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ORIGINAL PAPER

Investigation of blend biopolymer electrolytes based on Dextran-PVA with ammonium thiocyanate

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Abstract

A new polymer electrolytes based on Dextran, poly vinyl alcohol (PVA) with different concentrations of ammonium thiocyanate (NH_4SCN) have been prepared by solution casting technique using distilled water as a solvent. The synthesized biopolymer membranes have been characterized by various techniques such as X-ray diffraction (XRD), Fourier transform–infrared spectroscopy (FTIR), differential scanning calorimetric (DSC), AC impedance, linear sweep voltammetry (LSV), and transference number measurement. The increase in amorphous nature of the blend polymer (700 mgDextran:300 mgPVA) with increase in salt concentration is observed in XRD pattern. The complex formation between the blend polymer and salt has been confirmed by FTIR. The glass transition temperature (T_g) of the prepared polymer membranes have been analyzed by DSC. From AC impedance analysis, a maximum ionic conductivity of 8.03×10^{-3} S/cm has been achieved by incorporation of 0.6 M.wt% NH_4SCN with blend polymer (700 mgDextran:300 mgPVA). The electrochemical stability of the highest conducting polymer electrolyte 700 mgDextran:300 mgPVA:0.6 M.wt%NH_4SCN has been observed as 3.01 V by LSV. From Wagner's polarization method, transference number has been calculated. The proton battery has been constructed with the highest conducting polymer electrolyte 700 mgDextran:300 mgPVA:0.6 M.wt%NH_4SCN. The open-circuit voltage (OCV) has been observed as 1.75 V and the battery performance is studied.

Keywords Dextran · PVA · XRD · FTIR · AC impedance · Primary proton battery

Introduction

In recent days, there is a requirement for increasing energy and environmental challenges demand clean, reliable, low cost, low toxicity, pollution free, and sustainable energy source for the modern society. One of the feasible technologies is to use green energy (or) green materials in energy devices. Generally, the electrochemical devices such as supercapacitor, batteries, fuel cell, sensors, and dye-sensitized solar cells are most preferred energy devices. Now day's researchers have great attention to use green materials in the above electrochemical devices. Solid polymer electrolyte (SPE) plays an important role in the electrochemical devices, because of its great advantages like dimensional stability, flexibility, safety, high electrochemical stability, high mechanical strength, and good electrode-electrolyte contact [1, 2]. Solid polymer electrolytes based on green material such as biopolymers are superior and alternate for synthetic polymers [3–5]. The synthetic polymers have many disadvantages like non-biodegradable, toxic, and no eco-friendly. This initiates the researchers to focus on biopolymers, which are biodegradable, renewable, and biocompatible [6]. Biopolymers like chitosan [7], starch [8], agar [9], cellulose [10], pectin [11], and gelatin [12] are usually used as host polymer in polymer electrolyte.

Among the various polymer, Dextran has been chosen as a backbone of polymer electrolyte, because of its ample natural resources, non-toxicity, and biodegradable in nature [13]. Dextran is extracted from microorganisms like Leuconostoc, Mesenteroides, and Lacobacillus. Dextran is a kind of polysaccharide which consist of 1,6-α-D-glucopyranosidic linkage in

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