanomanufacturing Project funded by the National Science Foundation last fall. This NSF project focuses on processing and manufacturing nano-array catalysts and exploring new nanomanufacturing sciences and technologies that can potentially become the instrumentation and mass production foundations toward commercially viable nanocatalyst industry processes and products. At the end of the day, we are really looking at this technology as something that could be a major breakthrough in the near future.”

Xiuling Lu Joins IMS

IMS welcomes faculty member Dr. Xiuling Lu. Dr. Lu is an assistant professor of pharmaceutics in the UConn School of Pharmacy. She received her Ph.D. in biochemical engineering from the Chinese Academy of Sciences in 2005. Prior to joining UConn in 2011, Dr. Lu was a research assistant professor at the University of North Carolina at Chapel Hill. Professor Lu’s research interests include nanoparticle-based drug delivery for the improvement of therapeutic indices of anti-cancer agents, image-guided drug delivery for optimizing cancer diagnosis and therapy, and neutron-activatable nanoparticles for radiation therapy. Dr. Lu principally focuses on multifunctional nanoparticle-based drug delivery systems using biocompatible materials, including polymers, lipids, and mesoporous silica. Utilizing the unique properties of these materials, Dr. Lu has developed tumor-specific nanocarriers for effective drug delivery and treatment monitored by non-invasive imaging.
**IMS RESEARCH AWARDS**


**Elena E Dormidontova**, *Curvature-Dependent Polymer Hydration in Biomaterials*, 9/15/2014-8/31/2017, $300,000.


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**Mu-Ping Nieh Received NSF EAGER Award**

Professor Mu-Ping Nieh (IMS/CBE/BME) has received an Early concept Grants for Exploratory Research (EAGER) from the National Science Foundation (NSF) for his research on “stringing” lipid-based nanoparticles with polymers. The award ($149,920) is granted for one and half years to study the spontaneous clustering of lipid-based nanoparticles which have the potential to serve as instrument-free, high-sensitivity biosensing materials for pathogen, cancer, virus, and toxin detections. Nieh’s group has shown that the antibody with a high specificity to E-coli pathogen (i.e., anti-E-coli antibody) can be decorated on the surface of the nanoparticles. This allows the visible clustering of nanoparticles around the targeted pathogen through the “stringing” process. The success of the project will lead to low-cost, on-site biosensing techniques.

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**A. Dongare Received NSF CAREER Award**

Assistant Professor Avinash Dongare (IMS/MSE) has been awarded the National Science Foundation’s Faculty Early Development Program CAREER Award for Mesoscale Modeling of Defect Structure Evolution in Metal Materials. This award, granted by the NSF Division of Civil, Mechanical & Manufacturing Innovation (CMMI), provides $500,000 to fund his research on “advanced computational mechanics for the virtual analysis of structural metallic material for the use in extreme environments”. Dongare’s study demonstrates the potential for quasi-coarse-grained dynamics (QCGD) to expand the capabilities of molecular dynamics (MD) simulations to model behavior of metallic materials at the mesoscales for a reduced number of representative atoms enabling the modelling of metallic materials at the mesoscale under extreme conditions.
C. V. Kumar Received NSF EAGER Award

Professor Kumar (IMS/CHEM) has received the National Science Foundation’s prestigious Early Concept Grants for Exploratory Research (EAGER) for the grant DNA Floor Boards.

The award provides $174,000 for two years to study how DNA and proteins are self-assembled into macroscopic structures that are otherwise not found in nature. The proteins are chemically modified in Kumar’s lab in a special way and these bind to DNA helices to form hierarchical structures. The unique feature of these assemblies is that they are organized from nanometer to millimeter length scales (picture shown to the right, below). These self-assembled structures are being tailored to construct efficient, biodegradable, DNA-based Solar Cells, and paper-based diagnostics. Funding is from the Division of Materials Research, Biomaterials program.

Kay Wille Received NSF CAREER Award

Assistant Professor Wille (IMS/CEE) has received the National Science Foundation’s prestigious Faculty Early Career Development (CAREER) grant. The award provides $500,000 for 5 years to study the behavior and properties of nano-sized particles in cement-based materials. The central hypothesis is that enhancing the chemical bond energy between polymer and nanoparticle (<100 nm) in addition to improving the stabilization forces between polymer-particle units in cement-based matrix, will lead to better dispersion quality and densification of the matrix. The proposed research is subdivided into five interconnected research aims: 1) constituents characterization, 2) polymer synthesis and characterization, 3) particle-polymer interfacial interactions, 4) nanoparticle stabilization and 5) concrete density assessment (see figure below). Funding is provided by the Division of Civil, Mechanical, & Manufacturing Innovation (CMMI).

Anson W. K. Ma, BMI Resin Project - Phase II, GKN, 1/1/2015-5/7/2015, $49,000.


Steven L Suib, Porous Solid Electrolytes for Advanced Lithium Ion Batteries, 8/13/2014-8/12/2016, $360,000.


Steven L Suib, Ceramic Oxide Coating, General Electric Company, 1/1/2014-6/30/2015, $100,000.

Luyi Sun, Environmentally Friendly Flame Retardants Based on Inorganic Nanosheets, 9/1/2014-8/31/2015, $15,000.

UConn’s Dr. Cato T. Laurencin, a renowned surgeon-scientist, has won a National Institutes of Health Pioneer Award for his exceptionally creative research in regenerative engineering.

The $4 million grant is part of the NIH’s program for high-risk research with potentially high rewards. It will support his cutting-edge work in regenerative engineering, a new field he has described in the journal Science Translational Medicine.

The NIH Director’s Pioneer Award recognizes an exclusive class of individual scientists whose work is deemed exceptionally creative, highly innovative, and to have the potential to produce “unusually high impact” in addressing or solving “exceptionally important problems” in biomedical or behavioral sciences. In the 11-year history of the Pioneer Award, relatively few recipients are also practicing physicians who take research findings from the lab to the bedside.

Laurencin is internationally known for developing revolutionary new ways to treat musculoskeletal injury. Last year, a bioengineered matrix he invented to regenerate ligament tissue inside the knee, began clinical trials in Europe. Today he is working to bring new technologies involving regenerative engineering to regenerate entire joints and perhaps someday entire limbs.

