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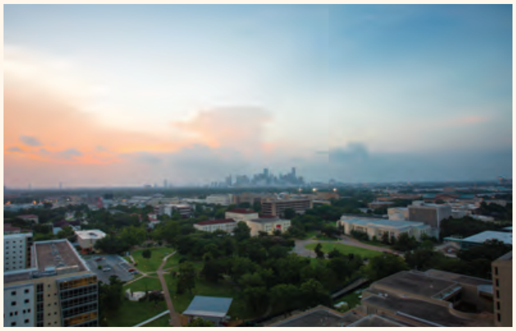
DEPARTMENT OF MECHANICAL ENGINEERING



MECE 6111, FALL 2015
Pradeep Sharma (psharma@uh.edu)

Thu 2:30-4:00 pm, W122 ENGINEERING BUILDING 2

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UNIVERSITY of HOUSTON
CULLEN COLLEGE of ENGINEERING
Department of Mechanical Engineering

AUG 27, 2015

Constitutive modeling of particle flows

ABSTRACT:

Granular matter is very common --- sands, soils, raw materials, food stuffs, pills, powders --- but the challenge of predicting the motion of a collection of flowing grains has proven to be a difficult one, from both computational and theoretical perspectives. Grain-by-grain discrete element methods can be used, but these approaches become computationally unrealistic for large bodies of material and long times. A broadly accurate continuum model would be ideal if it could be found, as it would provide a much more rapid means of calculating flows in real-world problems, such as those encountered in industrial design and geotechnical engineering. With this challenge in mind, in this talk we present a new constitutive relation for granular matter, which produces quantitatively accurate predictions. The model is constructed in a step-by-step fashion. First we compose a local relation based on existing granular rheological approaches (i.e. the principle of "inertial" rheology) and point out where the model succeeds and where it does not. The clearest missing ingredient is shown to be the lack of an intrinsic length scale. To tie flow features more carefully to the characteristic grain size, we justify a nonlocal modification which takes the form of a size-dependent term in the rheology (with one new material parameter). The nonlocal model is then numerically implemented with a custom-written User-Element in the Abaqus package, where it is shown to greatly improve flow predictions compared to the local model. In fact, it is the first model to accurately predict all features of flows in `split-bottom cell' geometries, a decade-long open question in the field. In total, we will show that this new model, using three material parameters, quantitatively matches the flow and stress data from over 160 experiments in several different families of geometries. We then show how the same model can be used to reconcile many of the "strange" features of granular media that have been documented in the literature, such as the observation that thinner granular layers behave as if they are stronger, and the motion-induced "quicksand" effect wherein flow at one location effectively removes the yield stress everywhere. The talk will close with several ongoing directions in our group. These include (1) a growing experimental front aimed at using continuum mechanics to optimize terramechanical designs for locomotion on grains, (2) mesh-free simulation of our continuum models to study granular impact, and (3) extending our modeling efforts into the wet granular media regime.

KEN KAMRIN

Assistant Professor
Department of Mechanical Engineering
Massachusetts Institute of Technology
Cambridge, MA

BIOGRAPHY:

Professor Ken Kamrin received a BS in Engineering Physics and a minor in Mathematics at UC Berkeley in 2003, and a PhD in Applied Mathematics at MIT in May 2008. Kamrin was an NSF Postdoctoral Research Fellow at Harvard University in the School of Engineering and Applied Sciences before joining the faculty of the department of Mechanical Engineering at MIT in 2011, where he was appointed the Class of 1956 Career Development Chair. Kamrin's research focuses on constitutive modeling and computational continuum mechanics for large deformation processes, with interests spanning elastic and plastic solid modeling, viscous and non-Newtonian flows, amorphous solid mechanics, upscaling and continuum homogenization, and analytical methods in mechanics. Kamrin has been awarded fellowships from the Hertz foundation, US Defense department, and National Science Foundation. Kamrin received the 2010 Nicholas Metropolis Award from the American Physical Society and the Journal of Computational Physics for his work in computational physics, and will receive 2014 Eshelby Mechanics Award for Young Faculty at the upcoming ASME IMECE. Kamrin received the NSF CAREER Award in 2012.

