Research Highlight from Solid State Ionics Lab

In view of the concern regarding the safety, cost, and longevity of existing lithium-ion batteries, all-solid-state batteries employing ceramics or ceramic-polymer composites as the electrolyte have gained renewed interest recently. Solid electrolytes with good electrochemical stability and fast lithium-ion conduction could significantly improve both the lifetime and the safety while providing a significant increase in the energy and power density of lithium metal batteries.

The research focus of *Solid State Ionics* group in Metallurgy Engineering and Materials Science, IIT Indore is on the fabrication and electrochemical characterization of ceramic electrolytes, polymer-ceramic composite electrolytes, and all solid-state rechargeable lithium batteries employing lithium metal as the andoe. The emphasis is on understanding the fundamental aspects of lithium-ion transport across solid electrolyte and at the cathode-electrolyte interface. We use this knowledge to design new polymer-ceramic composite electrolytes with lithium superionic conductor ceramics developed in our lab as the active filler in the polymer membranes.

In this regard, $LiZr_{2-x}Sn_x(PO_4)_3$ system was investigated for the crystal structure, ionic conductivity, and electrochemical properties. While both the end members of this solid-solution exhibit complex polymorphism with poor Li-ion conducting triclinic and monoclinic phases crystallizing at room temperature (RT) in samples calcined at temperatures lower than 1100 °C, the composition $LiSnZr(PO_4)_3$ crystallizes in high-conducting rhombohedral phase at RT even at calcination temperatures as low as 900 °C. This sample showed excellent bulk Li^+ conductivity ~1×10^{-2} $\Omega^{-1}m^{-1}$ which signifies the importance of *inductive effect* in improving the room temperature ionic conductivity by utilizing the electronegativity of counter-cations in NASICON framework.