Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

Save the Date

The Department of Materials Science & Engineering will be hosting the Jerome B. Cohen Distinguished Lecture presented by

Daan Frenkel

1968 Professor of Theoretical Chemistry,
University of Cambridge

Daan Frenkel (1948) received his PhD in experimental Physical Chemistry from the University of Amsterdam (NL). Subsequently, he worked as a postdoctoral research associate in Chemistry at the University of California at Los Angeles. After that, he worked at Shell Research (Amsterdam), the Universities of Utrecht and Amsterdam and the FOM Institute for Atomic and Molecular Physics in Amsterdam. In 2007, he was appointed to the 1968 Chair of Theoretical Chemistry at Cambridge (UK). His research focuses on numerical simulations of many-body systems, with a special emphasis on problems relating to ordering and self-assembly. He is a member of the Dutch Academy of Science, the Royal Society of London, the American Academy of Arts and Sciences and the US National Academy of Science.

Monday, October 16, 2017 - 4 pm, Pancoe Auditorium

Talk 1: From Self-assembly to Recognition.

Reception to follow in Pancoe Café at 5 pm

Abstract: A holy grail of nano-technology is to create truly complex, multi-component structures by self-assembly. Most self-assembly has focused on the creation of "structural complexity". In my talk, I will discuss "Addressable Complexity": the creation of structures that contain hundreds or thousands of distinct building blocks that all have to find their place in a 3D structure. Experiments have demonstrated the feasibility of making such structures. Simulation and theory yield surprising insights that can inform the design of novel structures and materials. Surprisingly, the design principles for addressable self-assembly may provide a tool to distinguish different cell surfaces

Tuesday, October 17, 2017 - 4 pm, Pancoe Auditorium

Talk 2: The Disorder Created by Entropy Is In the Mind.

Abstract: So much has been said about entropy that it is probably best to remain silent on the subject. Somewhat unwisely, I will nevertheless talk about this dangerous subject because in numerical simulations one is confronted very directly with what entropy is – and, more importantly, with what it is not. I will talk about entropy from the perspective of numerical simulations. Specifically, I will discuss (well known) examples where entropy increases with increasing order, I will briefly touch on Gibbs' paradox and I will discuss how recent numerical tools allow us to compute close and distant relatives of the Statistical Mechanical entropy.

MATERIALS SCIENCE AND ENGINEERING 2220 CAMPUS DRIVE COOK HALL EVANSTON, ILLINOIS 60208-3108 847-491-3537 847-491-3587 FAX 847-491-7820

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Andre D. Taylor

Associate Professor
Chemical and Environmental Engineering Department
Yale University

September 19, 2017

4:00pm Tech L211

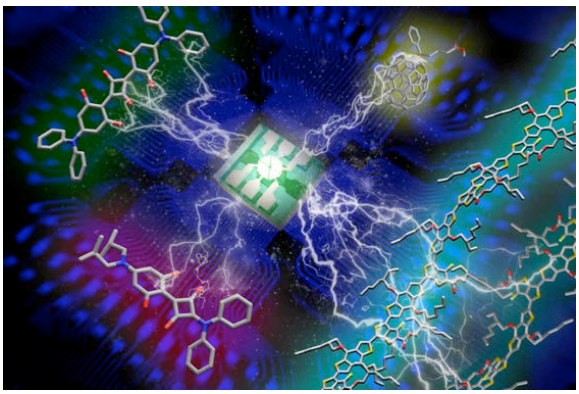
Challenging Nanostructured Materials for Advanced Energy Devices

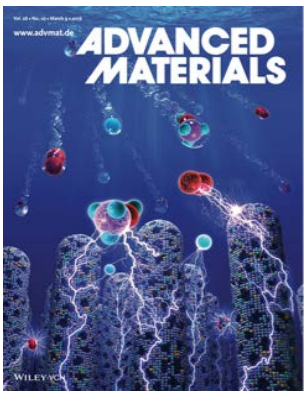
Abstract: One of the key challenges facing the widespread use and commercialization of promising energy devices (i.e. fuel cells, batteries, organic solar cells etc.) is the high cost of the electrocatalytic and electrolyte materials and inefficiencies in their assembly and utilization. In this talk, I will present three examples of how we are designing nanomaterials such as graphene-based carbons, MXenes, and bulk metallic glass (BMG) alloys that can be incorporated into new architectures for high performance nanostructured-enabled energy devices.

1) *Transparent Electronics*. We have developed a fully automated Spin Spray Layer by Layer assembly system with sub-second deposition cycle times allowing nano-level control over film growth with a demonstration of transparent (invisible) battery electrodes. Techniques for developing freestanding multifunctional single-walled nanotube (SWNT) and MXene composite thin films for solar cell transparent conductive electrodes will also be described.

2) *Electrocatalysts*. I will describe a new class of materials, $Pt_{58}Cu_{15}Ni_5P_{22}$ bulk metallic glass that can circumvent Pt-based anode poisoning and agglomeration/dissolution typically associated with supported catalysts during long-term operation in fuel cells. By using subtractive (dealloying) and additive (galvanic replacement) techniques we can push these materials into new directions beyond their glass formability. These amorphous metal alloys can serve as an interesting platform for next-generation catalysts and devices such as the first all bulk metallic glass micro fuel cell.

3) *New Device Architectures*. Our development of a mesoporous catalytic membrane for Li-O_2 batteries recently led us to the recent development of vampire batteries that use heme molecules as a redox mediator. We will also describe our latest efforts on Förster resonance energy (FRET) based solar cells with a single junction power conversion efficiency >10% for a polymer based solar cell.





Bio: Prof. André D. Taylor is an Associate Professor and leads the Transformative Materials and Devices Group in the Chemical and Environmental Engineering Department at Yale University. He specializes in the synthesis and arrangement of nanomaterials in devices such as fuel cells, lithium ion batteries, and solar cells. He received all three degrees in chemical engineering with a BS from the Missouri University of Science and Technology, an MS from Georgia Institute of Technology, and a PhD from the University of Michigan. While in graduate school Dr. Taylor was a Sloan Fellow, NSF-Rackham Merit Fellow, Eastman Kodak Fellow, and GEM (MS and PhD) Fellow. He worked as a research engineer for DuPont's Engineering Polymers division and Intellectual Asset Management Group and was a research faculty scientist in the chemical engineering department at the University of Michigan. Dr. Taylor has developed CMOS compatible micro fuel cells (with integrated heaters and temperature sensors) and a method of patterning ITO substrates for both flat and non-planar surfaces for optoelectronic devices (Artificial Eye Project). Dr. Taylor has given several invited lectures at the local, national, and international levels. He has several patents and archival publications related to his research. He is an NSF CAREER award recipient and a Presidential Early Career Award in Science and Engineering (PECASE) recipient. In 2015, Dr. Taylor was a Dr. Martin Luther King Jr. Visiting Associate Professor at MIT. See website above for publication links and recent press releases from his lab.

THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING PRESENTS THE 2018 JOHN E. DORN MEMORIAL LECTURE FEATURING:

Linda Faye Nazar

Professor
University of Waterloo, Canada

Beyond Li-Ion: From Solid State to Aqueous Electrochemical Energy Storage Batteries

While it is widely acknowledged that traditional Li-ion batteries - which work on the principle of reversible storage of electrons and Li-ions in bulk materials - are approaching their limits, the question is: what real opportunities lie beyond? This presentation will focus on the challenge to find better electrochemical energy storage systems that go "beyond Li-ion" batteries. I will discuss our recent findings in new solid-state ion conductors (Na, and Li) in the context of all-solid-state batteries, and aqueous multivalent intercalation batteries. These electrochemical energy storage systems both represent exciting new technologies that could meet the needs for high energy density and/or high power storage. Yet many barriers remain to realizing their full promise. They require cleverly designed materials for the electrodes, vastly different electrolyte strategies than those used for traditional Li-ion batteries and advanced electrode architectures. Guiding materials development also requires developing a fundamental understanding of the underlying chemistry of ion conduction in solids and across interfaces, which will be a focus of this lecture.

Tuesday, January 16 • 4 pm | Tech L211

Reception • 5 pm | Willens Wing Atrium

Linda Nazar, FRSC, is a Senior Canada Research Chair in Solid State Energy Materials and Distinguished Research Professor at the University of Waterloo, Waterloo Canada. She is a member of the Fellow of the Royal Society of Canada, and is an Officer of the Order of Canada. She is widely recognized for her pioneering work on energy storage materials with topics that span Li-S and Li-O2 batteries; Li-ion, Na-ion, Mg-ion and Zn-ion batteries, solid state electrolytes, and the role that nanotechnology plays in energy materials science. Her work has earned her a place on the Web of Science's 2014, 2016 and 2017 Highly Cited Researcher Lists.

Prof. Nazar received her B.Sc. in Chemistry from the University of British Columbia in Vancouver, Canada, and her Ph.D. in Chemistry from the University of Toronto. Following a postdoctoral appointment at the Exxon Research Labs in Annandale, N.J., she joined the faculty at the University of Waterloo, Waterloo Ontario Canada. Dr. Nazar is the recipient of several academic and professional honors and awards, including the Electrochemistry Society Battery Division Research Award (2009), the Rio Tinto Alcan Award for Electrochemistry (2010); the International Battery Association award (2011), the IUPAC Distinguished Women in Chemistry/Chemical Engineering award (2011), the August-Wilhelm-von-Hofman Lecture award (German Chemical Society, 2013), and the International Lithium Battery Association award (2017).

John E. Dorn (1909–71) was the most distinguished and well-known metallurgical alumnus of Northwestern University. In the late 1950s he helped his alma mater, which then had a very small materials science department, to receive Department of Defense funding to host one the nation's first three Materials Research Centers. Both the center and the department were launched on a path to their present world-renowned stature.

Dorn was particularly famous for his work on the high-temperature creep of metals. He and his best-known student, Oleg Sherby, who went on to become a professor at Stanford University, established that the activation energy of high-temperature creep is the same as that of self-diffusion. Sherby was the first Dorn lecturer in 1974.

A Chicago native, Dorn received both BS (1931) and MS (1932) degrees in chemistry from Northwestern and a PhD (1936) in physical chemistry from the University of Minnesota. After a two-year postdoctoral fellowship at Battelle Memorial Institute in Columbus, Ohio, he became a faculty member at the University of California, Berkeley, where he spent the rest of his scientists at the time. He was known as an outstanding teacher as well as research scientist. Dorn authored or coauthored 180 research papers. His honors included the ASTM Charles Dudley Medal (1958), the ASM Howe Medal (1959), the ASTM Gillette Lectureship (1962), and the ASM Albert Easton White Distinguished Teacher Award (1964). He was elected a medallion member of the Honeur Société Francaise de Metallurgie in 1968. He received an honorary PhD from Northwestern in 1971.

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THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING PRESENTS THE 2018 MORRIS E. FINE MEMORIAL LECTURE FEATURING:

Susanne Stemmer

Professor
Materials Department, University of California, Santa Barbara

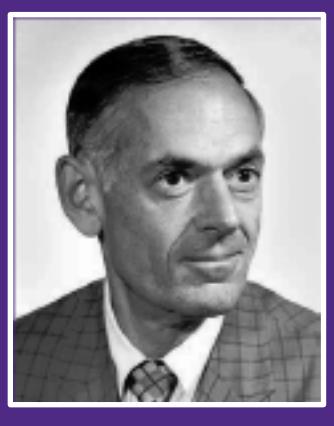
Topological Heterostructures by Molecular Beam Epitaxy

Topology, both in real space and in reciprocal space, has emerged as a new design principle for materials that can host a wealth of novel properties. Interfaces and heterostructures with topological materials offer opportunities to control and manipulate their electronic states and associated phenomena, for example, via electric field effect, strain, or symmetry breaking. In this presentation, we will discuss recent progress in the growth of thin films of the three-dimensional Dirac semimetal Cd3As2 by molecular beam epitaxy. We show that high-mobility, epitaxial Cd3As2 films can be grown and discuss some of the phenomena that can be observed, such as an unusually large negative longitudinal magnetoresistance under parallel electric and magnetic fields. These heterostructures allow for experimental tests of theoretically predicted transitions between topological states by manipulating parameters, such as confinement and film strain. For example, as the film thickness is reduced, a band gap opens in the bulk Dirac electronic states and we observe a quantum Hall effect that is associated with surface states. In the second half of the talk will discuss a different type of topological phenomenon, namely the realization and control of non-trivial spin textures in oxide heterostructures and how these affect the electrical transport properties, such as the Hall effect.

Tuesday, February 20 • 4 pm | Tech L211

Reception • 5 pm | Willens Wing Atrium

Susanne Stemmer is Professor of Materials at the University of California, Santa Barbara. She did her doctoral work at the Max-Planck Institute for Metals Research in Stuttgart (Germany) and received her degree from the University of Stuttgart in 1995. Following postdoctoral positions, she moved to Rice University, where she was Assistant Professor from 1999 to 2002. In 2002, she joined the University of California, Santa Barbara. Her research interests are in the development of scanning transmission electron microscopy techniques, oxide molecular beam epitaxy, functional and strongly correlated oxide heterostructures, and topological materials. She has authored or co-authored more than 240 publications. Honors include election to Fellow of the American Ceramic Society, Fellow of the American Physical Society, Fellow of the Materials Research Society, Fellow of the Microscopy Society of America, and a Vannevar Bush Faculty Fellowship of the Department of Defense.



Morris E. Fine, Walter P. Murphy and Technological Institute Professor Emeritus of Materials Science and Engineering, was a pioneer in teaching the unifying concepts underlying all classes of materials: metals, ceramics, polymers, biomaterials, and electronic materials. He was a co-founder of Northwestern's Department of Materials Science, the first of its kind in the world. Fine received his PhD in physical metallurgy from the University of Minnesota in 1943. After working on the Manhattan Project in Chicago and Los Alamos, he worked for Bell Labs until 1954, when he came to Northwestern. Fine advised 70 Ph.D. students and many M.S. students, and provided advice and guidance to many generations of MSE students at-large, always sharing his enthusiasm for new ideas. His research spanned a broad range of topics, from physical chemistry to mechanical behavior, and included studies on metals and alloys, ceramics, and composite materials. He published over 300 papers and received numerous awards. His belief in research that is both fundamental and useful and collaboration with the local steel industry led to successful application of his Cu-strengthened "NuCu" structural steels. More than 500 tons of this steel were used for a bridge in Lake Villa, Illinois, that opened in 2006. In 2009, the Department of Materials Science and Engineering created the Morris E. Fine Lecture to celebrate his life and contributions.