SEP 03, 2015

Subsea Engineering: Challenging the next generation of engineers

DIANA GRAUER

OneSubsea Corporate Technology Manager
Bachelor of Science, Mechanical Engineering, Kansas State University
Ph.D., Mechanical Engineering, Kansas State University

ABSTRACT:

As the oil and gas industry expands, it faces new challenges with each new design and deployment. New developments focus on maximizing recovery from new and existing assets. Subsea engineers continue to push the envelope in the three challenge areas: depth, size and distance. Today subsea fields are approaching 10,000 feet of depth in the lower tertiary trend of the Gulf of Mexico, but we already know that this trend extends to depths approaching 14,500 ft. Tomorrow's subsea fields will tackle harsher environments and stranded reservoirs. The next generation of subsea engineers will need to develop new tools and technology for the next generation of subsea field development and find ways to integrate those new technologies into the aging infrastructure of existing fields.

BIOGRAPHY:

As Corporate Technology Manager of OneSubsea, Dr. Grauer is responsible for driving and facilitating the OneSubsea NPD process, as well as ownership of the technology competitive landscape and product portfolio map. She leads all long term development efforts, including fundamental research supporting the next generation of subsea technology, by managing collaboration and outreach activities with universities and development partners. Dr. Grauer joined the OneSubsea family Cameron, where she served as Engineering Manager of Technology & Engine Development for the Process & Reciprocating Compression Division. In her management role at Cameron, she and her team were responsible for NDP in support of new and aftermarket reciprocating compression products, specifically stationary natural gas transmission engines, turbochargers, and related technology.

Prior to Cameron, Dr. Grauer was a Research Engineer jointly engaged by the Advanced Process & Decision Systems and Energy Efficiency & Industrial Technology departments at the Idaho National Laboratory. She worked on the dynamic analysis of Hybrid Energy System integration, as well as large scale system optimization of dynamic combined heat and power generation cycle performance. Dr. Grauer led an effort to develop a scenario analysis capability for evaluation of integrated energy systems for Department of Defense installation energy islanding.

Dr. Grauer has also taught courses at Idaho State University, University of Idaho, Boise State University, and Kansas State University.

SEP 10, 2015

The spin degree of freedom in thermoelectrics

JOSEPH HEREMAN

Professor
Department of Mechanical and Aerospace Engineering
The Ohio State University, Columbus, OH

ABSTRACT:

The recent decade has seen a doubling of the efficiency of thermoelectric converters through the use of various band structure engineering techniques and nanotechnology. Here we add the spin degree of freedom to research on thermal solid-state energy converters, based on the recently discovered spin-Seebeck effect [SSE, 1,2]. In SSE, a temperature gradient applied to a spin-polarized material creates a spin flux that is driven into an adjacent material (Pt) where it gives rise to a voltage by the inverse spin-Hall effect via spin/orbit interactions. The thermal spin flux can be carried by either magnons or spin-polarized electrons. The magnon thermal conductivity in ferromagnets gives, under a temperature gradient, a magnon heat flux that is directly proportional to a spin flux [3]. Spin-polarized electrons can also sustain a spin flux: the effect can then be as large as the highest thermoelectric voltages in semiconductors [4]. In fact, even in diamagnetic solids under a magnetic field, the atomic motion due to phonons modulates the local diamagnetic moment (phonon-induced diamagnetism, [5]) enough to generate measurable changes in the anharmonicity and lattice thermal conductivity. The talk will conclude with a review of the potential to use spin fluxes in solid-state heat-to-electricity energy converters. The magnon-drag thermopower, first identified on Fe [6], can be seen as a self-spin-Seebeck effect, eliminating the need for an interface between a ferromagnet and a normal metal. Magnetism can now be considered as a new design tool that adds to thermoelectrics research. The engineering advantages of spin-Seebeck based devices over conventional thermoelectric generators will be described. Conversely, we will also show how phonon anharmonicity can be affected by magnetic fields, even in diamagnetic systems [7]. The local atomic displacements corresponding to the phonons locally modulate the valence band, which in turn creates a very small local modulation of the local diamagnetic susceptibility. In the presence of an external magnetic field, this exerts a local magnetic force on the atoms, which affects the Grueneisen parameter and thus phonon-phonon interactions. The effect on the lattice thermal conductivity of InSb is measurable, and modeled by the theory without any adjustable parameter.

