Study on Dielectric Properties of Gel Polymer Electrolyte Based on PVA-K₂CO₃ Composites

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The advance of gel polymer electrolyte (GPEs) based on conducting salt-polymer has been a subject of concern recently due to their significant applications. This work presents a study of dielectric properties of GPE based on polyvinyl alcohol (PVA) and potassium carbonate (K₂CO₃) (PVA-K₂CO₃) electrolyte for electrochemical applications. The electrolyte material was synthesized by mixing a conducting salt (K₂CO₃) with PVA in different proportions (from 10 - 50 wt. %) in order to study the effect of the salt on the dielectric properties of the electrolyte. The synthesized GPE was characterized using X-ray powder diffraction (XRD) to study electrolyte's crystal phase. Both complex permittivity and complex modulus formalism (dielectric behaviour) of the electrolyte were analysed through electrochemical impedance spectroscopy (EIS). The characterization result shows that the peak intensity of the PVA is significantly reduced with the increase of K₂CO₃ wt.%, which could be attributed to the decrease of PVA crystallinity which can enlarge the amorphous region of the polymer due to the strong plasticizing effect of the salt. High values of complex permittivity (dielectric constant and dielectric loss) were observed at low frequencies, which increased with increasing temperature, indicating an increase in conductivity. From the real part of electric modulus, the material is featured to be highly capacitive. Based on the asymmetrical peak shape of the imaginary part of electric modulus, the non-Debye type relaxation is predicted. Straight-line graphs were observed from the frequency dependency of loss tangent ($\tan \delta$), showing no single relaxation process is present.

Keywords: electrical modulus, dielectric, polymer electrolyte, Impedance spectroscopy

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