Employing of Trukhan Model to Estimate Ion Transport Parameters in PVA Based Solid Polymer Electrolyte

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Abstract: In the current paper, ion transport parameters in poly (vinyl alcohol) (PVA) based solid polymer electrolyte were examined using Trukhan model successfully. The desired amount of lithium trifluoromethanesulfonate (LiCF$_3$SO$_3$) was dissolved in PVA host polymer to synthesis of solid polymer electrolytes (SPEs). Ion transport parameters such as mobility ($\mu$), diffusion coefficient ($D$), and charge carrier number density ($n$) are investigated in detail using impedance spectroscopy. The data results from impedance plots illustrated a decrement of bulk resistance with an increase in temperature. Using electrical equivalent circuits (EEC), electrical impedance plots (ZivsZr) are fitted at various temperatures. The results of impedance study demonstrated that the resistivity of the sample decreases with increasing temperature. The decrease of resistance or impedance with increasing temperature distinguished from Bode plots. The dielectric constant and dielectric loss values increased with an increase in temperature. The loss tangent peaks shifted to higher frequency region and the intensity increased with an increase in temperature. In this contribution, ion transport as a complicated subject in polymer physics is studied. The conductivity versus reciprocal of temperature was found to obey Arrhenius behavior type. The ion transport mechanism is discussed from the tan$\delta$ spectra. The ion transport parameters at ambient temperature are found to be $9 \times 10^{-8}$ cm$^2$/s, $0.8 \times 10^{17}$ cm$^{-3}$, and $3 \times 10^{-6}$ cm$^2$/Vs for $D$, $n$, and$\mu$ respectively. All these parameters have shown increasing as temperature increased. The electric modulus parameters are studied in an attempt to understand the relaxation dynamics and to clarify the relaxation process and ion dynamics relationship.

Keywords: solid polymer electrolyte; electrical impedance study; electrical equivalent circuits; bode plots; trukhan model; dielectric relaxation study; electric modulus study; ion transport mechanism

1. Introduction

Human life and earth planet have been threatened by current types of energy forms, so that researchers required thinking about a promising alternative which can be seen in electrical energy form [1]. In this regard, lithium-ion batteries are considered as one of popular source of electrical energy sources. For these to be applicable in a large scale, it needs for proper electrolytes which can be