“If successful, this project will help usher in this new era of what we call regenerative engineering, providing revolutionary clinical solutions to millions,” Laurencin says. “Developing a new therapeutic strategy for the regeneration of complex musculoskeletal tissues and joints will revolutionize the way musculoskeletal tissue injury and wear is treated, tremendously improving the quality of lives of patients.”

Laurencin notes that his team’s work is particularly inspired by the sacrifices made by members of the country’s military who are wounded. “We hope to find solutions to be of assistance to these heroes,” he says.

Dr. Francis S. Collins, director of NIH, says, “Supporting innovative investigators with the potential to transform scientific fields is a critical element of our mission. This program allows researchers to propose highly creative research projects across a broad range of biomedical and behavioral research areas that involve inherent risk but have the potential to lead to dramatic breakthroughs.”

Laurencin notes that his team’s work is particularly inspired by the sacrifices made by members of the country’s military who are wounded. “We hope to find solutions to be of assistance to these heroes,” he says.

Laurencin is the Albert and Wilda Van Dusen Chair in Academic Medicine, founding director of UConn Health’s Institute for Regenerative Engineering, and founding director of the Raymond and Beverly Sackler Center for Biomedical, Biological, Physical, and Engineering Sciences at UConn Health. A tenured professor in UConn’s chemical engineering, materials engineering, and biomedical engineering departments, he also is the eighth faculty member in UConn’s 130-year history to hold the distinguished title of University Professor.

Laurencin, the first UConn researcher to win an NIH Pioneer Award, is an elected member of the prestigious Institute of Medicine of the National Academy of Sciences and has been named to America’s Top Doctors. In engineering, he is an elected member of the National Academy of Engineering, and was named one of the 100 Engineers of the Modern Era by the American Institute of Chemical Engineers at its Centennial Celebration.

Awarded the Presidential Faculty Fellow Award by President Bill Clinton and the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring from President Barack Obama, Laurencin’s work has been highlighted by National Geographic Magazine in its “100 Discoveries That Changed Our World” edition. Laurencin received his BSE. in chemical engineering from Princeton University, his MD magna cum laude from the Harvard Medical School, and his Ph.D. in biochemical engineering/biotechnology from the Massachusetts Institute of Technology.

Chris DeFrancesco for UConn Today)
Yao Lin Awarded Humboldt Research Fellowship for Experienced Researchers by the Alexander von Humboldt Foundation

Dr. Yao Lin, Associate Professor of the Chemistry Department and Polymer Program at the Institute of Materials Science, has been awarded a Humboldt Research Fellowship for Experienced Researchers by the Alexander von Humboldt Foundation. Named after the famed German biologist, explorer, and naturalist Alexander von Humboldt, the award enables extraordinary scientists and scholars from across the globe to spend an extended period of time in Germany working on research of their choosing.

Through the fellowship program, more than 700 awards are offered annually to support scientists in their research endeavors. Dr. Lin will work for the next three summers with Professor Dr. Alexander Böker, his long-time collaborator, at RWTH Aachen University in Germany.

Controlling polymer architecture and topology creates exciting opportunities for discovering new macromolecular structures and properties. Riveted by the unique structures and functions of protein channels in nature, Dr. Yao Lin proposes to develop polypeptide-grafted cyclic polymers for the generation of well-controlled, channel-like macromolecular nanostructures.

Dr. Lin’s research places emphases on applying biological concepts to synthetic macromolecules for material applications. Through the synthesis of polypeptide-grafted cyclic comb polymers, Dr. Lin designs hybrid macromolecules with complex architectures and well-defined topological structures. The polymers developed in this study can be used to extend the group’s current understanding of the critical roles of macromolecular channels in fluid transport, molecular selectivity and reactivity, which may ultimately lead to new materials capable of decontaminating specific hazardous molecules.

“The remarkable functions and physical properties of nanostructures from biological macromolecules has long inspired scientists to create synthetic systems that work with similar precision and efficiency,” Dr. Lin says. “Practical design of biologically inspired synthetic materials has emerged at the interface of polymer science, chemistry, and biology. The growth of polymer research at this interface provides both challenges and opportunities to educate students and inspire them to pursue careers in science and engineering.”

Before joining the UConn in 2008, Dr. Lin received his Ph.D. in Polymer Science and Engineering from the University of Massachusetts, Amherst in 2005. He completed a George W. Beadle post-doctoral fellowship in bioscience and chemistry at the Argonne National Laboratory and the University of Chicago.

Paper Co-Authored by Anson Ma is Recognized by South Texas Section of AIChE

The paper entitled *Strong, Light, Multifunctional Fibers of Carbon Nanotubes with Ultrahigh Connectivity*, has been recognized by the South Texas Section of the American Institute of Chemical Engineers as “2013 Best Applied Paper”. The paper was published in the journal *Science* in January 2013.
James Rusling Honored by International Society of Electrochemistry

Dr. James Rusling (IMS/CHEM) has been awarded the Bioelectrochemistry Prize of ISE Division 2. This is in recognition of his research on thin biosystems for bioelectrochemical applications, direct electron transfer with proteins, bioelectrochemical catalysis, and detection of cancer biomarkers. The prize was created to award “a scientist who has made an important contribution to the field of bioelectrochemistry.”

The prize consists of a certificate and the sum of 750 Euro, about $1000. The announcement of the prize was made officially at the 2014 Annual ISE Meeting in Lausanne, Switzerland. ISE will present the award at the 2015 Annual Meeting in Taipei where Dr. Rusling will give a lecture on his research.

IMS Celebrates Arthur McEvily’s 90th Birthday

On December 19th, IMS celebrated Professor Emeritus Dr. Arthur McEvily’s 90th birthday.

Dr. McEvily is recognized across the globe as a leading authority on fatigue and fracture of metals and alloys. After receiving his doctorate from Columbia University in 1959, Dr. McEvily worked as an Aeronautical Research Scientist at NASA in Langley, Virginia and later served as head of the solid state physics division. He then worked as a research scientist at Ford Motor Company for six years before joining UConn as head of the Department of Metallurgy from 1967-1978.

He is the recipient of many awards, distinctions, and fellowships, including the Nadai Medal from the American Society of Mechanical Engineers (ASME), the Egleston Medal from Columbia University, and the Henry Marion Howe medal from the American Society for Metals (ASM). In 2009, Dr. McEvily was named a fellow of the International Congress on Fracture (ICF) in recognition of his contributions to the understanding of fatigue mechanisms and processes in structural alloys. He has authored or co-authored more than 240 papers and two books, including the textbook *Metal Failures: Mechanisms, Analysis, Prevention*. 

