

INVESTIGATION AND CHARACTERIZATION OF A SOLID POLYMER ELECTROLYTE BASED ON METHYL GRAFTED SRI LANKAN NATURAL RUBBER (MG49) AND LiBOB FOR LITHIUM-ION CONDUCTIVITY

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The growing global demand for sustainable and efficient energy storage solutions has intensified interest in solid polymer electrolytes (SPEs) as safer and cost-effective alternatives to conventional liquid electrolytes used in lithium-ion batteries. This study focused on the preparation and characterization of an SPE based on methyl-grafted natural rubber (MGNR) and lithium bis(oxalato)borate [LiBOB, $\text{LiB}(\text{C}_2\text{O}_4)_2$]. MGNR, derived through methyl methacrylate grafting onto natural rubber, was selected for its improved mechanical properties and compatibility. SPE samples were prepared using the solvent casting method, resulting in thin, mechanically stable, brownish-white films. The temperature dependence of conductivity followed Vogel-Tamman-Fulcher behaviour, indicating ion transport facilitated by polymer chain segmental motion. An optimum ionic conductivity of $9.29 \times 10^{-5} \text{ S cm}^{-1}$ was achieved for the composition containing 0.25 g MGNR and 0.25 g of salt at 27 °C. It was increased to $2.05 \times 10^{-4} \text{ S cm}^{-1}$ when the temperature was increased from 27 °C to 55 °C. This is a good value for natural rubber-based electrolyte and is suitable to be used in electrochemical storage devices. At low salt concentrations, the conductivities of the samples are low irrespective of the temperature. When increasing LiBOB concentration, from 40%/w to 50%/w, the conductivity increases, while it decreases when the concentration is further increased to 80%/w. The initial increase in conductivity with LiBOB concentration could be due to the increase in density of ions provided by the dissociation of salt, which eventually increases conductivity. A further increase in salt concentration may create a highly dense charge region, reducing ion mobility due to blocking effects. Additionally, the salt may reach its dissociation limit, beyond which further increase in concentration does not contribute to a higher ion density in the electrolyte. The findings of this study highlight several novel aspects, including the value addition to Sri Lankan natural raw materials, low production cost, and environmental friendliness. These features position this material system as a promising candidate for future energy storage applications.

Keywords: Electrochemical storage devices, Ionic conductivity, LiBOB, Natural rubber, Solid polymer electrolytes