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Materials Science and Engineering

Vanessa Wood

Professor
Department of Information Technology and Electrical Engineering
ETH Zurich

Friday, January 12, 2018
4:00pm Pancoe Auditorium

Understanding and Optimizing Solution Processed Systems

Liquid-phase and wet-processing techniques offer tremendous opportunities for scalable and low-cost manufacturing. Today, these techniques enable technologies such as lithium ion batteries and promise to play a future role in a wide variety of electronic, photonic, and electrochemical systems. Materials and devices made from these approaches often exhibit hierarchical structures and have complex interfaces that are key to their performance. In this talk, I will describe the importance of understanding structure-performance relationships to achieve the full potential of solution processed systems.

To characterize structure and structural dynamics in these complex, multiscale materials, we leverage a wide variety of techniques including electron microscopies, x-ray imaging, diffraction, and scattering, neutron scattering and imaging, and muon spectroscopy. Combining information from characterization with simulation and experiment, we use our findings to understand the origins of performance limitations and develop design guidelines to systematically improve material and devices.

My talk will present two examples. First, I will describe how x-ray tomographic microscopy has enabled us to quantify microstructure in lithium ion and understand limitations to transport. Second, I will describe how combining results coupling quasi-static and capacitive electronic measurements with experimental inelastic neutron scattering and computational of phonon has enabled us to understand why specific surface treatments to nanocrystalline materials improves their performance in optoelectronic devices.

Vanessa Wood holds a Bachelors in Science from Yale University in Applied Physics (2005), a Masters in Electrical Engineering and Computer Science, Massachusetts Institute of Technology (2007), and a PhD in Electrical Engineering, Massachusetts Institute of Technology (2009). Her PhD work, with Prof. Vladimir Bulović, was focused on the development of quantum dot LED technology. From 2010-2011 she was a postdoc in Department of Materials Science and Engineering at MIT, working with Professors Yet Ming Chiang and Craig Carter on lithium ion battery flow cell technology.

In 2011, she was appointed as an assistant professor in Department of Information Technology and Electrical Engineering at the Swiss Federal Institute of Technology (ETH Zürich). She received tenure in 2014 and holds the chair in Materials and Device Engineering. She won the 2014 Science Prize in Electrochemistry endowed by BASF and Volkswagen Group and is a 2017 World Economic Forum Young Scientist. She is scientific advisor to Battrion AG, a start-up founded out of her group in 2015.

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Materials Science and Engineering

Nancy R. Sottos, Ph.D.

Donald B. Willet Professor of Engineering in the Department of Materials Science and Engineering and the Beckman Institute at the University of Illinois Urbana-Champaign

Tuesday, November 14, 2017
4:00pm Tech L211

Interfacial Stress, Strain and Stabilization in Li-ion Battery Electrodes

The high-rate exchange of lithium ions required for more power and faster charging of Li-ion batteries generates significant stresses and strains in the electrodes that ultimately lead to performance degradation. To date, electrochemically-induced stresses and strains in battery electrodes have only been studied individually and the relative contributions to battery performance/degradation have remained unknown. This seminar describes a new technique to probe the electro-chemo-mechanical response of electrodes by calculating the electrochemical stiffness via coordinated *in situ* stress and strain measurements in both graphite anodes and lithium manganese oxide ($LiMn_2O_4$) cathodes. Tracking changes in the electrochemical stiffness provides new insights into the effects of individual phase changes on the mechanical responses and kinetic limitations on lithium insertion and removal from the host electrode. Additionally, we investigate more deeply the mechanisms for strain generation in electrodes and the surprising effects of various interfacial coatings. The *in situ* strain measurements provide new insights into the electrochemical-induced volumetric changes in electrodes with progressing cycling and provide guidance for both passive and dynamic materials-based strategies to reduce strain and capacity fade, and potentially heal/stabilize electrode interfaces.

Nancy Sottos is the Donald B. Willet Professor of Engineering in the Department of Materials Science and Engineering and the Beckman Institute at the University of Illinois Urbana-Champaign. Sottos started her career at Illinois in 1991 after earning a Ph.D. from the University of Delaware. Her research interests include self-healing polymers and advanced composites, mechanochemically active polymers, tailored interfaces and novel materials for energy storage. Sottos' research and teaching awards include the ONR Young Investigator Award, Scientific American's SciAm 50 Award, the Hetényi Best Paper Award in Experimental Mechanics, the M.M. Frocht and B.J. Lazan Awards from the Society for Experimental Mechanics, the Daniel Drucker Eminent Faculty Award and an IChemE Global Research Award. She is a Fellow of the Society of Engineering Science and the Society for Experimental Mechanics.

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Materials Science and Engineering

David G. Cahill

Willet Professor and Department Head of Materials Science and Engineering
University of Illinois at Urbana-Champaign

Tuesday, February 27, 2018
4:00pm Tech L211

Ultrafast heat transfer in nanoscale materials

On the macroscopic lengths scales of conventional engineering systems, heat transfer by conduction is generally a slow process well-described by the heat diffusion equation. The characteristic time-scale of diffusion scales with the square of length; therefore, at nanometer length scales, heat conduction can involve processes that occur on time-scales of picoseconds, i.e., a few trillionth of a second. We use ultrafast pump-probe optical techniques to directly study a variety of unconventional heat transfer mechanisms that are critical in nanoscale devices and nanoscale materials. Our studies encompass a diverse variety of systems (metallic nanoparticles for photothermal medical therapies, phase change materials for solid-state memory, and heat-assisted magnetic recording) and physical mechanisms (the thermal conductance of interfaces between dissimilar materials, the non-equilibrium between thermal excitations of electrons, phonons, and magnons, and the cross-terms in the transport of heat, charge, and spin). In this talk I will highlight three recent examples: i) ultrafast thermal transport in the surroundings of plasmonic nanostructures; ii) limitations on ultrafast heating of metallic multilayers imposed by electron-phonon coupling; and iii) the generation of currents of magnetization by the spin-dependent Seebeck effect and extreme heat fluxes exceeding 100 GW m^{-2}.

David Cahill is the Willett Professor and Department Head of Materials Science and Engineering at the University of Illinois at Urbana-Champaign. He joined the faculty of the U. Illinois after earning his Ph.D. in condensed matter physics from Cornell University, and working as a postdoctoral research associate at the IBM Watson Research Center. His research program focuses on developing a microscopic understanding of thermal transport at the nanoscale; the discovery of materials with enhanced thermal function; the interactions between phonons, electrons, photons, and spin; and advancing fundamental understanding of interfaces between materials and water. He received the 2015 Touloukian Award of the American Society of Mechanical Engineers and the Peter Mark Memorial Award from the American Vacuum Society (AVS); is a fellow of the AVS, American Physical Society (APS) and Materials Research Society (MRS); and a past-chair of the Division of Materials Physics of the APS.

Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

Sanat K. Kumar

Professor
Department of Chemical Engineering
Columbia University, New York

Tuesday, January 23, 2018
4:00pm Tech L211

Tuning Nanoparticle Dispersion in Polymer Hosts and their Consequences on Properties

There is considerable on-going interest in controlling the spatial dispersion of nanoparticles (NP) in a polymer matrix to create materials with significantly improved properties. We begin with the idea that NPs grafted with polymer chains behave akin to surfactants and assemble into a variety of structures when they are placed in amorphous polymer hosts. The consequences of these different dispersion states on mechanical properties, especially how these results are affected by the glassiness of the matrix are probed next. We then go beyond these equilibrium, surfactant-inspired paradigms and show that the isothermal crystallization rate of a polymer host can be used to dramatically vary NP spatial organization. Since the resulting nacre-like NP self-assembly significantly improves the polymer's mechanical properties, we conclude that crystal growth kinetics represents an underappreciated handle to tailor the NP spatial dispersion and hence the properties of this class of commercially relevant polymer nanocomposites. We finally explore the application of these materials in the context of gas separation membranes. Grafting polymer chains to NPs increases gas permeability without affecting selectivity. We conjecture, based on experiments and theory, that these results arise because the grafting process is a facile means of controlling the free volume of these polymers.

Sanat K. Kumar creates, analyzes, and models new classes of polymer-based materials with improved properties. A particular focus is on hybrid materials (polymer with inorganic filler) with relevance to biomimicry, and energy storage and conversion. His research interests are in Polymers, Polymer nanocomposites, batteries, fuel cells, biomimetic materials. Kumar's group has been the pioneer over the last decade in the practically relevant topic of Polymer Nanocomposites where inorganic nanoparticles are added to polymers to obtain materials with synergistic properties. Kumar received a BTech in chemical engineering from the Indian Institute of Technology, Madras in 1981 and a ScD in chemical engineering from the Massachusetts Institute of Technology, in 1987.

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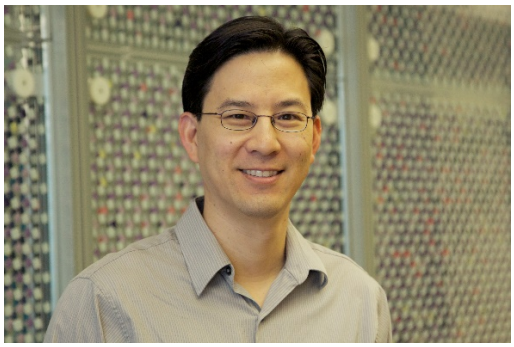

William Shih

Professor
Department of Biological Chemistry and Molecular Pharmacology
Harvard Medical School and the Department of Cancer Biology, Dana-Farber Cancer Institute; Core Faculty, Wyss Institute for Biologically Inspired Engineering at Harvard.

Tuesday, February 13, 2018
4:00pm Tech L211

DNA-origami barrels

DNA origami, in which a long scaffold strand is assembled with a large number of short staple strands into parallel arrays of double helices, has proven a powerful method for custom nanofabrication. Although diverse shapes in 2D are possible, the single-layer rectangle has proven the most popular, as it features fast and robust folding and modular design of staple strands for simple abstraction to a regular pixel surface. Here we introduce a barrel architecture, built as stacked rings of double helices, that retains these appealing features, while extending construction into 3D. We demonstrate hierarchical assembly of a 100 megadalton barrel that is ~90 nm in diameter and ~270 nm in height, and that provides a rhombic-lattice canvas of a thousand pixels each, with a pitch of 9 nm, on its inner and outer surfaces. Complex patterns rendered on these surfaces were resolved using up to twelve rounds of exchange PAINT super-resolution fluorescence microscopy. We envision these structures as versatile nanoscale pegboards for applications requiring complex 3D arrangements of matter.

William Shih is a Professor in the Department of Biological Chemistry and Molecular Pharmacology at Harvard Medical School and the Department of Cancer Biology at the Dana-Farber Cancer Institute and a Core Faculty member at the Wyss Institute for Biologically Inspired Engineering at Harvard. William studied Biochemical Sciences at Harvard for his A.B. (1990–1994) and Biochemistry at Stanford for his Ph.D. (1994–2000) He did a postdoctoral fellowship at The Scripps Research Institute (2001–2004) and has since been back at Harvard as a faculty member. William was a 2013 Blavatnik National Award Finalist in the Physical Sciences and the 2017 Foresight Prize Awardee in Experimental Nanotechnology.

Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

Chinedum Osuji

Associate Professor of Chemical & Environmental Engineering
Yale University

Tuesday, April 10, 2018
4:00pm Tech L361

Single crystals and bespoke textures in self-assembled soft materials

We examine strategies for directing self-assembly in nanostructured soft materials to create single crystals and bespoke textures. Our work elucidates physical processes that are relevant for such directed self-assembly, in part by leveraging in situ scattering tools, with an overall goal of exploiting fundamental understanding to create useful materials or devices. In particular, we consider the use of magnetic fields and confinement effects for directed self-assembly of soft mesophases of block copolymers and discotic liquid crystals. The ability to produce highly ordered functional materials over macroscopic length scales is demonstrated. We explore the role of alignment and connectivity in creating materials with highly anisotropic ion transport, and in creating highly selective nanofiltration membranes with uniformly aligned nanopores produced by molecular self-assembly. Application of orthogonal fields, and field processing across sequential phase transitions enables a novel realization of macroscopic single crystals of self-assembled mesophases with precisely specified texture. Recent progress on low field (sub-1 T) alignment and the associated potential to develop bespoke textures in block copolymers using local field screening are presented.

Prof. Osuji received his B.S. in Materials Science and Engineering from Cornell University with a senior thesis on the use of random copolymers for polymer interface reinforcement supervised by Prof. Edward J. Kramer. He received his PhD in Materials Science and Engineering from MIT in 2003 for studies of structure-property relationships and self-assembly of liquid crystalline block copolymers, supervised by Prof. Edwin L. Thomas. After MIT he spent 2 1/2 years as a Senior Scientist at a start-up company, Surface Logix Inc., where he conducted research on the use of soft lithography, microfluidics and surface patterning for fabricating cell-based assays, planar waveguides and other devices. Prof. Osuji conducted post-doctoral work on shear induced structure formation and dynamics of colloidal gels with Prof. David A. Weitz in Applied Physics at Harvard from 2005-2007. In 2007 he joined the faculty at Yale University and is currently an Associate Professor in the Department of Chemical and Environmental Engineering. In July 2018 he will join the faculty as a Professor of Chemical and Biomolecular Engineering at the University of Pennsylvania. He leads an experimental research group focused on structure and dynamics of soft matter and complex fluids. Topics of interest include structure-property relationships in ordered soft materials, directed self-assembly of block copolymers and other soft mesophases, and rheology and slow dynamics of disordered systems.

