IMPACT OF CHOLINE CHLORIDE/1,4-BUTANEDIOL DEEP EUTECTIC SOLVENT ON TAMARIND SEED POLYSACCHARIDE-BASED POLYMER ELECTROLYTE

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ABSTRACT

IMPACT OF CHOLINE CHLORIDE/1,4-BUTANEDIOL DEEP EUTECTIC SOLVENT ON TAMARIND SEED POLYSACCHARIDE-BASED POLYMER ELECTROLYTE

Many research has been done on natural polymer electrolytes (PE) made of polysaccharides to solve leakage problems with widely used liquid electrolytes (LE). Nevertheless, polysaccharides' hydroxyl groups result in brittle electrolyte films with poor ionic conductivity. It has been demonstrated that harmful plasticizers like ethylene carbonate (EC) and propylene carbonate (PC) may improve polysaccharide film brittleness issues. Deep eutectic solvent (DES) has a low toxicity, low volatility, and good thermal stability, making it a viable substitute for conventional plasticizer. Thus, in this research, flexible and self-supporting tamarind seed polysaccharide (TSP)-based polymer electrolyte films incorporated with lithium triflate (LiTf) and doped with various amount of DES were prepared using solution casting technique. As the optimal quantity of DES is essential in producing highly conducting SPE, the effect of different amounts of DES on the structural, electrical, morphological, and mechanical properties of TSP-based electrolyte films were analysed using Fourier Transform Infrared Spectroscopy (FTIR), Electrochemical Impedance Spectroscopy (EIS), Optical Microscopy (OM) and Universal Tensile Machine (UTM), respectively. Flexible and free-standing film of TSP-based polymer electrolyte with improved ionic conductivity of 2.30×10^{-4} S cm^{-1} was obtained with the addition of up to 0.4 wt% of DES. This was due to the presence of DES that occupied the space between TSP chains and prevented the formation of hydrogen bonding. The inhibition of hydrogen bonding reduces the crystallinity of the TSP matrix, increasing the amorphous phase within the system, thereby enhancing the mobility of conducting Li^+ ions. Additionally, the presence of free Cl^- ions from DES further enhanced the system's ionic conductivity by serving as transit sites for Li^+ ion movement. These statements can be further confirmed by the TSP-DES and salt-DES interaction as observed via FTIR analysis. Optical micrographs of TSPL 0.4 revealed a smooth surface devoid of particle agglomeration, indicative of salt-DES interactions, which further contributed to the improved ionic conductivity. Tensile testing demonstrated a maximum tensile strain of 50.00% for TSPL 0.4, affirming its superior flexibility. This system shows promise for application in lithium-ion batteries owing to its favourable ionic conductivity. However, when the wt% of DES exceeded 0.4, the ionic conductivity decreased due to excessive DES causing the reformation of ion multiples, obstructing the current pathway. This decrease was supported by the observation of agglomeration on the surface of TSPL 0.5 and 0.6 in the optical micrographs, along with reduced flexibility indicated by a decrease in tensile strain. The preparation of a natural solid polymer electrolyte (SPE) in this study aligns with the objectives of the 12th Shared Prosperity Vision for 2030 (KEGA12), and Sustainable Development Goals 7 (SDG7).

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