Arthur McEvily
“When you walk through this campus, it’s incredibly energizing—it’s knowledge, its passion, its innovation, its fun and laughter. The learning, the expertise, and what’s going on here is amazing. And yet, if it doesn’t get to you and me, it’s really just research. But when industry gets involved, then it becomes something we can all share. The event was designed to build bridges between local industry leaders and UConn, thus fostering collaborations to help businesses innovate, improve, reduce costs, and flourish.”

-Deb Santy

On November 5, 2014, faculty from Engineering and the Institute of Materials Science welcomed industry representatives and prospective research partners to the UConn School of Engineering’s second annual Industry Open House. Co-sponsored by the Institute of Materials Science, the U.S. Department of Commerce and Connecticut Innovations, and the Office of the Vice President for Research and Technology Acceleration Partners, the event attracted representatives from a diversity of companies specialized in defense, energy, chemical, biomedical devices, and other industry sectors.

The event featured more than seventy interactive posters detailing commercially promising UConn research, ten-minute-long “speed dates” with faculty and student researchers, and informal networking opportunities. The research showcased multiple disciplines, including advanced manufacturing, biomedical, chemical engineering, energy, environment, education and economic development, high performance computer (cyber security and big data), materials, mechanics, nanotechnology, robotics, sensing and communication, and structures and transport. The open house offered many opportunities for attendees and participants to learn about new technological developments underway in UConn laboratories and to discuss the benefits of partnership and collaboration.

Dr. Rainer Hebert, Associate Professor of MSE and Director of the Additive Manufacturing Innovation Center, was a popular “speed dating” faculty member, participating in fourteen one-on-one meetings. He reflects that meetings with industry representatives provide educational opportunities regarding new technological applications and the opportunity to revitalize old collaborations for future partnerships.

Sahil Vora, a Chemical Engineering Ph.D. candidate in Dr. Anson Ma’s research group, enjoyed forging connections with prospective industry partners and discussing his group’s research. “Since industry requires a lot of researchers, we can provide them with a better idea of what applications should be targeted,” Vora says.

Dr. Seok-Woo Lee, Pratt & Whitney Assistant Professor in the Department of Materials Science and Engineering, notes that partnerships between UConn researchers and industry professionals significantly deepens industry’s understanding of the materials they use, which can lead to the creation of better products. Additionally, areas of common interest between academia and industry may give way to exciting new research avenues. Dr. Lee states, “In talking with others at this conference, our discussions could lead to the discovery of an innovative area that could become my research focus in the future… it’s a win-win situation.”

(Adapted from Momentum, SoE)
This two-day short course provides an introduction to polymers. The objective is to provide the attendees with an understanding of the basic relationships between polymer synthesis, structure, and properties. The course will cover chain, step, and metal-catalyzed syntheses, and manufacturing of both conventional and new polymers, their structures, their properties, their processing, and their applications. We will discuss key aspects of polymer structure including molecular weight, chain, stiffness, and configuration, branching of the chains, and crosslinking. The influence of these variables on the physical states of the polymer will then be explored. We will delve into the rheological, viscoelastic, and mechanical properties of neat polymers, as well as their blends and composites, including nanocomposites. Useful concepts such as glass transition, time-temperature superposition, and gelation will also be introduced.

Instructors:
Rajeswari M. Kasi, Ph.D. and Anson W. K. Ma, Ph.D.

About the Instructors
Rajeswari M. Kasi, Ph.D.
Associate Professor of Chemistry and member of Polymer Program, IMS

Dr. Kasi received a M.Sc. in chemistry from the Indian Institute of Technology, Madras, India and a Ph.D. in polymer science and engineering from the University of Massachusetts, Amherst in 2004. She was a postdoctoral fellow in the Department of Chemistry from 2004 – 2006. In 2006, she joined the faculty of Chemistry and Polymer program. Her research interests involve synthesis-structure-property relationships of soft materials, including liquid crystalline polymers, block copolymers, polymer nanocomposites, and macromolecules-polymer conjugates for photonic, sensing, biomedical, and energy applications.
This two or three day short course will provide an overview of additive manufacturing of both metals and polymers. The objective is to provide the attendees with an understanding of the potential value of this new technology. On the metal side, the course will provide an overview of manufacturing technologies and equipment for powders, beam-powder interactions, powder bed heating, solidification, and post-processing. The advantages and disadvantages of laser- and electron-beam technologies will be discussed along with support structures, software for support structure, design, and layout of parts in build volumes. Manufacturing aspects such as tolerances, repeatability, and powder removal will be covered along as case studies involving mini-blisk and foils. Attendees will tour UConn’s Additive Manufacturing Center. On the soft material side, we will provide an overview of additive manufacturing methods such as inkjet printing, fused deposition modeling (FDM), selective laser sintering (SLS), stereolithography (SLA), and bio-printing. Basic material requirements such as rheology and surface tension, will be discussed along with a variety of application examples. Attendees will get to see some of UConn’s current soft material capabilities in action.

Instructors: Rainer Hebert, Ph.D. and Anson W. K. Ma, Ph.D.

Anson W. K. Ma, Ph.D.
Assistant Professor of Chemical Engineering, and member of Polymer Program, IMS
Dr. Ma is a faculty member of both the Polymer Program and Chemical Engineering Program at the University of Connecticut. He obtained his Ph.D. degree from the University of Cambridge, United Kingdom and his postdoctoral training from Rice University, where he was named the J. Evans Attwell-Welch Fellow. Dr. Ma’s research at UConn focuses on improving the reliability and resolution of inkjet and 3D printing technologies. He received an NSF CAREER award from the US National Science Foundation (NSF) in 2013 and a Distinguished Young Rheologist Award from TA Instruments in 2012.

Rainer Hebert, Ph.D.
Associate Professor of Materials Science & Engineering, Director for Undergraduate Studies, and Director of UConn’s Additive Manufacturing Innovation Center
Dr. Hebert is a faculty member in the Department of Materials Science and Engineering. He also serves as director of the Additive Manufacturing Innovation Center. He holds a Ph.D. in Materials Science and Engineering from the University of Wisconsin-Madison and has research interest mainly in the area of rapid solidification. He has been involved in additive manufacturing for about two and a half years, including a 10-month sabbatical in Pratt & Whitney’s additive manufacturing group.
IMS is home to the Complex Fluids Laboratory. It features state-of-the-art tools for conducting rheological and surface-science studies that are vital to quality control and process innovation. It also contains a variety of polymer processing equipment for solution-, melt-, and reaction-based processing.

