Ion Transport Study in CS: POZ Based Polymer Membrane Electrolytes Using Trukhan Model

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Abstract: In this work, analysis of ion transport parameters of polymer blend electrolytes incorporated with magnesium trifluoromethanesulfonate (Mg(CF₃SO₃)₂) was carried out by employing the Trukhan model. A solution cast technique was used to obtain the polymer blend electrolytes composed of chitosan (CS) and poly (2-ethyl-2-oxazoline) (POZ). From X-ray diffraction (XRD) patterns, improvement in amorphous phase for the blend samples has been observed in comparison to the pure state of CS. From impedance plot, bulk resistance (Rₘ) was found to decrease with increasing temperature. Based on direct current (DC) conductivity (σ_dc) patterns, considerations on the ion transport models of Arrhenius and Vogel–Tammann–Fulcher (VTF) were given. Analysis of the dielectric properties was carried out at different temperatures and the obtained results were linked to the ion transport mechanism. It is demonstrated in the real part of electrical modulus that chitosan-salt systems are extremely capacitive. The asymmetric peak of the imaginary part (M_i) of electric modulus indicated that there is non-Debye type of relaxation for ions. From frequency dependence of dielectric loss (ε″) and the imaginary part (M_i) of electric modulus, suitable coupling among polymer segmental and ionic motions was identified. Two techniques were used to analyze the viscoelastic relaxation dynamic of ions. The Trukhan model was used to determine the diffusion coefficient (D) by using the frequency related to peak frequencies and loss tangent maximum heights (tanδ_max). The Einstein–Nernst equation was applied to determine the carrier number density (n) and mobility. The ion transport parameters, such as D, n and mobility (μ), at room temperature, were found to be 4 × 10⁻⁵ cm²/s, 3.4 × 10¹⁵ cm⁻³, and 1.2 × 10⁻⁴ cm²/Vs, respectively. Finally, it was shown that an increase in temperature can also cause these parameters to increase.

Keywords: polymer blends; impedance study; dielectric properties; electric modulus study; loss tangent peaks; ion transport parameters; Trukhan model