Composite Electrodes for All-Solid-State Li-ion Batteries

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Abstract:

An alternative anode besides Li-metal is required for sustained functionality and capacity for all-solid-state batteries utilizing a $Li_{0.35}La_{0.55}TiO_3$ (LLT) electrolyte. The $Li_4Ti_5O_{12}$ (LTO) composition was shown to be one such oxide that shows a low redox potential, good stability during Li intercalation, and high stability with high voltage cathodes. Unfortunately, $Li_4Ti_5O_{12}$ displays a very low electrical conductivity of 10^{-13} S/cm; therefore, a composite strategy including a high conductor is required to compensate for this deficiency within the anode. It is assumed that a continuous electrode-electrolyte transition utilizing a composite structure with possible incorporation of high electrical conductor would provide the lowest electrode polarization, thermomechanical stresses, and highest Li-ion exchange rate This work investigates the use of $Li_4Ti_5O_{12}$ (LTO)-LLT composites with and without Ag impregnation as a potential anode material for LLT-based batteries.

The LLT electrolyte substrates were fabricated by tape casting and sintering process to form ~200 μm thick planar supports. Particulate composites of a LTO-LLT mixture with various amounts of carbon pore former were prepared and screen-printed and bonded onto substrates at 900-1100°C for 1 h. The pore former was incorporated into the electrode to limit sintering shrinkage and provide porosity for potential Ag impregnation. Symmetrical electroded-cells were fabricated from these materials and evaluated by electrochemical impedance spectroscopy (EIS).

Silver was incorporated into the porous electrodes by infiltration with $AgNO_3$ and subsequent calcination to 450°C. The electrode polarization was greatly decreased to 28 $k\Omega \cdot cm^2$ by incorporating Ag-nano-particulates into the LTO-LLT microstructure. The electrochemical performance of the battery structure was evaluated, and the processing/property relationship will be described within the presentation.

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