BIOGRAPHY:

Heremans joined the faculty of the Ohio State University as an Ohio Eminent Scholar and Professor in the Departments of Mechanical and Aerospace Engineering, Materials Science and Engineering, and Physics. He is a member of the National Academy of Engineering, and fellow of the American Associations for the Advancement of Science and the American Physical Society. He graduated from the Catholic University of Louvain (Belgium) with Ph.D. in Applied Physics (1978). Prior to joining OSU, he had a 21-year career at the General Motors Research Labs, and later at Delphi, as researcher and research manager. His research interests focus on the experimental investigation of electrical and thermal transport properties and on the physics of narrow-gap semiconductors, semimetals and nanostructures. In the last decade his group focuses on fundamental aspects of thermoelectric and thermal spin transport.

SEP 17, 2015

Vehicle Run-Off-Road and Recovery - Development of Laboratory Training Tools and Nonlinear Control Algorithms for On-Board Systems

JOHN WAGNER

Professor,
Department of Mechanical Engineering
Clemson University,
Clemson, SC

ABSTRACT:

Traffic fatalities and injuries continue to affect a vast number of drivers on roadways each year in the United States. Of deaths due to vehicular accidents, around 60% are involved in a run-off-road crash, a scenario in which the vehicle leaves the paved portion of the roadway and travels along the shoulder or side of the road. To help reduce the number and severity of vehicular crashes, roadway infrastructure modifications and electronic safety systems have been developed and are continually implemented. However, 95% of all single vehicle run-off-road events have been found to be driver related. Poor driver performance is a major contributing factor that results in run-off-road scenarios evolving into serious crashes. The driver often executes dangerous maneuvers, such as overcorrection, which can ultimately cause fatal results. One countermeasure that is under development to directly address the driver's performance is a driving education and training program. To specifically target run-off-road recovery training, a simulator-based driving experience can be implemented immediately, providing a safe environment and the ability to gather data. A human subject study is used to validate the simulator as an effective tool for replicating the run-off-road experience and gathering insight into driver reactions. In addition, a series of nonlinear control algorithms, including sliding mode and state flow, have been developed for synchronized steering and braking actions to return the vehicle safely to the road surface. An analysis of subjective questionnaire data and objective performance evaluation parameters show strong correlations between run-off-road crash data and driver-vehicle-environment factors (e.g., higher vehicle velocities, curved roads, and large friction coefficient differences between the road and shoulder) which negatively impact drivers' recoveries from this situation. To best combat run-off-road crashes, the behavior of drivers must be addressed in addition to the application of on-board safety control algorithms.

BIOGRAPHY:

John Wagner holds B.S., M.S., and Ph.D. degrees in mechanical engineering from the State University of New York at Buffalo and Purdue University. He was previously on the engineering staff at Delco Electronics (Kokomo, Indiana) designing and testing automotive electronic control systems using hardware-in-the-loop technology. His research interests include nonlinear control theory, behavioral modeling, diagnostic/prognostic strategies, and mechatronic system design with application to automotive and power generation systems. His multi-disciplinary research activities emphasize a collaborative teaming approach with both industrial and government sponsors. Dr. Wagner is a licensed Professional Engineer and a Fellow of the American Society of Mechanical Engineers.

SEP 24, 2015

Design Domain of LED-based Solid State Lighting Considering Cost, Energy Consumption and Reliability

BONGTAE HAN

Professor
Mechanical Engineering Department
University of Maryland,
College Park, MD 20742

ABSTRACT:

High power light emitting diodes (HP LEDs) are expected to become a general light source of the next generation. Unlike the conventional light sources (compact florescent light, incandescent light, etc.), the design considerations for LED-based luminaires are unique in that many design solutions are possible for the same required light output because the design parameters of passively cooled LED-based luminaires are interdependent and the corresponding requirements are dictated by operating conditions. After briefly describing the high power white LED characteristics, this seminar presents a methodology to define the optimum design domains of passively cooled LED-based luminaires for a given light output requirement, considering cost, energy consumption and reliability.

