Stabilizing NCM Cathode Materials to 4.8 V in All Solid State Batteries

Laidong Zhou[a], Kaup, K.,[a] Park, K.H.; S. Y. Kim[a], Q. Zhang[b], L.F. Nazar[a*]
[a]*University of Waterloo, Department of Chemistry and Waterloo Institute for Nanotechnology*
[b] *Neutron Scattering Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37830, United States*
**E-mail: lfnazar@uwaterloo.ca*

All-solid state lithium-ion batteries (ASSBs) have emerged as attractive alternatives to conventional liquid electrolyte cells for electrochemical energy storage, owing to their anticipated enhanced safety and higher energy densities. ASSBs are founded on high performance superionic conducting solid electrolytes, where the search for improved materials hinges on understanding their intrinsic nature and gaining comprehensive knowledge of the factors that dictate facile Li-ion transport. In turn, incorporating them into high functional ASSBs relies on mastering the interface of the solid electrolyte with the electrode materials.

These topics will be the focus of the presentation based on recent findings in our laboratory. Correlation of structure with ionic conductivity in a range of newly developed fast ion Li conductors helps inform how cation disorder and a frustrated energy landscape impacts conductivity and activation energy. These considerations lead to exciting new classes of solid state electrolytes (SEs) with high ionic conductivity and low electronic conductivity. Owing to the excellent interfacial stability of the SEs against un-coated high-voltage cathode materials, ASSBs utilizing $LiNi_{0.85}Co_{0.1}Mn_{0.05}O_2$ exhibit superior rate capability and long-term cycling (up to 4.8 V vs Li^+/Li) compared to state-of-the-art ASSBs. Low-resistance solid-solid interfaces enable room temperature cells with capacities close to their liquid Li-ion counterparts at practical discharge rates. High cathode loadings are also demonstrated in ASSBs with stable capacity retention of > 4 $mAh \cdot cm^{-2}$. The properties responsible for high-voltage stability against NCMs will be discussed in the presentation.

Keywords : All-solid-state battery; solid-state electrolyte; lithium metal halide; NCM ASSB;