

ABSTRACT

Lithium ion-based polymer blend electrolytes are developed. Poly(ethyl methacrylate) (PEMA)/poly(vinylidene fluoride-co-hexafluoropropylene) (PVdF-HFP) blend is used as polymer host and lithium trifluoromethanesulfonate (LiTf) salt is used as lithium ion (Li^+) source. Reflux and solution cast techniques are employed to produce sample films. Optimized polymer blend-salt composition is added with varied weight percentages (wt. %) of ethylene carbonate (EC) and propylene carbonate (PC) as plasticizers as well as 1-butyl-3-methyl imidazolium trifluoromethanesulfonate (BMITf) and 1-butyl-3-methyl imidazolium iodide (BMII) ionic liquids. Five polymer electrolyte systems are used in this project: PEMA/PVdF-HFP-LiTf, PEMA/PVdF-HFP-LiTf-EC, PEMA/PVdF-HFP-LiTf-PC, PEMA/PVdF-HFP-LiTf-BMII and PEMA/PVdF-HFP-LiTf-BMITf. Electrochemical impedance spectroscopy (EIS) studies show that the addition of plasticizers and ionic liquids has improved the ionic conductivity of the polymer blend electrolytes. The best conducting sample is found in 94 wt.% [70 wt.% PEMA/PVdF-HFP-30 wt.% LiTf]-6 wt.% EC sample (designated as EC-6) with ionic conductivity of $1.04 \times 10^{-4} \text{ S cm}^{-1}$. EC-6 exhibits the lowest ideal glass transition temperature (T_0) value of 244 K. The temperature-dependent conductivity studies of all systems except the plasticized systems are shown to follow the Arrhenius rule whereas the EC- and PC-added systems obey the Vogel-Tamman Fulcher (VTF) rule. Fourier transform infrared (FTIR) studies have shown that coordination of Li^+ ions has occurred on the oxygen (O) atoms in the carbonyl (C=O) and C-O-C groups of PEMA, and on the fluorine (F) atoms in the CF_2 group of PVdF-HFP in the PEMA/PVdF-HFP-LiTf system. For the EC- and PC-plasticized systems, Li^+ ions are coordinated to O atoms of both the C=O groups of PEMA and the

plasticizer, whereas the carbon (C) atom of the plasticizer interacts with the O atom of the C–O–C group of PEMA and the F atom of the CF₂ group of PVdF–HFP. BMII and BMITf are shown to interact with the C=O and C–O–C groups of PEMA and the CF₂ group in PVdF–HFP via its imidazolium cation (BMI⁺). Thermogravimetric analyses (TGA) have shown that the thermal stability of PEMA is increased after being blended with PVdF–HFP. PEMA/PVdF–HFP–LiTf–BMII system exhibits the lowest decomposition temperature, T_d of 202 °C while PEMA/PVdF–HFP–LiTf–BMITf system shows the best thermal stability among all PE systems with T_d of 275 °C.