Polymer-Inorganic Composite Ion Conductors for Lithium Ion Batteries

Dee Strand, Wildcat Discovery Technologies (dstrand@wildcatdiscovery.com)
Bin Li, Wildcat Discovery Technologies
Cory O'Neill, Wildcat Discovery Technologies
Alex Freigang, Wildcat Discovery Technologies

Substantial research efforts have focused on development of materials with high ionic conductivities. Ionically conducting polymer electrolytes based on polyethylene oxide (PEO) can achieve conductivities of 10-5 S/cm at room temperature, but often have poor mechanical strength despite incorporation of inorganic particles. Recently, inorganic materials such as Li7La3Zr2O12, P2S5-Li2S, Li10SnP2S12, Li1+x+yAlxTi2-xSiyP3-yO12, and Li1.3Ti1.7Al0.3(PO4)3 have all shown promise as solid electrolytes, with room temperature conductivities as high as 10-4 S/cm. Despite high conductivities, sulfide type materials require stringent moisture control during processing and some compositions are unstable against lithium metal. Ceramic membranes of these materials also pose challenges in creating mechanically stable interfaces with electrodes.

There has been relatively little work on improving the conductivity of the solid (dense) electrodes and the electrode/electrolyte interface. One major challenge to all-solid cells is the conductivity through the electrodes. Current electrodes have been optimized using liquid electrolyte systems, requiring porosity for good solid-liquid interfacial transport. However, in an all solid-cell, no transport can occur through empty pores, causing the overall electrode conductivity to suffer. This problem is further compounded by the electrode-electrolyte interface, since it is now a solid-solid versus a solid-liquid interface. One approach has been to sinter fully dense oxide based cathodes, which can be cycled at good capacities. However, this approach is limited in the number of chemistries that can be fully sintered without damaging the phase/composition and to materials that have high intrinsic electronic conductivities. This presentation will show challenges and opportunities for incorporation of inorganic ion conductors into rechargeable lithium ion cathodes.

BIOGRAPHY

Dr. Dee Strand is CSO at Wildcat Discovery Technologies, a materials discovery company focused on battery materials and other clean energy applications. Dr. Strand has over twenty years of experience in materials research, development, and commercialization, primarily in the areas of energy storage and electronic applications. Prior to joining Wildcat in 2013, Dr. Strand served as a Research Fellow at Dow Chemical, where she was the technical lead in Dow Energy Materials, as well as the Principal Investigator on external research programs with universities and national labs on battery materials. Dr. Strand completed her Ph.D. in Analytical Chemistry at the University of Wisconsin-Madison under the supervision of Professor John Schrag. Dr. Strand also holds a Master of Science degree in Chemistry from the California Institute of Technology and a Bachelor of Science degree in Chemistry from North Dakota State University.