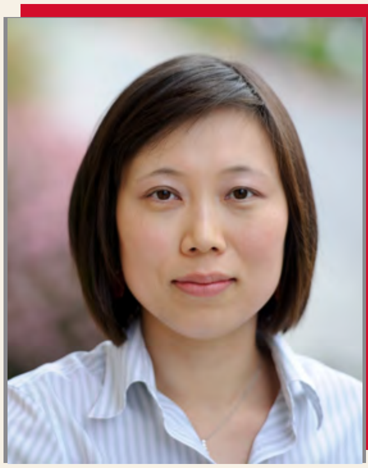
BIOGRAPHY:

Dr. Bongtae Han is Keystone Professor of Engineering and Director of Electronic Products and Systems Division of the Mechanical Engineering Department of the University of Maryland; and is currently directing the LOMSS (Laboratory for Optomechanics and Micro/nano Semiconductor/ Photonics Systems) of CALCE (Center for Advanced Life Cycle Engineering). Dr. Han has co-authored a text book entitled "High Sensitivity Moiré: Experimental Analysis for Mechanics and Materials", Springer-Verlag (1997) and edited two books. He has published 10 book chapters and over 150 journal and conference papers in the field of microelectronics, photonics and experimental mechanics. He holds 2 US patents and 4 invention disclosures. Dr. Han received the IBM Excellence Award for Outstanding Technical Achievements in 1994. He was a recipient of the 2002 Brewer Award, presented at the Annual Conference of the SEM in Emerging Technologies. His publication awards include the Year 2004 Best Paper Award of the IEEE Transactions on Components and Packaging Technologies, and the Gold Award (best paper in the Analysis and Simulation session) at the 1st Samsung Technical Conference in 2004. His recent contributions to an innovative 1,500-face lumen LED luminaire, jointly developed with GE, have been recognized in a Press Release (Oct. 21, 2010, MarketWatch.com, The Wall Street Journal). He served as an Associate Technical Editor for Experimental Mechanics, from 1999 to 2001, and has been serving as an Associate Technical Editor for Journal of Electronic Packaging, Transaction of the ASME since 2003.

He was elected a Fellow of the SEM (Society for Experimental Mechanics) and the ASME (American Society for Mechanical Engineers) in 2006 and 2007, respectively.

OCT 01, 2015

Bridging Combustion and Nanotechnology



XIAOLIN ZHENG

Associate Professor
Department of Mechanical Engineering
Stanford University
Stanford, CA

ABSTRACT:

Intersection between combustion and nanotechnology offers exciting opportunities to provide mutual benefits for both areas. Previous combustion research related to nanotechnology has primarily focused on the synthesis of nanoparticles (NPs), combustion of Al NPs and soot formation. Nevertheless, nanotechnology, in the past decade, has achieved significant progress in the area of one-dimensional (1-D) nanomaterials, such as nanowires (NWs) and nanotubes (NTs), and the high aspect ratios of these 1-D nanomaterials offer additional benefits of isotropic properties in comparison to NPs. 1-D nanomaterials have already made great impact on many areas, ranging from energy conversion systems, electronic and optical devices, to biological sensing and health monitoring systems, but, to a much less degree, on combustion. This talk will present two examples of our efforts in bridging combustion and 1-D nanomaterials. First, we developed several flame synthesis methods to synthesize, decorate or dope 1-D metal oxide nanomaterials and these materials exhibit much enhanced photoelectrochemical water splitting performance. Second, we applied 1-D transition metal oxides to catalyze the oxidation reactions of hydrocarbons. These 1-D nanostructured catalysts compared to the supported NPs, exhibit comparable or even better catalytic activity and stability, great flexibility in increasing the catalyst loading, and convenience in tuning the surface chemistry. Finally, we demonstrated a distributed optical ignition method that uses a camera flash to ignite Al NPs, resulting in the ignition of solid phase energetic materials, and liquid and gaseous fuels. The flash ignition occurs when the Al NPs have suitable diameters and sufficient packing density to cause a temperature rise above their ignition temperatures. Interestingly, even micron size Al particles can also be flash ignited by addition of WO_3 NPs due to enhanced light absorption and oxygen supply.

BIOGRAPHY:

Xiaolin Zheng is an Associate Professor of Mechanical Engineering at Stanford University. She received her Ph.D. in Mechanical & Aerospace Engineering from Princeton University (2006), B.S. in Thermal Engineering from Tsinghua University (2000). Prior to joining Stanford in 2007, she did her postdoctoral work in the Department of Chemistry and Chemical Biology at Harvard University. Her research interests include flame synthesis of nanomaterials and their applications in solar energy conversion, and developing manufacturing methods for flexible electronic devices. She is a member of MRS, ACS and the Combustion Institute. Her research has been honored with awards including the 3M Nontenured Faculty Award from 3M (2013), Presidential Early Career Award for Scientists and Engineers (PECASE) from the White House (2009), Young Investigator Awards from the ONR (2008) and DARPA (2008), Terman Fellowship from Stanford (2007), and Bernard Lewis Fellowship from the Combustion Institute (2004).