Prof. Osuji is the recipient of a CAREER award from the National Science Foundation (2008) and the 2010 Arthur Greer award of Yale College. He received an Office of Naval Research's Young Investigator award and a 3M Nontenured Faculty award in 2012. He is the 2015 recipient of the Dillon Medal of the American Physical Society and the 2015 Hendrick C. Van Ness Award.

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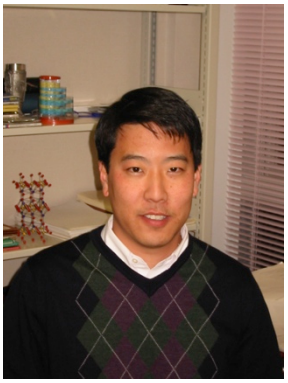

Harold Y. Hwang

Departments of Applied Physics and Photon Science,
Stanford University and SLAC National Accelerator Laboratory

Tuesday, May 1, 2018

4:00pm Tech L361

Freestanding Crystalline Oxide Membranes and Heterostructures

The ability to create and manipulate materials in two-dimensional (2D) form has repeatedly had transformative impact on science and technology. In parallel with the exfoliation and stacking of intrinsically layered crystals, the atomic-scale thin film growth of complex materials has enabled the creation of artificial 2D heterostructures with novel functionality and emergent phenomena, as seen in perovskite oxides. We present a general method to create freestanding complex oxide membranes and heterostructures with millimeter-scale lateral dimensions and nanometer-scale thickness. This facilitates many new opportunities we are beginning to explore, including the topological melting transition of 2D crystalline order, the application of extreme strain states, and integration with other materials families.

Harold Y. Hwang is a Professor of Applied Physics and Photon Science (SLAC) at Stanford University. He received a B.S. in Physics, B.S. and M.S. in Electrical Engineering from MIT (1993), and a Ph.D. in Physics from Princeton University (1997). He was formerly a Member of Technical Staff at Bell Labs (1996-2003) and Professor at the University of Tokyo (2003-2010). His current research focuses on correlated electrons and emergent phenomena at artificial interfaces and in confined systems; atomic-scale synthesis of heterostructures of quantum materials; low-dimensional superconductivity; oxide heterostructures for energy applications; and novel devices based on interface states. Recognitions include the MRS Outstanding Young Investigator Award (2005), the IBM Japan Science Prize (Physics, 2008), Fellowship in the American Physical Society (2011), the Ho-Am Prize (Science, 2013), and the Europhysics Prize (2014, with Jochen Mannhart and Jean-Marc Triscone).

Jennifer L.M. Rupp

Electrochemical Materials
Department for Materials Science and Engineering
Department for Electrical Engineering and Computer Science
Massachusetts Institute of Technology, MIT

Tuesday, May 22, 2018
4:00pm Tech L361

Novel Memristive Oxides and Devices for Neuromorphic Data Computing with Dual Functions to Sense for Chemical Species or Integrate Batteries

The next generation of information memories and neuromorphic computer logics in electronics rely largely on solving fundamental questions of mass and charge transport of ionic defects in materials and their structures. Through this presentation we introduce the concept of memristors to store data and information based on ionic carriers for Resistive Random Access Memories and Neuromorphic Computing beyond classic electronic transistors. Understanding the defect kinetics in the solid state material building blocks and their interfaces with respect to lattice, charge carrier types and interfacial strains are the prerequisite to design new material memristive architectures and device structures.

Through this presentation basic theory[1] and model experiments for solid state oxides their impedances and memristance[2], electro-chemo-mechanics and lattice strain[3-5] modulations is being discussed as a new route for tuning material and properties in ionic conducting oxide film structures up to new device prototypes based on resistive switching. Central are the making of new oxide film materials components, and manipulation of the charge carrier transfer and defect chemistry (based on ionic, electronic and protonic carriers)[1-2, 5-6], which alter directly the resistive switching property and future computing performances. A careful study on the influence of microstructure and defect states vs. the materials` diffusion characteristics is in focus. For this, we suggest novel oxide heterostructure building blocks and show in-situ spectroscopic and microscopic techniques coupled with electrochemical micro-measurements to probe near order structural bond strength changes relative to ionic, protonic and electronic diffusion kinetics and the materials integration to new optimized device architectures and computing operation schemes. In addition, new perspectives in the field from the materials science point view will be introduced by demonstrating first strained memristors to tune performance beyond extrinsic doping or even radically suggesting to select Li as a moving cation for memristive switches connecting classic solid-state Li conductors employed in batteries[8-10] to novel lithium-operated memristive computational devices.

At the end, the talk is set to dream out loud a little what happens if we functionalize electrochemical devices and oxide hardware to gain multiple functionalities: memristors that can also have dual functions such as to not only compute data neuromorphically but also track the environment and sense for chemical species, or also have integrated battery functions?

Prof. Jennifer Rupp is the Thomas Lord Assistant Professor of Electrochemical Materials at the Department of Materials Science and Engineering, and Assistant Professor at the Department of Electrical Engineering and Computer Science at MIT. Prior she is a non-tenure track assistant professor at ETH Zurich Switzerland where she was holding two prestigeous externally funded career grants, namely an ERC Starting Grant (SNSF) and Swiss National Science Foundation (SNF) professorship from 2012 on.

She previously was affiliated as a visiting and senior scientist at the MIT (2012-2011), the National Institute of Materials Science (NIMS) in Tsukuba Japan (2011), and was working as a postdoc at ETH Zurich (2010-2006). Rupp team`s current research interests are on solid state material design and tuning of structure-property relations for novel energy and information devices and operation schemes. This ranges from alternative energy storage via solid state batteries or catalytic convertor systems processing by smart material design solar light and CO2 to renewable synthetic fuels, or novel types of neuromorphic memories and computing logic entities for data storage and transfer beyond transistors. Here, her team goes the whole way from material design, novel processing techniques to make ceramics, cermets or glassy-type ceramic structures up to device prototypes, their operation and characteristics. She has published more than 80 papers, invented 9 patents, and enjoys to be active discussing material tech trends on the theme of energy with the public, economists and policy makers being a frequent speaker and member of the World Economic Forum (2015-2018). Rupp and team received several honors and awards such as 2017 Science Electrochemistry Award by Volkswagen and BASF, keynote lecture at Nature Energy conference 2016, "Top 40 international scientist under the age of 40" by World Economic Forum 2015, Spark Award for the most innovative and economically important invention of the year 2014 at ETH Zurich, Gordon Research lecture 2014, the Kepler award “new materials in energy technology” by the European Academy of Science 2012 or Young Scientist Award by the Solid State Ionic Society.

