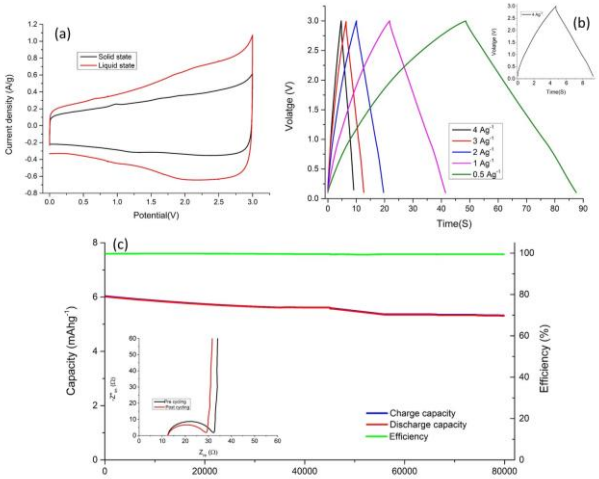
Flexible and highly conductive PS-*b*-PEO-*b*-PS/EMImTFSI membranes for solid-state supercapacitors

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Abstract

The advent of solid-state electrolytes expanded the use cases of energy storage devices into structural applications. In this regard one of the challenging aspects of developing a solid-state electrolyte is striking a balance between ionic conductivity and mechanical strength. This is critical in the development of devices with real world applications. Ionic liquids and polymer combinations have been explored prior for batteries, while investigations on supercapacitors are scarce. The use of ionic liquids is especially attractive due to their higher stability window enabling the fabrication of devices with higher energy density. Here we report the use of membranes based on block copolymers (BCP) of polystyrene and polyethylene oxide (PS-b-PEO-b-PS) in combination with an ionic liquid (EMImTSFI) with phase separated morphology as structural electrolytes for supercapacitors. We studied various PEO and ionic liquid volume fractions in the BCP and its effect on morphology and ion transport properties. We observed that at lower amounts of ionic liquid the volume fraction of PEO influences ionic conductivity and as the IL intake increases, there is an effective decoupling between PEO volume fraction and ion transport property. The block copolymer configuration along with high volume fraction of conducting phase has effectively suppressed the crystallinity of PEO rendering the membranes highly conductive. The fabricated membranes exhibited a conductivity above $1x10^{-3}$ S/cm at room temperature while being mechanically stable (storage modulus: 25.8 MPa). The solid-state symmetric supercapacitor fabricated using CNT mat electrodes exhibited an energy density and power density of 7.1 $WhKg^{-1}$ and 5.7 $KwKg^{-1}$ respectively at a current density of $4Ag^{-1}$ with a capacity retention of 5.3 mAh/g for 80 K cycles.



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