OCT 08, 2015

In Situ Nanomechanics

TING ZHU

Professor
Woodruff School of Mechanical Engineering
Georgia Institute of Technology, Atlanta, GA

ABSTRACT:

In situ nanomechanics is an emerging field that investigates the mechanical properties and deformation mechanisms of nanostructured materials. The study of in situ nanomechanics is typically conducted by integrating the real-time mechanical testing inside an electron microscope and the mechanics modeling with atomic resolution. It provides a powerful approach to visualize the intrinsic nanomechanical behavior of materials - seeing is believing. In this talk, I will present recent studies of in situ nanomechanics from my group, including the electrode degradation in nanoscale lithium-ion batteries (Nature Nanotechnology, 7, 749, 2012); deformation-induced stacking fault tetrahedra in FCC nanocrystals (Nature Communications, 4, 2340, 2013); fracture toughness of graphene (Nature Communications, 5, 3782, 2014); and twinning-dominated deformation in BCC nanowires (Nature Materials, 14, 594, 2015). The in situ nanomechanics studies provide new insights that cannot be offered by traditional mechanics studies. Ultimately, the in situ nanomechanics research aims to enable the design of nanostructured materials to realize their latent mechanical strength to the full. Our research involves collaborations with Drs. Scott Mao, Jianyu Huang and Jun Lou.

BIOGRAPHY:

Ting Zhu is a professor and a Woodruff Faculty Fellow in the George W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology. He received his Ph.D. in Mechanical Engineering from Massachusetts Institute of Technology in 2004. He worked as a postdoctoral associate at Harvard University, before joining Georgia Tech in 2005. His research is focused on mechanics and materials modeling. Zhu is an ASME Fellow. He receives the ASME Sia Nemat-Nasser Early Career Award in 2013 and the Young Investigator Medal from the Society of Engineering Science (SES) in 2014.

OCT 15, 2015

Pathway to model oceanic overflow: experimental study of stratified flows

JUN CHEN

Associate Professor of Mechanical Engineering Purdue University, West Lafayette, Indiana

ABSTRACT:

Mixing and entrainment processes significantly influence global oceanic circulation, where the shear dominates the stabilizing effect of the stratification and the flow at the stratification interface becomes unstable, resulting in turbulent mixing. Owing to limited spatial resolution in global-scale ocean/climate simulations, the sub-grid scale mixing dynamics must be properly parameterized. The mixing process is first investigated in laboratory experiments by generating gravity currents flowing into a steady ambient medium along an inclined plate. The level of turbulence is experimentally enhanced using active grids. Experiments are conducted at different Richardson number by varying the density stratification and flow rate. A second set of experiments examines the mixing in a stratified jet. In both experiments, Particle Image Velocimetry (PIV) and Planar Laser Induced Fluorescence (PLIF) are combined to measure velocity and density fields simultaneously at high resolution, thus enable detailed investigation of the flux term and turbulent energetics. The obtained data are used to evaluate the Richardson number dependence of entrainment rate and compared with the prediction of different parameterizations, as well as to examine the mixing efficiency and the physics for developing improved parameterization models.

BIOGRAPHY:

Dr. Jun Chen received his B.S. degree and M.S. degree in aerospace engineering from Beijing University of Aeronautics and Astronautics. He obtained his PhD degree in mechanical engineering from Johns Hopkins University in 2005. After that he conducted postdoctoral research in Los Alamos National Laboratory. He joined Purdue faculty of School of Mechanical Engineering in 2008. Dr. Chen's research interests are in the area of experimental and applied fluid dynamics, including development of advanced flow diagnostic techniques, turbulent flow measurements and modeling, stratified flows, cardiovascular flow dynamics, wind energy, etc. His research projects were funded by by DOE, NIH, NASA, DoEd, etc.

