Plasticized and plasticizer free lithium acetate doped polyvinyl alcohol–chitosan blend solid polymer electrolytes: Comparative studies

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Abstract. In this work, two systems (plasticized and plasticizer free) of polyvinyl alcohol (PVA)–chitosan blend based solid polymer electrolytes containing lithium acetate (LiOAc) are successfully prepared through solution casting method. In Fourier transform infrared (FTIR) spectroscopy studies, the changes in peak position of amine and hydroxyl band signify the salt-polymer and plasticizer-salt-polymer interactions. The room temperature conductivity of each electrolyte is investigated by impedance analysis in the frequency range of 50 Hz – 1 MHz. Upon addition of 30 wt.% LiOAc, a conductivity of \( (6.46 \pm 1.80) \times 10^{-5} \text{ S cm}^{-1} \) is achieved. The conductivity increases to \( (1.15 \pm 0.19) \times 10^{-3} \text{ S cm}^{-1} \) with the addition 70 wt.% ethylene carbonate (EC). The temperature dependence of conductivity is found to follow Vogel-Tammann-Fulcher (VTF) rule. From the VTF plot, the glass transition temperature \( (T_g) \) was analyzed and the highest conducting electrolyte is found to possess the lowest \( T_g \) value.

1. Introduction

Tremendous interest has been paid to solid polymer electrolytes (SPEs) as an option to liquid electrolytes in power source devices. SPEs have been extensively studied as they possess good mechanical properties, no leakage problem, less flammability and less toxicity [1]. Numerous polymers like polyvinyl chloride (PVC) [2], poly(N-vinyl pyrrolidone) (PVP) [3] and polyvinyl alcohol (PVA) [4] have been used as polymer host in SPEs. There are plenty of hydroxyl groups present as side groups on the backbone chain of PVA [5]. PVA is a chemically stable material and easy to be processed to form film [6]. Chitosan is produced by deacetylation of chitin [7]. Applications of chitosan are mainly found in tissue engineering [8] and biomedical fields [9]. Cations of salt can coordinate at the lone pair electrons of oxygen and nitrogen atoms in chitosan [10]. Chitosan based polymer electrolytes have been studied for application in power source devices e.g. solid state battery [11] and fuel cell [12].

Many researchers have used polymer blending technique to improve the conductivity of SPE. The conductivity of starch-chitosan blend based electrolyte incorporated with ammonium bromide \((\text{NH}_4\text{Br})\) was found to be higher than the electrolytes using single starch and single chitosan [13–15]. Blending