

Gel-polymer electrolytes based on poly (methyl methacrylate) host polymer for sodium-ion rechargeable batteries

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Research and development works on sodium-ion batteries (SIBs) grow exponentially in recent days because of the abundance of sodium raw materials. Due to the larger size and lower mobility of Na⁺ ions, synthesis of suitable electrolytes with sufficient ambient temperature ionic conductivities would be a major challenge faced by the materials research community. In this work, we developed gel-polymer electrolytes (GPEs) based on poly (methyl methacrylate) (PMMA) host polymer matrix and NaClO₄ ionic salt dissolved in ethylene carbonate (EC) and dimethyl carbonate (DMC). The optimized PMMA-NaClO₄-EC-DMC GPE composition (10:14:38:38 wt%) showed an ambient temperature ionic conductivity of 8.4 mS cm⁻¹. Variation of ionic conductivity with inverse temperature showed Arrhenius behavior with almost constant activation energies of 0.16 eV for all the compositions studied. DC polarization test showed that the ionic contribution to conductivity is very high (99.8%) and the electronic contribution is negligibly small (0.2%) in the best conducting composition, which is very good to avoid short circuiting inside the battery. Cyclic voltammetric studies on best conducting composition showed that the electrolyte is electrochemically stable for a voltage window of 4 volts (- 2 to + 2 volts). This optimized composition with highest ambient temperature ionic conductivity and negligible electronic conductivity is found to be highly suitable for practical applications in secondary SIBs.

Key words: *Sodium-ion batteries, gel-polymer electrolytes, electrochemical impedance spectroscopy, ionic conductivity, DC polarization*

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