The lab is equipped with two stress-controlled rheometers (Paar Physica & AR-G2) and one strain-controlled rheometer (ARES). The Paar Physica unit has a temperature range of −180 °C to 200 °C and is ideal for characterizing liquids and soft materials. The temperature ranges of ARES and AR-G2 units are −120 °C to 600 °C and −40 °C to 200 °C, respectively. Collectively, the three are able to perform both simple shear and more complex oscillatory measurements on a wide range of complex fluids such as particle suspensions, emulsions, polymer melts, and thermosets.

The lab is also furnished with latest tools for creating microfluidic and lap-on-a-chip devices for applications such as particle separation and drug screening. Thermal and shear stages (Linkam) are available to study the effect of flow on the optical texture of structured fluids like suspensions and liquid crystals for temperature as low as −196 °C and up to 600 °C. Our inkjet printing development platform utilizes stroboscopic imaging techniques to evaluate the jettability of fluids and identify appropriate jetting conditions for optimal precision and performance. Such capabilities enable comparative studies to evaluate sample lot variations for quality control as well as quick screening of different formulations for new product development. More advanced measurement techniques can also be used to monitor the kinetics for chemical cross-linking and physical gelation processes.

For surface science measurements, CFL is equipped with a DataPhysics tensiometer (OCA20) and a Langmuir trough (KSV-NIMA). The tensiometer can be used to characterize the surface tension for gas-liquid and liquid-liquid systems as well as the wettability of liquids on a flat or curved substrate. The latter is especially important for evaluating the critical surface energies of solids – the key to understand and solve (de)wetting and adhesion problems. Additionally, we have specialized interfacial rheology tools and methods to quantify the mechanical integrity of surfactant- or particle-laden interfaces, which is critical to understanding the stability of emulsions and foams that are widely used in pharmaceutical, agricultural, gas and oil, and personal care industries.

In the development of new materials, a reduction in ‘time-to-market’ can present a distinct competitive advantage. Quick, simplistic, and early assessment of a material’s characteristics for the determination of mechanical and rheological
properties can provide essential information to accelerate the conception of a final product. For this, the lab contains a Thermo Scientific HAAKE MiniLab. This is a miniature conical, twin-screw compounder with an integrated backflow channel which is perfect for development of new formulations and testing of new additives. When operating with 100% backflow, it becomes a batch mixer with a well-defined residence time making it possible to monitor reactive extrusion melts.

Slightly larger volume batches can be prepared using the lab’s Brabender. This unit has a maximum temperature of 400 °C, speed of 100 rpm, and 30-mL, 60-mL and 650-mL capacity heads. It also has interchangeable mixing blades. The roller blades are typically used with molten thermoplastics as they create intensive mixing and impose a strong kneading force. The tumbling-kneading action of the sigma blades is used for mixing dry powders and solid-liquid systems. The cam blades impose a medium shear rate and provide a combination of milling, mixing, and shearing that is useful for the processing of elastomers.

A bench-top twin-screw extruder, the Thermo-Scientific-Prism-TSE-16-TC, is also available for research and development or small-scale production. It has a maximum speed of 500 rpm. It contains pre-mixers, chill rolls, strand pelleting lines, and an air-cooled face-cut system. Its barrel has additional ports for feeding solids/liquids and for venting.

In addition, Carver Press is available for compression molding resins into sheets. This unit has a maximum temperature of 300 °C and force of 295 kN. A small ram injection-molding system, a HAAKE MiniJet, provides a means to compression mold small tensile bars from limited samples size (~ 5g). This unit has a maximum injection pressure of 1,200 bar and maximum mold and cylinder temperatures of 250 °C and 400 °C, respectively.

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**Spectroscopy & Gas Chromatography Laboratory (IMS 314)**

When it comes to Fourier transform infrared spectroscopy (FTIR), Raman Spectroscopy, and Gas Chromatography/Mass Spectrometry (GC/MS), IMS lab manager Gary Lavigne is the go-to person for sample preparation and analysis, instrument operation and maintenance, and student training. This lab is frequently called upon to assist the IMS Industrial Affiliate Program.

The lab contains two Fourier transform infrared spectrometers (FTIR); both are outfitted with an optical bench and an infrared microscope. When faced with an unknown, this is typically the first stop. The frequency at which energy is absorbed is characteristic of a particular chemical functional group, thus the infrared spectrum represents a “fingerprint” of sorts. Often the general chemistry of an unknown can be narrowed down with a library search in which the spectrum for the sample is compared with our library of over 230,000 known spectra. FTIR spectra of inorganic fillers typically show only a few broad bands thus making identification tenuous. When present, the identification of inorganics is generally confirmed by another analytical technique. In addition to compositional analysis, FTIR is also commonly used to monitor changes (i.e. chemical reaction, weathering, chemical compatibility, etc.) and for failure analysis.

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Unknown 5 micron particle on amorphous carbon.
An assortment of modes are available: Attenuated Total Reflection (ATR), Grazing angle, Diffused Reflection, and Photoacoustics. ATR and Grazing angle are both used for surface characterization with the former being used to characterize the top 1-2 microns and the latter to monitor monomolecular layers deposited on reflective surfaces. Diffuse reflection is used to characterize powder surfaces. Photoacoustics spectroscopy (PAS) monitors changes in temperature, pressure, or density induced by the absorption of incident infrared radiation. It is used to characterize opaque samples such as carbon-black filled elastomers.

This lab also contains a micro Raman spectrometer with four laser frequencies (488, 514, 633 and 785 nm) and a research grade microscope. The latter provides 1 micron spatial resolution. Raman is particularly sensitive to carbon-carbon bonds or polyene sequences and is used to differentiate between carbon structures such as graphite, carbon nanotube, diamond-like carbon, and glassy carbon. Raman is a photon scattering technique thus it is only possible to collect subsurface data if the material is optically transparent at the incident laser frequency. Identification of the latter generally requires analysis of suspects as our Raman library contains approximately 5,000 spectra, thus it is quite small relative to the Infrared library.

