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I-CReST 2025:033-013 – Unlocking the Hidden Power of Polyethylene Glycol Plasticizers in Enhancing Ionic Conductivity of Cellulose-Based Biopolymer Electrolytes

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ABSTRACT

Achieving safer and more sustainable energy storage requires innovative electrolyte design. Solid biopolymer electrolytes (SBEs) offer a promising pathway with natural polymers at its core. This in turn provided enhanced safety, compatibility and electrochemical stability. However, optimizing ionic conductivity remains a critical challenge. This work explores the transformative role of plasticizers in overcoming these limitations, focusing on polyethylene glycol (PEG) plasticizer in 2-hydroxyethyl cellulose (2HEC) system doped with ammonium thiocyanate (ATC). Strategic incorporation of PEG led to a significant enhancement in charge transport, with ionic conductivity increasing from 1.16×10^{-4} S/cm to 1.76×10^{-3} S/cm at 8 wt.% PEG. Fourier Transform Infrared (FTIR) spectroscopy confirmed intensified polymer salt interactions through the emergence of a distinctive C–O stretching peak (800 cm^{-1} – 1200 cm^{-1}), while X-ray diffraction (XRD) analysis revealed a broadened peak at $2\theta \approx 23°$, indicating increased amorphous content which is an essential factor in facilitating ion migration. By unlocking the hidden potential of plasticizers, this study redefines the structure–conductivity relationship in biopolymer electrolytes, paving the way for next-generation energy storage solutions. These insights offer a crucial step toward the development of high-performance, eco-friendly electrochemical systems that align with global sustainability goals.