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Gel polymer electrolytes for supercapacitor application

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Energy storage systems have consistently played a vital role in societal progress and technological advancement. Among the promising solutions to meet current energy demands are supercapacitors, known for their high capacitance, high power density, and reasonably good energy density. Based on the type of electrode material used, supercapacitors are generally categorized into two main types: pseudocapacitors and electrochemical double-layer capacitors (EDLCs). Another key component of supercapacitors is the electrolyte. Traditional liquid electrolytes often pose challenges such as leakage, safety concerns, and low ionic conductivity. To overcome these issues, polymer electrolytes have garnered growing interest in both research and industry over the past two decades [1-2]. Their potential use extends beyond solid-state lithium or lithium-ion batteries to other electrochemical applications like supercapacitors, electrochromic devices, and sensors. In this study, a hydrophilic ionic liquid, 1-ethyl-3-methylimidazolium hydrogen sulfate, was employed to prepare polymer films using polyvinyl alcohol as the host polymer using solution casting technique. These films were characterized and evaluated for their performance in supercapacitor applications.

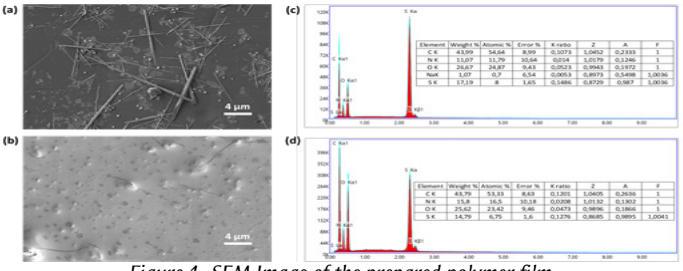

Figure 1. SEM Image of the prepared polymer film

The morphological studies were performed using SEM and are shown in Fig. 1(a-b). As can be seen from the SEM image, when the polymer content is relatively higher, the granular structures were observed in the films confirming the crystal phase in the films. The electrochemical properties of the prepared ionogels were evaluated by measuring the ionic conductivity at room temperature and also by varying the temperature (from room temperature to 100 °C), the electrochemical potential/stability window, and finally studying the dielectric and modulus loss to understand the ion transport efficiency. The composition of 85:15 (Ionic Liquid: PVA) was optimized to provide good mechanical stability and ionic conductivity for its application in energy storage devices. The room temperature ionic conductivity of the optimized film was found to be of the order of 5.12×10^{-3} S cm^{-1}. The optimized film was incorporated with a MWCNT electrode in a two-electrode setup as a complete cell to evaluate its performance for a supercapacitor application. The cell was tested using ac impedance spectroscopy, galvanostatic charge discharge and cyclic voltammetry. The fabricated cell provided a capacitance of ~39.4 F g^{-1} with an energy density of 5.5 Wh kg^{-1} and a power density of 0.3 kW kg^{-1}.

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References:

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