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Materials Science and Engineering

2018 MSE DOW Lecture

K. Lu

Shenyang National Laboratory for Materials Science,
Institute of Metal Research, Chinese Academy of Sciences, China

Tuesday, April 24, 2018

4:00pm Lecture in Pancoe Auditorium

5:00PM Reception in Pancoe Cafe

Stability of gradient nano-grained structures in metals

Dramatic property variations and unprecedented performances have been discovered in nanostructured metals in which high density interfaces are introduced. However, stability of nanostructures under thermal or mechanical stimuli becomes critical for not only property advancements but processing development as well. For instance, coarsening of nano-sized grains occurs at much lowered temperatures than their coarsen-grained counterparts, as low as ambient temperature in some metals. Grain coarsening may take place even at cryogenic temperatures during plastic deformation. This talk is to present a recent study on grain size dependences of stability in nano-grained metals. Gradient nano-grained samples, in which the spatial variations of grain size are graded from the nano-scale to the macro-scale, were prepared by means of surface plastic deformation. Stability of the nano-grained structures in pure metals and alloys was investigated by annealing at elevated temperatures and under repeated dry-sliding, respectively. Experimental results showed that very small nano-grains below a critical size exhibit extraordinary stability, under both mechanical loading and thermal annealing, in contradictory to the "smaller less stable" trend. The inherent stability of nano-grains may originate from an autonomous grain boundary relaxation to low energy states during plastic deformation of the very fine grains.

Dr. K. Lu received BS in MSE from Nanjing University of Science & Technology in 1985 and PhD in MSE from Institute of Metal Research of Chinese Academy of Sciences (CAS) in 1990. He is a professor and the founding director of Shenyang National Laboratory for Materials Science, Institute of Metal Research, CAS. His research interests are nanostructured metals and alloys. He authored and co-authored 390 international journal publications and held 30 patents. He is an elected member of Chinese Academy of Sciences, German National Academy of Sciences Leopoldina, National Academy of Engineering (USA), and The Academy of Sciences for Developing World. He is a Fellow of the AAAS, MRS, and TMS.

DOW

The 2018 DOW Lecture is sponsored by the Department of Materials Science and Engineering and generously supported by the Dow Chemical Company.

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Materials Science and Engineering

Marina Leite

Assistant Professor
Department of Materials Science and Engineering
Institute for Research in Electronics and Applied Physics
University of Maryland – College Park

Tuesday, May 29, 2018

4:00pm Tech L361

Designing and probing novel materials for energy

My research group is engaged in fundamental and applied research in novel materials for energy harvesting and storage, nanophotonics, and optoelectronics. The performance of most photovoltaic devices is still limited by their nanoscale behavior. To reveal how the electrical and optical responses vary at relevant length scales, we acquire nanoscale resolved "photographs" and "movies" of the performance of inhomogeneous materials for photovoltaics, by means of novel nanospectroscopic methods. Our measurements provide a tomography of charge carrier generation, recombination, and collection within materials ranging from well-established thin films to emerging perovskites. In particular, we probe the correlation between perovskites' stability and the chemical changes that occur when the material is exposed to humidity, oxygen, temperature, light, and bias. In the realm of energy storage, the further development of rechargeable, safe batteries requires the understanding of why and how the material is changing upon charging/discharging. We elucidate the dynamics of lithiation/delithiation in all-solid-state batteries through *in situ* electron microscopy methods to ultimately identify and control undesired chemical reactions that lead to capacity fade. Concerning optical materials, we overcome the constraint imposed by the pre-defined dielectric functions of metals by alloying, where we have recently developed a library of their optical properties. Our approach enables new materials with *on demand* optical response for applications ranging from electrocatalysis to superabsorbers and color displays.

Marina Leite is an Assistant Professor in Materials Science and Engineering, and the Institute for Research in Electronics and Applied Physics at UMD. She has been an invited participant of the National Academy of Engineering 2017 EU-US Frontiers of Engineering Symposium, the awardee of the 2016 APS Ovshinsky Sustainable Energy Fellowship from the American Physical Society (APS), and of the 2014 Maryland Academy of Sciences Outstanding Young Scientist Award. Before joining UMD in 2013, Leite worked for two years at NIST developing nanoscale metrology for functional materials and was a post-doctoral scholar at Caltech (in H. Atwater's group). She received her PhD in physics from Campinas State University in Brazil and the Synchrotron Light Source Laboratory. Collectively, her group members received 66 awards/honors in the last 4.5 years, including seven NSF-GRF, three honorable mentions, and awards from MRS, IEEE, OSA, ACS, etc. Her research is funded by NSF-DMR, NSF-ECCS, APS, the Army Research Lab, and ARO.

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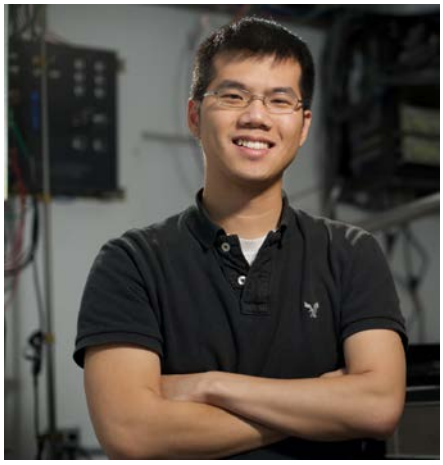

William Chueh

Assistant Professor of Materials Science and Engineering
Center Fellow at the Precourt Institute for Energy

Tuesday, June 5, 2018
4:00pm Tech L361

Understanding the Many Length Scales of Ion Insertion Solids

The availability of low-cost but intermittent renewable electricity (e.g., derived from solar and wind) underscores the grand challenge to store and dispatch energy so that it is available when and where it is needed. Redox-active materials promise the efficient transformation between electrical and chemical energy and are at the heart of carbon-neutral energy cycles. Understanding design rules that govern materials chemistry and architecture holds the key toward rationally optimizing technologies such as lithium-ion batteries and solid oxide fuel cells. Electrochemical reactions involved in these technologies span diverse length and time scales, ranging from Ångströms to meters and from picoseconds to years. As such, establishing a unified, predictive framework has been a challenge. The central question that motivates our research is, “can we understand and engineer redox reactions at the levels of electrons, ions, molecules, particles and devices using a bottom-up approach?” In this talk, I will discuss how we integrate synthesis, fabrication, characterization, modeling and data analytics to understand molecular pathways and interfacial structure, and to bridge fundamentals to energy storage and conversion technologies by establishing new design rules.

Will Chueh is an Assistant Professor in the Department of Materials Science & Engineering and a Center Fellow of the Precourt Institute for Energy at Stanford University. He leads a group of more than thirty tackling the challenge of decarbonizing various energy transformation pathways. He received his B.S. in Applied Physics, M.S. and Ph.D. (2010) in Materials Science from Caltech. Prior to joining Stanford in 2012, he was a Distinguished Truman Fellow at Sandia National Laboratories. Prof. Chueh has received numerous honors, including the MRS Outstanding Young Investigator Award (2018), Volkswagen/BASF Science Award Electrochemistry (2016), Camille Dreyfus Teacher-Scholar Award (2016), Sloan Research Fellowship (2016), NSF CAREER Award (2015), Solid State Ionics Young Scientist Award (2013), Caltech Demetriades-Tsafka-Kokkalis Prize in Energy (2012), and the American Ceramics Society Diamond Award (2008). In 2012, he was named as one of the “Top 35 Innovators Under the Age of 35” by MIT’s Technology Review.