The lab contains two gas chromatography-mass spectrometers (GC/MS). Gas chromatography uses boiling point to separate lower molecular weight compounds. Fractionated volatiles are subsequently characterized by mass spectroscopy and identified by a library search. Our MS library contains over 276,000 known spectra. This technique is extremely sensitive thus permitting trace analysis. One system is set up to handle liquid or dissolved samples and is commonly used for the monitoring of reactions and extractions. The second system is set up to handle solids and is equipped with syringeless injection or pyrolysis injection devices. The former is a unique thermal desorption device developed by G. Lavinge at IMS to allow direct injection of organic or inorganic material without solvents. It is frequently used to characterize and identify the source of odors, surface contaminant, polymer additives, and for the forensic analysis of defects. The pyrolysis injection device heats the sample to temperatures up to 1000°C to allow characterization of thermal breakdown products. This can be used to identify the presence of certain polymers or additives.

Besides the common “what is this?” request, Gary notes many industry requests focus upon questions like “why did it fail in service or during quality control testing?” “This may be due to a formulation error during compounding, like missing a key ingredient or adding too much of one compound, which can degrade the performance of the materials,” he notes. “Another source is the incomplete reaction of compounds possibly due to reduced cure time or temperature.”

For example, samples of product made from the same raw materials but produced on a new manufacturing line were submitted to understand why they kept failing quality control. “Because of Infrared analysis, we determined that the new press was over-curing the samples,” Gary says. Subsequent samples were used to correlate degree of cure to specific settings on the new manufacturing line.

In another example, toys that fused together during shipping were submitted for analysis. GC-MS analysis of their polymer coating showed the coating solvent had not evaporated completely prior to packing. Once packed, this residual solvent off-gassed, causing the outer coating of the toys within to soften then stick together in one large clump.
### IMS Distinguished Lecture
(2/16/2015, 4:00 p.m. in room IMS 20)

**Dr. Roald Hoffmann**  
Nobel Laureate in Chemistry, Cornell University  
*The Chemical Imagination at Work in Very Tight Places*

### IMS Polymer Program Spring Seminars 2015
(11:00 a.m. in room IMS 20)

**2/6/2015:** Bioinspired Synthesis of Organic Nanomaterials: From Supramolecular Helix to Two-dimensional Polymer; Dr. Qianli ‘Rick’ Chu, Assistant Professor, Chemistry, University of North Dakota

**2/13/2015:** Folding Gels and Shells: Designing Reconfigurable 3D Shapes and Mechanical Meta-Materials  
Dr. Ryan Hayward, Department of Polymer Science and Engineering, University of Massachusetts, Amherst

**2/27/2015:** Bulk Nanostructured Materials: Fundamentals and Applications; Professor Brian Wardle, Massachusetts Institute of Technology

**3/6/2015:** Ultra-low Wear Fluoropolymer Composites: It’s All about Tribotechnology; Dr. Christopher Junk, DuPont Central Research & Development

**4/3/2015:** Light-Tunable Fluids, Self-Propelling Microcapsules and Hemostatic Polymers: New Forms of Soft Matter with Unique Properties; Dr. Srinivasa Raghavan, Professor and Associate Chair and Director of Graduate Studies, Department of Chemical & Biomolecular Engineering, University of Maryland

**4/10/2015:** Polymer Nanocomposites: Bimodal and Block Copolymer Grafted Brushes to Control Functionality; Dr. Linda Schadler, Russell Sage Professor in Materials Science and Engineering & Associate Dean of Academic Affairs in the School of Engineering, Rensselaer Polytechnic Institute

**4/17/2015:** Direct Patterning of Arbitrary Metal Oxide Nanostructures Using Polymer Template Nanoreactors; Dr. Chang-Yong Nam, Staff Scientist, Center for Functional Nanomaterials, Brookhaven National Laboratory

**4/24/2015:** Designing Metallic Nanolayered Composites for High Strength and Damage Tolerance; Dr. Amit Misra, Professor and Chair, Department of Materials Science and Engineering, University of Michigan

**5/1/2015:** Engineering Immunity Using Synthetic Materials; Dr. Darrell Irvine, Professor of Materials Science & Engineering and Biological Engineering, Massachusetts Institute of Technology

### Materials Science & Engineering Spring Seminars 2015
(9:05 a.m. in room IMS 20)

**1/30/2015:** Novel Porous Metal Oxides and Sulfides and Their Applications in Adsorption, Batteries, and Catalysis  
Dr. Steven L. Suib, Director, IMS, Professor of Chemistry, Board of Trustees Distinguished Professor, UConn

**2/6/2015:** TBA  
Kathy Saint, President Schwerdtle Stamp Company

**2/13/2015:** Thermal Transport in Low-Dimensional Materials  
Dr. Michael Pettes, Assistant Professor, Department of Mechanical Engineering, UConn

**2/20/2015:** Neutron Scattering for the Characterization of Engineering Materials  
Dr. E. Andrew Payzant, Engineering Materials Group Leader, Chemical and Engineering Materials Division Neutron Sciences Directorate, Oak Ridge National Laboratory

**4/17/2015:** Field Assisted Z Orientation of Functional Films Using a Continuous Roll to Roll Process  
Dr. Mükrerem Cakmak, Harold A. Morton Chair, Distinguished Professor; Director, Center for Multifunctional Polymer Nanomaterials & Devices, University of Akron

**5/1/2015:** Engineering Immunity Using Synthetic Materials; Dr. Darrell Irvine, Professor of Materials Science & Engineering and Biological Engineering, Massachusetts Institute of Technology
The IMS External Advisory Board (EAB) helps to focus the efforts of IMS in areas of teaching, service, and research. The EAB is made up of world-wide experts in the area of materials science and consists of members from governmental and industrial labs. The Board meets twice a year to provide advice and help in long-range planning.
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Dr. Cato T. Laurencin

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Dr. Kelly A. Burke
Dr. Cato T. Laurencin
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Dr. Barrett O. Wells

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IMS resident faculty are indicated in bold
MEET THE STAFF

**Kimberly Post** is the Administrative Assistant to the Director of IMS, Dr. Steven Suib. She joined the department in March 1988 after years of working for the Connecticut Department of Education (DOE) and the Department of Environmental Protection (DEP). Kim has witnessed extensive changes in technology since arriving at the University. She has had the opportunity of working with all four IMS Directors including the founding director of IMS, Dr. Leonid Azaroff. There are a number of faculty and staff members who have worked in IMS for decades and Kim has cherished the team’s evolution throughout the years. She functions as a Human Resources/Labor Relations/Payroll liaison and as an intermediary for all other programs and departments throughout the University. Outside of work, Kim is an active member of the American Legion Auxiliary, an organization she became involved in when her son, Michael, joined the Army. She lives in Stafford, Connecticut and finds the most joy when spending time with her two grandchildren, ages one and four.