OCT 22, 2015

How do cells find their centers, push out their boundaries, and spin their nuclei?: Answers to these mysteries revealed by multi-scale modeling

RICHARD B. DICKINSON

Professor and Chair
Department of Chemical Engineering
University of Florida
Gainesville, FL

ABSTRACT:

Living cells use molecular motors to convert chemical energy into mechanical work in order to perform essential functions such as cell division, cell locomotion, muscle contraction, and contraction of damaged tissue in wound repair. Molecular motors operate by using cycles of binding, hydrolysis, and release of protein-bound adenosine tri-phosphate (ATP) to modulate motor protein conformation and binding affinity in order to "walk" along the subunits of cytoskeletal filaments (actin filaments or microtubules). Although force-generating cycles of several molecular motors have been well characterized, how motors operate collectively to result in observed cell behavior on longer length and time scales is often poorly understood and involves a complex interplay of force-sensitive reaction kinetics, mechanics, and transport phenomena. I will discuss three long-standing questions in cell biology: (1) How do cells rotate the nucleus? (2) How do cells position the centrosome so precisely at the cell center? (3) How do cells push the cell membrane to form membrane protrusions during cell locomotion? In each of these cases, a multi-scale mechanistic models has shown that the observed cell behavior can arise on the long-time scale from the action of an ensemble of molecular motors operating on the sides or tips of cytoskeletal filaments.

BIOGRAPHY:

Richard Dickinson serves as Professor and Chair of the Department of Chemical Engineering at the University of Florida. He joined the Department in 1994 after receiving his B.S. in Chemical Engineering at the University of Washington, his PhD in Chemical Engineering from the University of Minnesota, a postdoctoral appointment at the University of Wisconsin, and an appointment as NATO Postdoctoral Fellow at the University of Bonn in Germany. Professor Dickinson's research is in the area of cellular/molecular bioengineering. His seminal research contributions to the fields of actin dynamics, bacterial adhesion, and cell motility has been recognized by his election as Fellow of the American Institute of Medical & Biological Engineering, an NSF Career Award, and a UF Research Foundation Professorship. He also received the R. Wells Moulton Distinguished Alumnus Award from the University of Washington Chemical Engineering Department. He has supervised or co-supervised 15 PhD students to graduation and published over sixty research articles. His commitment to excellence in engineering education has been recognized by the University-wide Teacher-of-the-Year Award, which is the highest teaching honor bestowed by the University of Florida. Professor Dickinson currently serves as Associate Editor of Chemical Engineering Education and on the Editorial Board of Cellular and Molecular Bioengineering.

OCT 29, 2015

Collaboration and Control in Networked Systems

MARTIN CORLESS

Professor
Department of
Mechanical Engineering
Purdue University
West Lafayette, IN

ABSTRACT:

A traditional scenario in systems and control engineering involves a single system to be controlled (the plant) and an associated controller.
The controller is designed to achieve some desired performance or behavior from the plant. Many modern scenarios involve a network of many plants which need to be simultaneously controlled to achieve some common objective or behavior. Examples include formation flying of unmanned air vehicles; sensor networks; communication networks; next generation traffic control system and decentralized resource allocation among many users. In these scenarios there is not a single controller but each plant has an associated controller. Also, each plant does not communicate with all of the other plants but with just a few neighboring plants. So a single centralized controller cannot be used. This gives rise to a network graph which describes the communication structure associated with the plants. This talk presents some basic results and some recent results on collaboration and control in networked systems.

BIOGRAPHY:

Dr. Corless received his B.S. degree in mechanical engineering from University College, Dublin, Ireland in 1977. He obtained his PhD degree in mechanical engineering from University of California, Berkeley in 1984. After that he joined Purdue faculty of School of Mechanical Engineering. Dr. Corless' research interests are in the area of dynamics, control systems and automative systems. Dr. Corless received W.A. Gustafson Teaching Award in 2003 and 2009 and C.T. Sun Research Award in 2011.

NOV 05, 2015

Flow Boiling in Microchannels – New Pathways to High Heat Flux Dissipation

SATISH G. KANDLIKAR

Professor
Department of Mechanical Engineering
Rochester Institute of Technology
Rochester, NY

ABSTRACT:

Reaching a high heat flux dissipation goal of 1 kW/cm2 from a large area with low temperature differences has been the implicit goal of research utilizing flow boiling in microchannels. After a decade of intense research, flow boiling in lain and fin-enhanced microchannels could not reach this goal due to instabilities and inherent low performance. A new class of microchannels has emerged and the possibility of reaching these high flux goals has become a reality. Recent research at RIT on Open Microchannels with tapered Manifold (OMM) has been able to meet these demands. The talk will illustrate the worldwide journey embarked by researchers in this quest and current status in this field.

