MIT Industrial Liaison Program Faculty Knowledgebase Report

Energy

May 18, 2023 11:00 am - 1:00 pm

11:00 AM

Welcome and Introductions
CJ (Changjie) Guo
Program Director, MIT Corporate Relations

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Dr. CJ Guo joined the Office of Corporate Relations as a Senior Industrial Liaison Officer in July, 2015. CJ comes to OCR with 25 years of extensive global experience in technology innovations, portfolio management and business development in emerging and conventional energy sectors with leading multinational corporations in the US, China and Canada.

CJ is a leading expert in emerging energy technologies and energy system transitions. With Shell, he was the Emerging Technology Theme Leader in China/Beijing (2011 to 2015), worked extensively with the Chinese energy communities on the country's future energy landscape, and the Senior Technology Advisor in alternative transportation fuels in the US / Houston (2006-2010), and served during 2010 as Chairman of the Fuel Operations Group for the US DOE FreedomCar Partnership. Prior to joining Shell, CJ has held technology development, commercialization and management positions with Air Liquide (2002-2006) and The BOC Group (1995-2001) after working as a research scientist in oil-sands upgrading with CANMET in Canada (1992-1994).

CJ earned his Ph.D., Chemical Engineering, at CSU, Ohio, his M.S. and B.S., Chemical Engineering at TYUT, China. He has earned various awards from Shell, Air Liquide, BOC, Shanxi Province (China). He holds many patents and has sat on the board of Shenzhen Sanmu Battery Technology Company as an independent board member during 2009-2010.

11:03 AM

Materials Processing & Recovery for Clean Energy
Ju Li

Battelle Energy Alliance Professor, MIT Department of Nuclear Science & Engineering
Professor, MIT Department of Materials Science and Engineering

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Ju Li is the Tokyo Electric Power Company Professor in Nuclear Engineering and a Professor at the MIT Department of Materials Science and Engineering. Prof. Li's group investigates the mechanical, electrochemical, and transport behaviors of materials, as well as novel means of energy storage and conversion. His research has led to advances in materials with applications in nuclear energy, batteries, and electrolyzers—and near- and long-term implications for decarbonizing the planet. His group also works on various aspects of computing, from the development of the first universal neural network interatomic potential to energy-efficient neuromorphic computing hardware.

Li is a recipient of the 2005 Presidential Early Career Award for Scientists and Engineers, the 2006 Materials Research Society Outstanding Young Investigator Award, and the TR35 award from Technological Review. He was elected Fellow of the American Physical Society in 2014 and a Fellow of the Materials Research Society in 2017. Li is the chief organizer of the yearly MIT A+B Applied Energy Symposia that aims to develop practical solutions to global climate change with "A-Action before 2040" and "B-Beyond 2040" technologies.

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Rapid green energy transition requires an enormous amount of new materials that are earth-abundant, cheap to process, high-performance, and recyclable. We are developing high-performance battery and electrolyzer materials (http://Li.mit.edu/bat) with consideration of industrialization, assisted by automated experimentation and machine learning. Some examples from lithium-ion batteries, hydrogen production, and CO2 reduction are used to illustrate the challenges.

11:40 AM

Modeling the Mechanics in Batteries: Safety, Reliability, and Lifetime

Juner Zhu
Executive Director, MIT Industrial Battery Consortium (2020-2022) and
Center for Battery Sustainability

The principles of electrochemistry govern the performance of batteries. On the other side of the coin, it is the mechanics of particles, electrodes, and cells that largely determine the safety, reliability, and lifetime of the electrochemical systems. Typical examples include fire incidents of EVs where the mechanical deformation of batteries leads to internal short circuits; the capacity fade of battery cells where cracks of active particles cause undesired side reactions and accelerate the degradation; and the management of Li-ion battery modules and some novel solid-state batteries where external pressure is usually applied to prolong the lifetime of the systems. This presentation will provide an overview of recent studies of modeling the mechanics in Li-ion and solid-state batteries at different length scales.

Tomasz Wierzbicki
Founder & Director & Principal Investigator
Professor of Applied Mechanics, MIT Department of Mechanical Engineering

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Professor of Applied Mechanics
MIT Department of Mechanical Engineering

Tomasz Wierzbicki is a professor of Applied Mechanics in the MIT Department of Mechanical Engineering.

12:20 PM

Learning the Physics of Li-ion Batteries from Images
Martin Bazant
Edwin G Roos (1944) Professor and Executive Officer of Chemical Engineering and Professor of Mathematics, MIT Department of Chemical Engineering
Co-Director, Center for Battery Sustainability

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Edwin G Roos (1944) Professor and Executive Officer of Chemical Engineering and Professor of Mathematics, MIT Department of Chemical Engineering
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Martin Bazant is the E. G. Roos (1944) Professor of Chemical Engineering and Mathematics and Executive Officer of the department of chemical engineering at MIT. He is a Fellow of the American Physical Society, the International Society of Electrochemistry and the Royal Society of Chemistry and has won multiple awards. Bazant's research focuses on mathematical modeling of transport phenomena, especially in electrokinetics and electrochemical systems. Noteworthy contributions include theories of induced-charge electro-osmosis, control of phase separation in Li-ion batteries, and a new method of water desalination -- “shock electrodialysis.” His educational innovations include the first graduate-level massive open online course (MOOC) in applied mathematics or chemical engineering. Bazant also consults extensively for industry and serves as the Chief Scientific Advisor for Saint Gobain Ceramics and Plastics, North America R&D Center in Northboro, MA. Bazant holds a PhD in physics from Harvard University.

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Theoretical physics has traditionally relied on human intelligence to discover the laws of nature. Artificial intelligence is beginning to challenge this paradigm but still struggles to learn any physical “laws” valid far beyond the training dataset. This talk presents a hybrid approach to solving PDE-constrained inverse problems to learn electrochemical physics directly from image data. From x-ray images of lithium iron phosphate nanoparticles during battery cycling, we learn the free energy landscape of the material, the reaction kinetics of coupled ion-electron transfer, and the nanoscale profile of surface reactivity (correlated with carbon coating thickness). From optical images of graphite anodes during fast charging, we learn the dynamics of staging phase transformations and the conditions for parasitic lithium plating. Incorporating this knowledge in multiphase porous electrode theory (MPET) enables predictive simulations of Li-ion batteries, which can be used to optimize of fast-charging protocols and formation cycling for extended battery lifetime.

1:05 PM

Adjournment