**Maria Mejias** is the Administrative Assistant to the IMS Associate Director, Dr. Mark Aindow. She was born in Puerto Rico and moved to the United States with her family at the age of seven. Following her high school graduation, she earned a Word Processing Certificate and attended Quinebaug Valley Community College. Maria worked as an English-to-Spanish translator in the legal arena before starting her career at UConn’s School of Nursing in 1992. She transferred to the Institute of Materials Science in 1997 and currently has primary responsibility of a full range of administrative support activities for IMS. She is responsible for the day-to-day operations of the IMS support unit (i.e. guiding visitors, manning telephone, etc.) and provides assistance to faculty and graduate students on a daily basis. Maria’s healthy lifestyle is filled with strength training, kickboxing classes, and Zumba. She is devoted to spending time with her husband, daughters, and grandson.

**Rhonda Ward** is the Administrative Assistant for the IMS Industrial Affiliates Program and also provides support for the IMS Central Office. A native of Ohio, Rhonda enjoyed a diverse career before joining IMS in 2010. In support of IMS, she established the weekly IMS News and produced the first IMS Newsletter. Among her duties as assistant to the Industrial Affiliates Program, Rhonda assists in building the bridge of communication with industry partners and arranges the IAP annual meetings and short courses. Outside of work, Rhonda’s passion lies in poetry. She arranges poetry events in her community and has shared her poetry at England’s International Women’s Art Festival and numerous venues throughout New England. She has traveled to Greece to read her poems and has written articles for Pfizer Worldwide in Paris. Rhonda is looking forward to attending a prestigious writer’s retreat in Bulgaria during the fall of 2015.
Student Seminar Series Gives Students Exposure to Career Development Skills and Connections in Industry

The Polymer Program, an interdisciplinary advanced graduate program within the Institute of Materials Science, consists of over 450 alumni, 80-90% of them with jobs in industry.

In an effort to form connections between students of the past and present and to assist current students in their career planning, the program, together with the Society of Plastics Engineers (SPE) UConn student chapter, now features alumni guest speakers in the Polymer Student Seminar Series. The student seminar series has been running for over 20 years, but until recently the presenters were primarily IMS students. For the past few years, students from other universities such as Massachusetts Institute of Technology (MIT), Yale University, and the University of Massachusetts, Amherst have been invited to present. The current SPE student leadership expanded the student seminar series in 2014 to include alumni and industrial speakers. The expanded program is partially sponsored by SPE’s Engineering Properties and Structure Division (EPS-div) as per arrangement by the UConn SPE faculty advisor, Professor Luyi Sun.

Garrett Kraft, President of the UConn SPE Chapter, said that UConn students are interested in “fostering industry connection and creating opportunities to connect with professionals, expand their network, and hopefully lead to job opportunities after graduating.”

In the fall, the seminar series included two Polymer Program alumni who now work in industry. Dr. Matthew Burdzy and Dr. Gerald Ling were invited back to campus to discuss their careers and offer advice to current IMS students about working in industry.

Dr. Burdzy of Henkel Corporation, the series’ first alumni presenter, spoke about innovations at Henkel as well as preparing for a successful career in industry. When he decided to attend UConn to pursue his graduate studies in Polymer Science, Matt was already working at Henkel in Rocky Hill, Connecticut. He earned his Ph.D. under Dr. Chong Sook (Sooky) Sung in 2003 and is currently the Technical Director of Adhesive Technologies at...
Gerald Ling (Ph.D. Polymer Science, 2009)

Henkel, a leading manufacturing company that makes a variety of products including detergents and adhesives.

Dr. Ling of Saint-Gobain, another featured alumni guest speaker, earned his Ph.D. under Dr. Montgomery Shaw in 2009 and is currently R&D Manager, Global TPE & Process Systems of Satin-Gobain Performance Plastics in Northborough, Massachusetts. In his talk *A millenial in corporate R&D* he shared his experience of navigating the corporate world while trying to carve out a personal niche. He said that the process is often challenging, especially when trying to develop a sense of belonging in a large corporation with a constantly changing environment. Gerald’s presentation also included essential non-technical skill sets, practical tips on job search, resume preparations, and interview skills.

Attracting over 40 students to each of their presentations, the alumni speakers were very engaging and their talks were well-received by those in attendance.

“The presenters talk about their own experiences, not something from a book,” said Young-Hee Chudy, Polymer Program Administrative Assistant, who helps connect and coordinate the alumni-student seminar series. “We are trying to make students realize how important other skills and personal contacts are, especially when they start looking for a job. The student seminar series could lead to students making connections with past UConn students who could help them find a job in the future.”

Students who attend the seminars are encouraged to follow up with the alumni speakers afterward.

“It is definitely a good idea to keep the line of communication open,” YoungHee said. “Recruiting has changed, especially with technology, but relationships and communication are still the most important factors.”

The series gives alumni the opportunity to renew their ties with the Polymer Program and IMS. They also meet with current faculty and learn about current research and activities.

“It’s a win-win for everyone involved,” YoungHee said. “It’s like going to a special career workshop, only it’s more personal and more direct.”

Alumni: If you are interested in presenting in the future series, please contact YoungHee (ychudy@ims.uconn.edu).

Materials Advantage Student Program offers students access to four prestigious materials science societies including the American Ceramic Society (ACerS), the Association for Iron & Steel Technology (AIST), ASM International, and the Minerals, Metals and Materials Society (TMS). Materials Advantage and the distinguished societies offer over $800,000 in scholarships and grants.

Materials Advantage student members make the most of their materials education through an impressive variety of outreach and professional development programs such as application writing workshops, resume critiques, and career panels. Members of the UConn chapter mentor K-12 future materials science engineers and host an annual banquet to promote networking and collaboration among IMS and MSE students, alumni, faculty, and industry professionals.

To find out how to join the Materials Advantage chapter at UConn, please visit http://ucma.engr.uconn.edu/.

