UNIVERSITY OF LOUISVILLE

COLLEGE OF ARTS & SCIENCES

Department of Chemistry

Brown and Williamson Series

Friday, April 16, 2021
@12:30 pm
Via: MS TEAMS

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Li-ion and Li-air batteries: harnessing oxygen redox and understanding interfacial reactivity in high energy batteries

ABSTRACT: Multiple directions in battery research are now being pursued with the goal of advancing beyond the specific energy limits imposed by current Li-ion batteries. When considering the design of new high-energy storage systems, new materials, processes, or chemistries are introduced that are inherently more unstable than conventional Li-ion battery materials, resulting in limited battery cycle life and safety. Three such examples of high energy battery chemistries-- high voltage operation of Ni-rich Li[Ni, Mn, Co]O2 Li+ insertion electrodes (Ni-rich NMC), Li-rich NMC electrodes (Li[Li,Ni,Mn,Co]O2), and Li-O2 electrochemistry-- will be discussed in this presentation. Previous observations of high-voltage instabilities include NMC surface reconstruction, transition metal dissolution, electrolyte decomposition, and formation of solid surface species. However, the picture of these processes is still incomplete, with the dependence on electrolyte and NMC composition not yet fully understood. I will present results in which isotopic labeling of 18O in Ni and Li-rich NMCs is combined with quantitative gas evolution analysis to identify key contributions to these high voltage instabilities, including instabilities related to solid-state anionic (oxygen) redox and the surprising impact of residual solid lithium carbonate (Li2CO3) on electrolyte and electrode degradation. These results are reminiscent of similar issues with Li2CO3 formation during Li-O2 battery operation, where large over potentials are observed during battery charging as a result of parasitic interfacial carbonate formation. This presentation will emphasize the need to accurately quantify these minor parasitic side reactions to fully understand their large influence on battery performance.

BIOGRAPHY: Bryan McCloskey is an Associate Professor and the Vice Chair of Graduate Education in the Department of Chemical and Biomolecular Engineering at the University of California, Berkeley, and also holds a joint appointment as a Faculty Engineer in the Energy Storage and Distributed Resources Division at Lawrence Berkeley National Laboratory. Upon completion of his PhD at the University of Texas at Austin in 2009, Bryan was a postdoc, and was subsequently promoted to Research Staff Member, at IBM Almaden Research Center, where he worked on elucidating the electrochemistry of Li-O2 batteries. In 2014, he joined UC and LBNL, where his laboratory currently focuses on metal-air batteries, photoelectrochemical CO2 reduction, and a variety of challenges facing Li-ion batteries, including high voltage cathode stability, advanced cathode material development, extreme fast charging, and low temperature and high transference number electrolyte formulations. He has co-authored more than 100 articles, holds 6 patents, and has won numerous awards for his research, including the Electrochemical Society Tobias Award, the Early Career Analytical Electrochemistry Prize of the International Society of Electrochemistry Division 1, and the VW/BASF Science Award- Electrochemistry. More information about the McCloskey Lab can be found at the Lab’s website: www.mccloskeylab.com.