A Wide Temperature Range Polymer Electrolyte for All-Solid-State Rechargeable Lithium Ion Battery

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Abstract

In this study, we report a novel approach to making a kind of wide operating temperature solid polymer electrolyte (SPE) based on polysiloxane for all-solid-state rechargeable lithium ion battery. It can be simply adopted into a thin film by a solvent casting method. The highest ionic conductivity can reach 7.9×10^{-5} S/cm at 25 ^{o}C and 6.2×10^{-4} S/cm at 70 ^{o}C. According to thermal analysis, the SPE has a relatively high decomposition temperature at 275 ^{o}C. A good electrochemical window up to 5.45 V at room temperature and 5.15 V at 60 ^{o}C are obtained (vs. Li/Li^{+}), which are higher than commercially used liquid electrolyte (around 4.20 V). Batteries employing $LiFePO_4$ as the cathode, lithium foil as the anode and the SPE thin film as electrolyte have been assembled. At 0.2C, the discharge capacity is 141 mAh/g and the capacity retention 98% after 100 cycles at 25 ^{o}C. The discharge capacity still remains a stable value of 112 mAh/g after 100 1C cycling at room temperature. At 60 ^{o}C, the battery easily achieves 100 charge-discharge cycles with 144 mAh/g discharge capacity at a 1C rate. Such results indicate commercial prospect of the electrolyte for next-generation all-solid-state rechargeable lithium ion battery technology competing to lower safety risk and extend the range of electric devices.