Materials Research Society University Chapter

The Materials Research Society (MRS) is a group of over 16,000 researchers in the materials science industry. MRS grants members access to monthly publications and journal databases on the latest developments in the field. The MRS chapter at UConn supports, educates, and provides tremendous networking opportunities for graduate students in materials science and related disciplines. In the past, UConn MRS members have taken part in the ASM Materials Camp, traveled to New York for a tour of the Brookhaven National Laboratory and represented the university at the MRS Fall Meeting and Exhibit in Boston.

To learn more about becoming a member, please visit http://mrs.engr.uconn.edu/.
Society of Plastics Engineers Student Chapter

The Society of Plastics Engineers (SPE) works toward expanding industry connections while educating the public about plastic benefits and technology. The UConn chapter was founded at the Institute of Materials Science in 1981. It currently consists of 15 active graduate students and is beginning to incorporate undergraduate students. Members of the SPE UConn chapter have toured local industry plants and taught polymer lessons to K-12 students. They have also attended academic seminars such as the New England Young Scholar Exchange Program, the Polymer Program Seminar Series, and the SPE Student Seminar Series. To join the UConn chapter, please visit http://spe.engr.uconn.edu.

Alpha Sigma Mu Student Chapter

Alpha Sigma Mu (ASM) is an international honors society for materials science and engineering students. Established by the Metallurgical Department of the Michigan College of Mining and Technology in 1932, ASM is made up of over 40 chapters consisting of exceptional students, alumni, and professionals. Selection for student membership is a mark of highest distinction, based on scholastic standing, character, and leadership. To get involved, please visit http://alphasigmamu.engr.uconn.edu.

Materials Advantage Student Chapter

The Materials Advantage Student Program offers undergraduate and graduate students access to four prestigious materials science and engineering societies including the American Ceramic Society (ACerS), the Association for Iron & Steel Technology (AIST), ASM International, and the Minerals, Metals and Materials Society (TMS). Materials Advantage and the distinguished societies offer over $800,000 in scholarships and grants. Materials Advantage student members make the most of their materials education through an impressive variety of outreach and professional development programs such as application writing workshops, resume critiques, and career panels. Members of the UConn chapter mentor K-12 future materials science engineers and host an annual banquet to promote networking and collaboration among IMS and MSE students.

To find out how to join the Materials Advantage chapter at UConn, please visit http://ucma.engr.uconn.edu.

Keramos Student Chapter

Keramos, the National Professional Ceramic Engineering Fraternity, provides members with professional development skills within a ceramics research-based community and consists of twelve coed student chapters throughout the United States. The organization promotes scholarship and development to graduate and undergraduate ceramic engineering students. Sapna Gupta, a Materials Science and Engineering (MSE) graduate student, founded the UConn chapter during the 2013 Materials Science and Technology (MS&T ’13) conference in Montreal, Canada with the support of her team leaders and chapter advisor, Professor Prabhakar Singh. The UConn Keramos community creates a local network of peers, engineers, and scientists to discuss current research and developments in the field of materials science and ceramics at large. Members enhance leadership skills and learn effective methods for research presentations. To find out how to get involved, please visit http://keramos.uconn.edu.
UConn Keramos Chapter hosted a microscopy contest to both highlight the importance of this technique to materials science and illustrate diversity of research here in IMS. The micrographs were judged for technical and artistic merit by IMS & MSE professionals. Cash prizes: $100 first winner, $75 second winner, $50 third winner.
A. Sourav Biswas & David Kriz, “Brain in Jar” (1st prize)
B. Nicholas Legendre, “An Isolated and Regenerated Mouse Myofiber”
C. Yang Guo, “Stroboscopic Imaging of Jetting Behavior” (2nd prize)
D. Louis Gambino, “My Moon, My Sun”
E. Paiyz E. Mikael, “PLGA-MWCNTs Composite Scaffold for Bone Regeneration” (3rd prize)
F. Bahareh Deljoo, “Vagrant of Sea Urchins”
G. Linghan Ye, “BiFeO3 Domain via PFM”
H. Rishabh Jain, “Micro Bubble”
Alumnus Bin Li Joins University of Nevada, Reno as Assistant Professor

Dr. Bin Li, an alumnus of the University of Connecticut Materials Science and Engineering (MSE) program, joined the Department of Chemical and Materials Engineering at the University of Nevada, Reno (UNR) in July 2014 as Assistant Professor.

Bin Li graduated from Huazhong University of Science and Technology, in Wuhan, China in 1990. While here earning his master’s degree in physical metallurgy with Dr. Philip Clapp, Bin Li studied phase transformation and frictional behavior between metals using molecular dynamics simulations on the atomic scale. Following the completion of his master’s degree, Bin Li began his Ph.D. studies under the supervision of Dr. Harold Brody. With Brody’s group, he developed an advanced technique to visualize real-time dendrite growth in alloys using high energy X-Rays at Cornell High Energy Synchrotron Source (CHESS) and Argonne National Laboratory (ANL).

Bin Li joined Johns Hopkins University in 2006 for postdoctoral research sponsored by the U.S. Army Research Laboratory (ARL). Working alongside Dr. Ka-liat Ramesh and Dr. Evan Ma, Bin Li collaborated with researchers at ARL to study processing and mechanical properties of ultrafine grained (UFG) magnesium alloys at high strain rates. He combined molecular dynamics simulations and transmission electron microscopy to investigate the deformation mechanisms of magnesium alloys and other materials.

Bin Li received the Best Fundamental Research Award from The Minerals, Metals and Materials Society in 2013 and is internationally recognized for his research on deformation twinning in hexagonal close-packed (HCP) metals.

Recruited to UNR as part of the Advanced Manufacturing Program, Bin Li will continue his research in developing new magnesium alloys and other advanced materials by using integrated computational materials engineering (ICME), a technique that integrates simulations and modeling at different length scales. He will use advanced materials characterization techniques to validate simulations and modeling.

Alumnus Paul Dickinson, Director of Enterprise Sales NAR at Dura-Line

Dr. Paul Dickinson graduated from the Institute of Materials Science in 1990 with a Ph.D. in polymer science and recalls great memories of the time that he spent at the University of Connecticut. After working for 23 years with AT&T Bell Labs, Lucent Technologies, and OFS, he accepted a new position in November 2013 at Dura-Line Corporation as Director of Enterprise Sales NAR. With manufacturing facilities around the world, Dura-Line is a global manufacturer and distributor of communication and energy infrastructure products and systems. The company is acclaimed as an international leader in high-density polyethylene (HDPE) conduit and provides duct and pressure-pipe solutions for telecom and data communication. At work, Paul leads an air blown fiber structured cabling business for applications in the Enterprise space, including vertical markets such as healthcare, higher level education, government, and military. He resides in Johns Creek, Georgia with his wife, Linda, and their two University of Georgia students, Samuel and Bailey.
What did you study during your undergraduate career and how did it lead to your interest in pursuing a Ph.D. in Polymer Science?

