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An AB alternating diblock single ion conducting polymer electrolyte membrane for all-solid-state lithium metal secondary batteries

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Abstract

Lithium 4,4'-difluorobenzene sulfonyl imide is copolymerized with polyethylene glycol (PEG, M_w = 200, 400, 600, 800 and 1000) to synthesize a series of AB alternating diblock copolymer electrolytes (ADCE-1, 2, 3, 4, 5) for reducing the crystallinity of solid-state single ion conducting materials for applications in all-solid-state lithium metal secondary batteries. The free-standing film of ADCE-5 with the highest [EO]/[Li^+] ratio (23.7:1) is found to display the lowest glass transition temperature (T_g) and the highest ionic conductivities of 6.61×10^{-6} S cm^{-1} at 30 °C and 2.24×10^{-4} S cm^{-1} at 100 °C. The alternating architecture of the polymer effectively prevents the polymer from phase separation originated from aggregation of the ionic groups as well as the ethylene oxide groups. As a result, segment motion may take place readily in the amorphous region at low temperature. Subsequently, a piece of glass fiber mat reinforced composite polymer electrolyte film is prepared for practical battery tests. The fabricated all-solid-state single ion conducting polymeric lithium metal secondary battery is able to work at a temperature as low as 40 °C with stable cycling performance. The battery delivers 102 mAh g^{-1} at 0.1 C and is stabilized at 94 mAh g^{-1} after 200 cycles.

Key words: solid polymer electrolyte membrane, single ion conductor, phase transition temperature, lithium metal secondary batteries

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