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Materials Science and Engineering

Zdeněk P. Bažant

McCormick Institute Professor, Walter P. Murphy Professor of
Civil and Environmental Engineering, Mechanical Engineering and
Material Science and Engineering

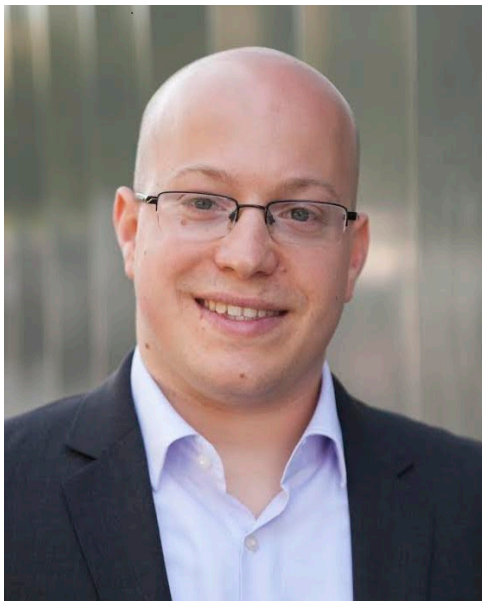
Tuesday, April 17, 2018

4:00pm Tech L361

Design of New Materials and Structures to Maximize Strength at Probability Tail: a Neglected Challenge for Quasibrittle and Biomimetic

In developing new materials, the research objective has been to maximize the mean strength (or fracture energy) of material or structure and minimize the coefficient of variation. However, for engineering structures such as airframes, bridges of microelectronic devices, the objective should be to maximize the tail probability strength, which is defined as the strength corresponding to failure probability 10-6 per lifetime. Optimizing the strength and coefficient of variation does not guarantee it. The ratio of the distance of the tail point from the mean strength to the standard deviation depends on the architecture and microstructure of the material (governing the safety factor) is what should also be minimized. For the Gaussian and Weibull distributions of strength, the only ones known up to the 1980s, this ratio differs by almost 2:1. For the strength distributions of quasibrittle materials, it can be anywhere in between, depending on material architecture and structure size. These materials, characterized by a nonnegligible size of the fracture process zone, include concretes, rocks, tough ceramics, fiber composites, stiff soils, sea ice, snow slabs, rigid foams, bone, dental materials, many bio-materials and most materials on the micrometer scale. A theory to deduce the strength distribution tail from atomistic crack jumps and Kramer's rule of transition rate theory, and determine analytically the multiscale transition to the representative volume element (RVE) of material, is briefly reviewed. The strength distribution of quasibrittle particulate or fibrous materials, whose size is proportional to the number of RVEs, is obtained from the weakest-link chain with a finite number of links, and is characterized by a Gauss-Weibull grafted distribution. Close agreement with the observed strength histograms and size effect curves are demonstrated. Discussion then turns to new results on biomimetic imbricated (or scattered) lamellar systems, exemplified by nacre, whose mean strength exceeds the strength of constituents by an order of magnitude. The nacreous quasibrittle material is simplified as a fishnet pulled diagonally, which is shown to be amenable to an analytical solution of the strength probability distribution. The solution is verified by million Monte-Carlo simulations for each of fishnets of various shapes and sizes. In addition to the weakest-link model and the fiber-bundle model, the fishnet is shown to be the third strength probability model that is amenable to an analytical solution. It is found that, aside from its well-known benefit for the mean strength, the nacreous microstructure provides a significant additional strengthening at the strength probability tail. Finally it is emphasized that the most important consequence of the quasibrittleness, and also the most effective way of calibrating the tail, is the size effect on mean structural strength.

Born and educated in Prague (Ph.D. 1963), Bažant joined Northwestern in 1969, where he has been W.P. Murphy Professor since 1990 and simultaneously McCormick Institute Professor since 2002, and Director of Center for Geomaterials (1981-87). He was inducted to NAS, NAE, Am. Acad. of Arts & Sci., Royal Soc. London; to the academies of Italy (lincei), Austria, Spain, Czech Rep., India.and Lombardy; to Academia Europaea, Eur. Acad. of Sci. & Arts. Honorary Member of: ASCE, ASME, ACI, RILEM; received 7 honorary doctorates (Prague, Karlsruhe, Colorado, Milan, Lyon, Vienna, Ohio State); Austrian Cross of Honor for Science and Art 1st Class from President of Austria; ASME Timoshenko, Nadai and Warner Medals; ASCE von Karman, Newmark, Biot, Mindlin and Croes Medals and Lifetime Achievement Award; SES Prager Medal; RILEM L'Hermite Medal; Exner Medal (Austria); Torroja Medal (Madrid); etc. He authored seven books: Scaling of Structural Strength, Inelastic Analysis, Fracture & Size Effect, Stability of Structures, Concrete at High Temperatures, Concrete Creep and Probabilistic Quasibrittle Srength. H-index: 119, citations: 62,500 (on Google Feb..2018, incl. self-cit.), i10 index: 560. In 2015, ASCE established ZP Bažant Medal for Failure and Damage Prevention. He is one of the original top 100 ISI Highly Cited Scientists in Engrg. (www.ISIhighlycited.com). His 1959 mass-produced patent of safety ski binding is exhibited in New England Ski Museum.



Jonathan Rivnay

Assistant Professor

Department of Biomedical Engineering &

Simpson Querrey Institute

Northwestern University

October 3, 2017

4:00pm Tech L211

"Organic Mixed Conductors for Applications in Bioelectronics"

Abstract: Direct measurement and stimulation of electrophysiological activity is a staple of neural and cardiac health monitoring, diagnosis and therapy. Such bi-directional interfacing can be enhanced by the attractive properties of organic electronic materials which can favorably bridge the biotic/abiotic interface. These materials are mixed ionic/electronic conductors: they allow for intimate interaction of the electron transporting polymer with the biological environment, including swelling and bulk interaction with ions and biomolecules. This feature improves both electrochemical properties and mechanical matching with surrounding tissue, critical for recording and stimulation in biomedical devices, and can be used to advance the state of the art. Organic electrochemical transistors, for example, have shown considerable promise as amplifying transducers for electrophysiology and biomolecular sensing due to their stability in aqueous conditions and high transconductance. I harness the volumetric gating of these devices to demonstrate human electroencephalography measurements with significant signal enhancement at low frequency. I then demonstrate the use of conducting polymers and polyelectrolytes as active elements in organic electronic ion pumps -- devices which allow for localized electrophoretic delivery, without the adverse effects of fluidic delivery. I show that release of an endogenous inhibitory neurotransmitter can stop seizure-like activity locally in brain tissue. Finally, I demonstrate how the ionic and electronic transport properties of organic mixed conductors can be controlled through synthetic and processing variation. These findings set the stage for a more general fundamental understanding of mixed conduction in organic electronic materials, which is necessary for future materials and device design for far-reaching bioelectronics application.

Biography: Jonathan earned his B.Sc. in 2006 from Cornell University (Ithaca, NY). He then moved to Stanford University (Stanford, CA) where he earned a M.Sc. and Ph.D. in Materials Science and Engineering studying the structure and electronic transport properties of organic electronic materials. In 2012, he joined the Department of Bioelectronics at the Ecole des Mines de Saint-Etienne in France as a Marie Curie post-doctoral fellow, working on conducting polymer based devices for bioelectronics. Jonathan spent 2015-2016 as a member of the research staff in the Printed Electronics Group at the Palo Alto Research Center (Palo Alto, CA) before joining the Department of Biomedical Engineering at Northwestern University in 2017.