BIOGRAPHY:

Satish G. Kandlikar is a Gleason Professor of mechanical Engineering at Rochester Institute of Technology in Rochester, NY, USA. He has been active in research in the areas of pool and flow boiling, microchannel flows, electronics cooling, hydrogen energy, fuel cells, microchannels and microfluidics. He has published over 350 journal and conference papers. He is the author/editor of several books/handbooks including Handbook of Phase Change: Boiling and Condensation published by Taylor and Francis, and Heat Transfer and Fluid Flow in Minichannels and Microchannels published by Elsevier Publishing Co. He is the founding chair of the ASME Nanochanncels, Microchannels and Minichannels conference. He has received a number of awards including Rochester Engineer of the Year Award, ASME Dedicated Service Award, Eisenhart Award for Outstanding Teaching and the prestigious ASME Heat Transfer memorial Award.

NOV 12, 2015

Model-Free control theory and application based on the uncertainty and disturbance estimator

BEIBEI REN

Assistant Professor
Department of Mechanical Engineering
Texas Tech University
Lubbock, TX

ABSTRACT:

Many systems have unknown dynamics, modeling errors, and various sorts of disturbances, and noise. "Building reliable systems from unreliable parts" is one of the key challenges facing the field of control. In this talk, the speaker will present her research on model-free control to deal with uncertainties and disturbances, focusing on her recent work on uncertainty and disturbance estimator (UDE)-based control to provide the flexibility and performance of advanced control methodologies with the conceptual simplicity of classical proportional-integral-derivative control. Two practical applications, including hysteresis accommodation on a piezoelectric-driven nanopositioning stage and the full degree-of-freedom control of a quadrotor platform under extreme conditions, will be presented to demonstrate the effectiveness of the proposed method. At the end of this talk, the overview of her other research projects, including station keeping and vibration control of marine mooring systems, positioning of marine installation systems in harsh ocean environments, laser pulse shaping for optimization of energy gains in laser systems for photolithography, and control of power electronics in smart grid integration will be covered.

BIOGRAPHY:

Dr Beibei Ren received her B. Eng. and M. Eng. degrees in Mechatronics Engineering from Xidian University, Xi'an, China, in 2001 and in 2004, respectively, and her Ph.D. degree in Electrical and Computer Engineering from the National University of Singapore, Singapore, in 2010. She was a research fellow at the Center for Offshore Research and Engineering, National University of Singapore, Singapore in 2010 and a postdoctoral scholar in the Department of Mechanical & Aerospace Engineering, University of California, San Diego, CA, USA from 2010 to 2013.She joined the Department of Mechanical Engineering,Texas Tech University, Lubbock, TX, USA,in 2013, as an Assistant Professor.She has published one research monograph "Modeling, Control and Coordination of Helicopter Systems" withSpringer, and about50 research papers in scientific journals and international conferences. Her main research interests include nonlinear systems, adaptive control, neural networks, distributed parameter systems, extremum seeking and their applications to helicopter systems, MEMS, laser systems, marine/offshore systems, wind energy systems and smart grid integration.

NOV 19, 2015

Stability and Transition on Flight Vehicles

HELEN L. REED

Regents Professor and Presidential Professor for Teaching Excellence
Aerospace Engineering
Texas A&M University

ABSTRACT:

The ability to accurately predict and control the transition process from laminar to turbulent flow will provide significant advances in air-vehicle design, with applications ranging from high-altitude long-endurance unmanned aerial vehicles, to energy-efficient transports, to hypersonic systems. The development, validation, and introduction of physics-based approaches for stability and transition prediction will lead to smaller and more manageable uncertainties in the design of vehicles. Moreover, control may be applied for two different reasons. First there is the desire to delay transition, which contributes to aerodynamic heating load reduction and range and/or endurance. A second desire is to encourage transition for enhanced mixing or separation delay, such as over control surfaces and the inlet of a scramjet engine. The most effective strategy for control is to capitalize on the flow physics, identify the relevant instability mechanisms and what affects them, and modulate the most unstable disturbances as they are just beginning to grow. Our team has successfully applied linear and nonlinear parabolized stability equation and global methods to these problems, and also considered the effects of 2-D surface excrescences and formulated a physics-based correlation for forward-facing steps in 3-D boundary layers. Through mechanism identification, verification, and validation activities, several lessons have been learned in applying stability formulations.

