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Article

Effect of ionic liquid 1-butyl-3-methylimidazolium bromide on ionic conductivity of poly(ethyl methacrylate) based polymer electrolytes

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ABSTRACT

Polymer electrolyte films comprising poly(ethyl methacrylate) (PEMA) as host, Magnesium Triflate [$Mg(CF_3SO_3)_2$ or MgTf] as salt and 1-butyl-3-methylimidazolium bromide (BmImBr) as the ionic liquid are prepared. Upon addition of BmImBr, the ionic conductivity shows a perceptible increase. Highest ionic conductivity of $(1.80 \pm 0.01) \times 10^{-4}$ S cm^{-1} is obtained for the polymer electrolyte with 40 wt% ionic liquid at ambient temperature. Temperature dependent ionic conductivity studies are performed to elucidate the mechanism of ion transport and it is found that the system obeys the Vogel-Tamman-Fulcher (VTF) mechanism. Differential Scanning Calorimetry (DSC) is carried out to investigate the glass transition temperature (T_g) and as expected, ionic liquid added polymer electrolytes exhibit lower glass transition temperature (T_g), than ionic liquid-free polymer electrolyte, proving the amorphous nature of the ionic liquid added polymer electrolyte. The sample with the highest ionic conductivity is used to fabricate Electrical Double Layer Capacitors (EDLC). Cyclic Voltammetry analysis shows that specific capacitance of the ionic liquid added polymer electrolyte is found to be higher than the polymer electrolyte without ionic liquid, which proves the plasticizing effect of ionic liquid on the polymer electrolyte.

Keywords: Poly(ethyl methacrylate), Ionic Liquid, $Mg(CF_3SO_3)_2$, Ionic Conductivity, Capacitance, Plasticizing Effect, Glass Transition Temperature.

1. INTRODUCTION

The 20th century was an era when polymers were used as structural materials or insulators. However, since 1975, they have been tailored as ion conductors when combined with the appropriate salts, which enhances their ionic conductivity. Since then, the polymer electrolytes have been manipulated to continuously improve their ionic conductivity, thermal stability and mechanical strength. These manipulations have gradually permitted the use of these polymer electrolytes in electrochemical devices.[1,2]

Poly(ethyl methacrylate), a derivation of the methyl acrylate polymers, has gained the confidence as a host polymer due to their large pendant group structure. Ionic conductivity of polymer electrolyte containing PEMA was reported in the order of 10^{-3} S cm^{-1}.[3] For the development of high conducting polymer electrolytes, a flexible backbone is a mandatory characteristic.[4] With the necessary manipulation, such as the addition of salts or plasticizers, PEMA can be attuned to fulfill the requirement as a high performing polymer electrolyte.

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