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Battery Safety Science Symposium

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Session II
Novel Electrode Materials: The Future

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Designing Electrode Architectures across Length Scales:
Some Lessons Learned from Li-ion and "Beyond Li" Chemistries

The design and operation of rechargeable batteries is predicated on orchestrating flows of mass, charge, and energy across multiple interfaces. Understanding such flows requires knowledge of atomistic and mesoscale diffusion pathways and the coupling of ion transport with electron conduction. Using multiple polymorphs of V2O5 as model systems, I will discuss our efforts to develop an Angstrom-level view of diffusion pathways. Scanning transmission X-ray microscopy and ptychography imaging provides a means of mapping the accumulative results of atomic scale inhomogeneities at mesoscale dimensions and further enables tracing of stress gradients across individual particles—thereby providing key insights related to degradation and safety. I will discuss mitigation of diffusion impediments with reference to two distinct approaches: (a) utilization of Riemann manifolds as a geometric design principle and (b) the atomistic design of polymorphs with well-defined diffusion pathways that provide frustrated coordination, enabling the design of monovalent and multivalent insertion hosts. Finally, I will discuss challenges with the electrodeposition of magnesium and unveil some strategies for mitigating dendrite formation.

About the speaker

Dr. Sarbajit Banerjee is the Davidson Chair Professor of Chemistry, Professor of Materials Science & Engineering, and Chancellor EDGES Fellow at Texas A&M University. Sarbajit is a graduate of St. Stephen's College (B.Sc.) and the State University of New York at Stony Brook (Ph.D.). He was a post-doctoral research scientist at the Department of Applied Physics and Applied Mathematics at Columbia University prior to starting his independent career at the University at Buffalo in 2007. He moved to Texas A&M University in 2014. He was awarded a National Science Foundation CAREER award in 2009; the American Chemical Society ExxonMobil Solid-State-Chemistry Fellowship in 2010; the Cottrell Scholar Award in 2011; the Minerals, Metals, and Materials Society Young Leader Award in 2013; the American Chemical Society Journal of Physical Chemistry Lectureship in 2013; the Scialog Innovation Fellowship in 2013; the IOM3 Rosenhain Medal and Prize in 2015; and the Royal Society of Chemistry/IOM3 Beilby Medal in 2016. In 2012, MIT Technology Review named Sarbajit to its global list of "Top 35 innovators under the age of 35" for the discovery of dynamically switchable smart window technologies that promise a dramatic reduction in the energy footprint of buildings. He was named a NASA NIAC Fellow in 2021 and has received two Special Creativity Awards from the National Science Foundation (2020 and 2021). He was awarded the 2018 Robert S. Hyer Graduate Student Mentor Award by the Texas Section of the American Physical Society and the 2019 Undergraduate Research Mentoring Award by the College of Science at Texas A&M University. He serves as Senior Editor of ACS Omega and is a Fellow of the Royal Society of Chemistry and the Institute of Physics. His research interests are focused on solid-state chemistry, electron correlated materials, mechanisms of electrochemical energy storage, heavy oil extraction and processing, and functional coatings.