DREXEL UNIVERSITY
Materials Science and Engineering
College of Engineering

Department of Materials Science and Engineering
Spring Seminar Series

2:45 PM, Wednesday, April 25
PISB 106

"Architectural Design in 3D Physically Thwarts Dendrite Formation—With Zinc Now Rechargeable, Who Needs Lithium Batteries?"

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Abstract: Our team at the U. S. Naval Research Laboratory explores rate-critical processes where events per second are required for high performance in such areas as energy storage, energy conversion, (electro) catalysis, and sensing. We then design next-generation systems built around pore–solid nanoarchitectures that seamlessly embody all of the requisite rate functions for high-performance electrochemistry: molecular mass transport, ionic/electronic/thermal conductivity, and electron-transfer kinetics. We have taken the lessons from 20 years of probing the operational and design characteristics of energy-relevant nanoarchitectures to create a safer zinc-based aqueous battery with energy capacity commensurate with still too-catastrophe–prone lithium-ion batteries. The key to realizing rechargeable zinc alkaline batteries lies in controlling the behavior of the zinc anode during cycling. Our team does this with a sponge form-factor, which physically ensures more uniform charge–discharge reactions and thwarts dendrite-formation. With this breakthrough, we can now address the family of zinc-based rechargeable alkaline batteries: nickel–3D zinc, silver–3D zinc, MnO_2–3D zinc, and even rechargeable 3D zinc–air.

Bio:

Debra Rolison heads the Advanced Electrochemical Materials section (also known as the U.S. Navy's nanoarchitectural firm) at the U. S. Naval Research Laboratory in Washington, DC. Her team designs, synthesizes, characterizes, and applies three-dimensionally structured, ultraporous, multifunctional nanoarchitectures for such rate-critical applications as catalysis, energy storage and conversion, and sensors. Her 2003 article in Science emphasizing the importance of nothing in catalytic nanoarchitectures presaged the current emphasis on mesoscale effects in catalysis. Along with Bruce Dunn (UCLA), Jeffrey Long (NRL), and Henry White (University of Utah), she established a new sub-discipline in electrochemical science: three-dimensional (3D) electrochemical energy storage in which battery function is volumetrically integrated within the cell rather than layered in 2D and all transport paths are wired in 3D.

Rolison was a Faculty Scholar at Florida Atlantic University (1972–1975), where she worked with Frank Schultz on nonaqueous ion-selective electrodes and the electrochemistry of m-sulfido molybdenum complexes before receiving her B. S. in Chemistry in 1975. She also spent a summer in 1974 as an undergraduate research intern in William Dolbier's group at the University of Florida. She then entered the graduate chemistry program at the University of North Carolina at Chapel Hill, where she joined the group of Royce Murray just as chemically modified electrodes were being invented. She received her Ph. D. in Chemistry from UNC in 1980 after demonstrating the Pt-like character of RuO_2 electrodes in nonaqueous electrolytes, helping to establish polymer-modified electrodes, and ensuring frequent pick-up games of killer volleyball; she then immediately joined the NRL as a staff scientist until founding NRL's Advanced Electrochemical Materials section in 1999. Rolison is a Fellow of the American Association for the Advancement of Science, the Association for Women in Science, the Materials Research Society, and the American Chemical Society. Among her major awards, she received the William H. Nichols Medal (2018), the Department of the Navy Dr. Dolores M. Etter Top Scientist & Engineer Team Award (2016), the ACS Division of Analytical Chemistry Award in Electrochemistry (2014), the Charles N. Reilley Award of the Society for Electroanalytical Chemistry (2012), the ACS Award in the Chemistry of Materials (2011), and the Hillebrand Prize of the Chemical Society of Washington (2011).

Her editorial advisory board service includes Chemical Reviews, Analytical Chemistry, Langmuir, Journal of Electroanalytical Chemistry, Advanced Energy Materials, and the inaugural boards of Nano Letters, the Encyclopedia of Nanoscience and Nanotechnology, Annual Review in Analytical Chemistry and ACS Applied Energy Materials. Rolison also writes and lectures widely on issues affecting women (and men!) in science, including proposing Title IX assessments of science and engineering departments. She is the author of over 225 articles and holds 35 U. S. patents.

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