

Mar 29, 2018

Electrochemical Reactions: Energy Storage and Beyond

ABSTRACT:

Reversible electrochemical reactions are the foundation for energy storage. We are interested in multiphase conversion reactions since they offer higher theoretical specific energies than intercalation based reactions. One class involves solid/liquid reactions such as metal plating and stripping. The other class involves solid/solid reactions such as the reversible transformation between metal fluorides and nanocomposites of metal and lithium fluorides. Batteries based on these non-intercalation based reactions still suffer from poor cycle life due to phase transitions and large volume and morphological changes. In the talk, we will discuss our work on addressing the challenges of lithium metal plating and stripping. A primary approach is to design solution reactions which produce chemically and morphologically homogeneous coatings on lithium. These coatings enable stable lithium cycling in liquid electrolytes while offering a pathway towards all solid state batteries. We will then show that battery reactions can also be leveraged as a new platform for materials synthesis. Utilizing the principle of multiphase conversion reactions, we recently developed a general method to synthesize a wide variety of nanoporous metals by removing one component from metal/lithium halide nanocomposites, commonly observed in battery cathode reactions. Studying these reactions not only affords new nanomaterials but also sheds light on the mechanisms underlying their behavior in rechargeable batteries.

BIOGRAPHY:

Dr. Ping Liu joined UC San Diego as an Associate Professor in Nanoengineering in January 2016. His group studies electrochemical materials science spanning energy conversion and storage, electrosynthesis, and electrochemical actuation. Professor Liu was a Program Director at the Advanced Research Projects Agency – Energy (ARPA-E) from 2012 to 2016, where he initiated and managed research programs in energy storage for electric vehicles and thermal management technologies to improve building energy efficiency. He was the manager of the Energy Technology Department at HRL Laboratories and was a research staff member with the National Renewable Energy Laboratory. He received his Ph.D. in Chemistry from Fudan University in China. He was a Distinguished Inventor in multiple years at HRL and won an R&D 100 award in 2009 for a battery technology developed at NREL. Dr. Liu has published over 70 peer-reviewed papers and has been issued 36 US patents in the broad areas of batteries, fuel cells, sensors and actuators.



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