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Materials Science and Engineering

Veronica Augustyn

Dept. of Materials Science & Engineering
North Carolina State University

Tuesday, November 21, 2017
4:00pm Tech L211

The Role of Structural Water in Electrochemical Energy Storage of Tungsten Oxides

Nanoconfined fluids in materials, such as interlayer structural water, could lead to new mechanisms of electrochemical energy storage with significantly enhanced kinetics. Hydrated tungsten oxides are model materials for the systematic investigation of the effect of structural water in electrochemical energy storage because of their stability in acidic and non-aqueous electrolytes, reversible redox, and multiple hydrated phases. Our results show that hydrated tungsten oxide exhibits surface-limited (pseudocapacitive) kinetics for proton intercalation even with high mass loadings and large particle sizes, which leads to high power capability. On the other hand, the anhydrous tungsten oxide exhibits primarily semi-infinite diffusion-controlled kinetics, typical of battery materials. Within operando atomic force microscopy, it is possible to track electrode height changes on timescales of a few seconds and with sub-Ångstrom resolution. These results on hydrated and anhydrous tungsten oxides show a difference in the structural response of both materials as a function of potential and sweep rate. These results ultimately demonstrate fundamental differences in the structural response of pseudocapacitive, hydrated layered oxides and battery-type oxides that both store charge via intercalation reactions and exhibit the same surface area and morphology.

Veronica Augustyn is an Assistant Professor of Materials Science & Engineering at North Carolina State University. From 2013 - 2015, she was a Postdoctoral Fellow at the Texas Materials Institute at the University of Texas at Austin. She received her Ph.D. in 2013 from the University of California, Los Angeles and her B.S. in 2007 at the University of Arizona, both in Materials Science & Engineering. Her research is focused on the development and characterization of materials for electrochemical energy technologies including batteries, electrochemical capacitors, electrolyzers, and fuel cells. In particular, she is interested in the relationships between material structure and morphology and the resulting redox behavior and electrochemical mechanisms. She also leads an award-winning international project at NC State, SciBridge, which develops renewable energy research and education collaborations between universities in Africa and the U.S. She is the recipient of a 2017 NSF CAREER Award and a 2016 Ralph E. Powe Jr. Faculty Enhancement Award, and is a Scialog Fellow in Advanced Energy Storage from the Research Corporation for Science Advancement.

Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

Xin Sun, Ph.D.

Director
Energy and Transportation Science Division,
Oak Ridge National Laboratory

Tuesday, October 24, 2017
4:00pm Tech L211

Linking Materials Science and Materials Engineering -- Microstructure-based Performance Predictions for Advanced Multi-phase Materials

It is well known that meso-scale microstructural features and their stability and evolution under service condition control the macroscopic performance for most engineering materials. Even though the precise definition of meso-scale may be material specific, meso-scale typically serves as the critical linkage between the bottom-up *materials science*-based approach and the top-down *materials engineering*-based approach. In this talk, a suite of modeling capabilities will be discussed to predict the influences of microstructure features and their evolution kinetics on engineering properties of advanced multiphase materials. The key challenge addressed is the quantitative linkages between the lower length scale performance limiting factors and the macroscopic engineering properties.

First, microstructure-based finite element method will be presented to predict the stress versus strain curves for multi-phase advanced high strength steels (AHSS) under different loading conditions. The methodology has been developed based on the actual microstructures and the individual phase properties measured with in-situ high energy X-ray diffraction, and it has been successfully demonstrated in predicting ductile failure of dual phase and TRIP steels without any prescribed failure criterion. In addition to property predictions, the microstructure-based finite element method has also demonstrated usage in computational materials design optimization for various design concepts for 3rd generation advanced high strength steels.

Next, a hierarchical modeling methodology will be presented aimed at predicting the overall stress versus strain curves as well as ductility for thin-walled high pressure die cast (HPDC) Mg castings. At the lower length scale, a microstructure-based finite element model is used to predict the intrinsic deformation limits of the cell-type alpha-beta matrix of the Mg casting for various beta phase volume fractions and morphologies. Once the matrix deformation limit is predicted, various extrinsic casting defects will be introduced to the next length scale. Representative volume elements (RVEs) considering various porosity size, shape, and volume fraction are constructed based on the experimentally characterized defect descriptors and their statistics. The modeling framework is then validated by comparing the predicted ductility and failure modes with experimental measurements.

Dr. Sun is currently the Division Director for the Energy and Transportation Science Division at Oak Ridge National Laboratory in Oak Ridge, Tennessee. Dr. Sun received her Ph.D. from the University of Michigan in 1995, and was a Laboratory Fellow and Technical Group Leader at Pacific Northwest National Laboratory prior to joining ORNL in May 2017. Over the past two decades, Dr. Sun has conducted cutting-edge multi-disciplinary research in the areas of multiphase advanced high strength steels, Mg castings, aluminum alloys and microstructure based manufacturing process simulations. She is a national laboratory leading authority on integrated computational materials engineering (ICME) and has authored/co-authored 185 peer reviewed journal publications and 10 books/book chapters.

Northwestern | McCORMICK SCHOOL OF ENGINEERING
Materials Science and Engineering

Zhenan Bao, Ph.D.

K.K. Lee Professor of Chemical Engineering,
and by courtesy Professor of Chemistry, Materials Science and Engineering, Stanford University

Tuesday, November 7, 2017
4:00pm Tech L211

Skin-Inspired Organic Electronic Materials and Devices

Skin is the body's largest organ, and is responsible for the transduction of a vast amount of information. This conformable, stretchable and biodegradable material simultaneously collects signals from external stimuli that translate into information such as pressure, pain, and temperature. The development of electronic materials, inspired by the complexity of this organ is a tremendous, unrealized materials challenge. However, the advent of organic-based electronic materials may offer a potential solution to this longstanding problem. In this talk, I will describe the design of organic electronic materials and devices to mimic skin functions. These new materials enabled unprecedented performance and functions in devices that are of interest for bio-electronic interfaces and applications.

Zhenan Bao is a K.K. Lee Professor of Chemical Engineering, and by courtesy, a Professor of Chemistry and a Professor of Material Science and Engineering at Stanford University. Prior to joining Stanford in 2004, she was a Distinguished Member of Technical Staff in Bell Labs, Lucent Technologies from 1995-2004. She has over 400 refereed publications and over 60 US patents with a Google Scholar H-Index >120. She pioneered a number of design concepts for organic electronic materials. Her work has enabled flexible electronic circuits and displays. In her recent work, she has developed skin-inspired organic electronic materials, which resulted in unprecedented performance or functions in medical devices, energy storage and environmental applications.

Bao is a member of the National Academy of Engineering. She is a Fellow of MRS, ACS, AAAS, SPIE, ACS PMSE and ACS POLY. She served on the Board of Directors for MRS in 2003-2005 and as an Executive Committee Member for the Polymer Materials Science and Engineering division of the American Chemical Society.

Bao is a co-founder and on the Board of Directors for C3 Nano and PyrAmes, both are silicon-valley venture funded start-ups. She serves as an advising Partner for NewGen Venture Capital.