BIOGRAPHY:

Helen L. Reed, Ph.D., P.E., holds designations as Regents Professor, Presidential Professor for Teaching Excellence, and Holder of the Edward "Pete" Aldridge '60 Professorship, and is a former Department Head of Aerospace Engineering at Texas A&M University, following faculty appointments at Stanford University and Arizona State University. She is also Co-Founder and Chief Technology Officer for Chandah Space Technologies, a start-up company specializing in small-satellite systems. She received her Ph.D. in Engineering Mechanics from Virginia Tech. Dr. Reed has 38 years of experience in physics-based understanding, prediction, and control of the receptivity, stability, and transition of boundary layers on aerospace vehicles, with applications to high-altitude long-endurance unmanned aerial vehicles, transports, and hypersonic trans-atmospheric vehicles. In parallel she also has 22 years of experience in small-satellite design and operations and student programs. She is a Fellow of the American Institute of Aeronautics & Astronautics (AIAA), the American Physical Society, and the American Society of Mechanical Engineers. She was the recipient of the 2007 J. Leland "Lee" Atwood Award from the American Society for Engineering Education and AIAA. She was also inducted into the Academy of Engineering Excellence and the College of Engineering “Committee of 100” at Virginia Tech. Presently she is a member of the National Research Council’s Aeronautics and Space Engineering Board (ASEB), the Chair of the AIAA Transition Discussion Group, subgroup lead for the NATO AVT ET 136 Technical Team: “Hypersonic Boundary Layer Transition Prediction”, and a consultant to the Institute for Defense Analysis.

NOV 26, 2015

HAPPY THANKSGIVING!

DEC 03, 2015

Graphene Electrodes for Next Generation Lithium-Ion Batteries

NIKHIL A. KORATKAR

John A. Clark and Edward T. Crossan Endowed Chair Professor
Department of Mechanical Engineering
Rensselaer Polytechnic Institute
Troy, NY

ABSTRACT:

Conventional graphitic anodes in lithium-ion batteries provide a maximum specific charge storage capacity of ~372 mAh/g. Moreover graphitic anodes cannot provide high power densities due to slow diffusivity of lithium ions in the bulk electrode material. In my talk, I will describe novel thermal and photo-thermally reduced free-standing graphene paper as high-energy and high-power density capable electrodes for lithium-ion batteries. These materials are also structurally robust and deliver stable performance for thousands of cycles of charge and discharge. I will explain the fundamental mechanisms that enable the superior performance of graphene electrodes over their graphitic counterparts. I will also discuss how defects in the graphene lattice can be used to attract Li and initiate the plating of lithium metal in the interior of porous graphene networks. I will show how the nano-porous nature of the graphene electrode prevents dendrites from forming in such structures. Using this principle, I will demonstrate an ultra-high energy density full-cell configuration with stable performance where graphene based electrodes are utilized as the anode and the cathode is lithium cobalt oxide. I will also demonstrate how the pore and defect structure of the graphene electrodes can be optimized to maximize both the gravimetric as well as volumetric energy density of the full-cell configuration.

BIOGRAPHY:

Nikhil Koratkar is the John A. Clark and Edward T. Crossan Endowed Chair Professor of Engineering at the Rensselaer Polytechnic Institute. Koratkar's research has focused on the synthesis, characterization, and application of nanoscale material systems. This includes graphene, carbon nanotubes, hexagonal boron nitride, transition metal dichalcogenides as well as metal and silicon nanostructures produced by a variety of techniques such as exfoliation of graphite, chemical vapor deposition, and oblique angle sputter and e-beam deposition. He is the author or co-author of over 140 archival journal papers (7000+ citations, H-Index = 48) and is presently serving as an editor of the Elsevier journal CARBON. He is a winner of the NSF CAREER Award (2003), RPI Early Career Award (2005), the Electrochemical Society's SES Young investigator Award (2009) and the American Society of Mechanical Engineering (ASME) Gustus L. Larson Memorial Award (2015).