

LiTa₂PO₈-based Composite Solid Polymer Electrolytes for High-Voltage Cathodes in Lithium-Metal Batteries

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Abstract : Solid-state Lithium metal batteries (SSLMBs) that contain polymer and ceramic solid electrolytes have received considerable attention as an alternative to substitute liquid electrolytes in lithium metal batteries (LMBs) for highly safe, excellent energy storage performance and stability under elevated temperature situations. Here, a novel fast Li-ion conducting material, LiTa₂PO₈ (LTPO), was synthesized and electrochemical performance of as-prepared powder and LTPO-incorporated composite solid polymer electrolyte (LTPO-CPE) membrane were investigated. The as-prepared LTPO powder was homogeneously dispersed in polymer matrices, and a hybrid solid electrolyte membrane was synthesized via a simple solution-casting method. The room temperature total ionic conductivity (σ) of the LTPO pellet and LTPO-CPE membrane were 0.14 and 0.57 mS cm⁻¹, respectively. A coin battery with NCM811 cathode is cycled under 1C between 2.8 to 4.5 V at room temperature, achieving a Coulombic efficiency of 99.3% with capacity retention of 74.1% after 300 cycles. Similarly, the LFP cathode also delivered an excellent performance at 0.5C with an average Coulombic efficiency of 100% without virtually capacity loss (the maximum specific capacity is at 27th: 138 mAh g⁻¹ and 500th: 131.3 mAh g⁻¹). These results demonstrate the feasibility of a high Li-ion conductor LTPO as a filler, and the developed polymer/ceramic hybrid electrolyte has potential to be a high-performance electrolyte for high-voltage cathodes, which may provide a fresh platform for developing more advanced solid-state electrolytes.

Keywords : li-ion conductor, lithium-metal batteries, composite solid electrolytes, liTa₂PO₈, high-voltage cathode

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