UC San Diego
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SEMINAR SERIES

Wednesday, January 15, 2020
Seminar Presentation: 11:00am – 12:00pm
SME room 248

"Redox-active Macromolecular Radicals Towards Sustainable Energy Storage"

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Abstract: Sociopolitical pressure towards elemental cobalt drives the demand for new energy storage materials. Specifically, Li-ion battery cathodes contain lithium cobalt oxide (LCO) or lithium nickel manganese cobalt oxides (LNCM), for which some cobalt is obtained from politically sensitive geographical regions or by means of child labor. One solution towards this challenge is the translation of organic or metal-free electrodes to replace of cobalt-containing cathodes. Here, macromolecular radicals as redox-active electrodes for batteries are presented. These polymers generally contain redox-active nitroxide radical groups that reversibly exchange electrons at rates much higher that of current metal oxide cathodes. This manifests as a higher power or a high charging rate. However, the mechanism of energy storage in macromolecular radicals is not entirely clear. Also, there are persistent issues with conductivity of the material, as well as its dissolution into the electrolyte, leading to capacity fade. The mechanism of the redox activity is quantitatively determined using quartz crystal microbalance with dissipation monitoring, in which two mechanisms are observed related to cation and anion transport. To address conductivity, conjugated radical polymers are examined. Finally, to address dissolution, crosslinked-macromolecular radicals are investigated. These results contribute to our long-term vision of achieving metal-free batteries made from organic materials.

Trainees will be exposed to basic concepts of polymers, radical chemistry, and energy storage. Techniques related to synthesizing macromolecular radicals, characterizing redox-active polymers, and batteries will be discussed. The determination of ion transport using quartz crystal microbalance with dissipation monitoring will be introduced. Future directions, advantages, and disadvantages of macromolecular radicals will be discussed.

Biosketch: Jodie L. Lutkenhaus is the William and Ruth Neely Faculty Fellow and Professor in the Artie McFerrin Department of Chemical Engineering at Texas A&M University. Lutkenhaus received her B.S. in Chemical Engineering in 2002 from The University of Texas at Austin and her Ph.D in Chemical Engineering in 2007 from Massachusetts Institute of Technology. Current research areas include polyelectrolytes, redox-active polymers, energy storage, and composites. She has received recognitions including World Economic Forum Young Scientist, Kavli Fellow, NSF CAREER, AFOSR YIP, 3M Non-tenured Faculty Award. She is the Chair of the AICHE Materials Engineering & Sciences Division. Lutkenhaus is the Deputy Editor of *ACS Applied Polymer Materials*. She also serves on the Editorial Advisory Boards for *ACS Macro Letters*, *Macromolecules*, *ACS Applied Nano Materials*, *Molecular Systems Design & Engineering*, and *Materials Today*.