I studied chemistry for three years followed by polymer science and technology for another three years in Calcutta, India. I liked learning about polymer science because of its vast application in the real world. I ended up working in a coating industry in Calcutta named Berger Paints India Limited (BPIL) for a few months before I moved to Connecticut to further my education. My interest to pursue higher education in America came from discussions I had with a scientist at Phillips Carbon Black Limited (PCBL), a carbon black manufacturer in Durgapur, West Bengal. I was an intern at PCBL for two months while I pursued my bachelor’s degree in polymer science and technology. One of the scientists at PCBL told me about an immense research and learning opportunity from renowned scientists and about the availability of state-of-the-art instruments at American universities. I decided to prepare for university admissions at the end of my internship at PCBL by studying for standardized tests.

What initially attracted you to the Institute of Materials Science Polymer Program at the University of Connecticut?

Back in 2001, the internet was not as ubiquitous as it is now in Calcutta. I got information about university programs through college admission books at the United States Citizenship and Immigration Services (USCIS) Center in Calcutta. I applied for Ph.D. study at ten different universities in the United States. Apart from UConn, I got admission offers from UMASS Lowell and Drexel University. I chose IMS primarily because of the interdisciplinary program that it offered. I thought that it would be a great opportunity to learn various aspects of materials science while keeping my main focus on polymer synthesis. I compared the research interests of faculty members and the curriculum of the IMS Polymer Program with programs at other schools, and I thought that coming to UConn would be the best option for me and for the professional career that I envisioned following the completion of my Ph.D.

What was the most gratifying IMS class that you took and why?

I took many good classes while I was at UConn. I like the chemistry aspect of polymer studies more than anything else, so I really enjoyed IMS classes related to polymer synthesis and organic synthesis. However, I learned a lot from polymer physics and polymer characterization classes.

What research, extracurricular activities, internships or other experiences were you involved with as a student?

My primary research was based on the development of novel initiators and catalyst systems for living radical polymerization (LRP) under the supervision of Dr. Alex Asandei. It was a great research area, especially during the onset of many other LRP techniques developed by scientists at other universities (e.g., Atom transfer radical polymerization (ATRP) at Carnegie Mellon University and the University of Pennsylvania, and reversible addition fragmentation chain transfer (RAFT) at the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia). I considered working on the forefront of modern polymer synthesis research, which was supported by many publications from our research group at different journals. I also enjoyed working on ring-opening polymerization (ROP) of various cyclic esters. I worked with students and professors in the Department of Chemical Engineering and the Department of Pharmacy, including Professor Can Erkey and Professor Diane Burgess. Together, we applied ROP to synthesize drug-polymer nanoparticles in
super critical solvents and later evaluated their efficiencies. I was fortunate to be the secretary (2004-2005) of the Society of Plastics Engineers (SPE) student chapter and then the president (2005-2006) of SPE at IMS. It was a great experience for me to learn leadership skills in areas not directly related to my research. I participated in Connecticut Public Television’s science exposition in 2006 and 2007, where I learned basic science that I didn’t get to experience in my everyday research. Another great opportunity I had was working with students of the Research Experience for Undergraduates (REU) program for three years at IMS. I worked with high school and college students from other universities, such as Yale and Bucknell University. The students contributed a lot to my Ph.D. education at IMS.

What jobs and opportunities have led to your present position? How has your materials education influenced your job or other involvements?

I have been working at PPG Industries since I graduated from UConn in 2007. I think my interdisciplinary educational background along with the multiple publications I authored while at IMS helped me to get this job at PPG. I started as Senior Research Chemist II at PPG’s Monroeville Chemical Research Center. I was lucky to be part of a very exciting technical research project with a product development team at PPG, where I was able to apply a lot of my polymer synthesis knowledge into my work. Later, I was promoted to Senior Research Chemist and moved to PPG’s Coatings Innovation Center in Allison Park, Pennsylvania. In my current position, I work to develop coatings for a variety of different applications in automotive and industrial business units. The knowledge I gained at IMS of the different aspects of polymers (synthesis, physics, engineering and characterization) has become truly essential for my job at PPG. I get to apply what I’ve learned almost every day at work.

What aspects of your career have you found to be the most rewarding?

I worked on a project at PPG which was successfully commercialized. I find that converting an idea into successful commercialization is very fulfilling. Nevertheless, I am happy when I learn something from an unsuccessful project that I can later apply to another project successfully.

What abilities or personal qualities do you believe contribute most to success in your field?

I am always open to new ideas and eager to take on challenges in both technical and non-technical areas at work. I have always worked in the development of novel coatings at PPG and feel great when the company decides to apply for a Patent based on my research outcomes. I was equally honored when PPG’s management asked me to lead the Research and Development Diversity Council team for more than four years in a row. That experience helped shape my leadership skills.

What kinds of experiences would you encourage for anyone pursuing a career in materials science?

Learning various aspects of materials is very valuable when it comes to working in the field of materials science. One can only have firsthand experience by working in interdisciplinary projects with different people. I would encourage students at IMS to embrace any interdisciplinary project opportunities that may come their way while they are at UConn.

What are your future academic and career goals?

I plan to continue my career working in industry. I feel that a career in this industry is very dynamic in a sense that there are many opportunities to learn, grow, and adapt to the changes in the market and I like being challenged continuously.

What are you currently reading?

I am reading The Endurance: Shackleton’s Legendary Antarctic Expedition by Caroline Alexander. I read this book every few years for inspiration on leadership quality.

Is there a particular quote that you find motivational?

“Success is a matter of execution, not intent.”
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Over the past fifty years, the UConn Institute of Materials Science (IMS) has invested in scientific development within the state, nation, and across the globe. Our students, faculty, staff, and alumni continue to make countless contributions made possible by the educational, outreach, and research efforts of IMS. IMS is home to more than 150 graduate students performing research in our materials science, materials science and engineering, and polymer science programs.

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