ASURS 2025

Applied Sciences Undergraduate Research Sessions

ABSTRACTS

DEVELOPMENT OF A SUPERCAPACITOR UTILIZING NATURAL RUBBER-BASED ELECTROLYTE AND ACTIVATED NANO CARBON ELECTRODES DERIVED FROM BAMBOO CULMS

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Super capacitors are one of the chief electricity storage applications in various industries. This study aims to produce a supercapacitor that is an environmentally friendly replacement for traditional supercapacitors with the development of renewable and biodegradable material. The electrolyte was synthesized by dissolving natural rubber carbon in tetrahydrofuran (THF), adding Lithium perchlorate ($LiClO_4$) as the conducting salt, and adding Ethylene carbonate (EC) and Propylene carbonate (PC) plasticizers that allow for better ion mobility and flexibility. FTIR suggested a successful salt-polymer interaction with the shifts in characterization peaks confirming complexation with Li^+ ions and the rubber matrix. Electrodes were produced from bamboo culms-derived nano carbon which underwent NaOH treatment to activate the surface. The XRD patterns showed semi-crystalline structure with, some graphitization, while Raman spectroscopy analysis indicated a high intensity of the D/G band, suggesting a high density of available active sites for charge storage. FTIR spectra of the carbon indicate surface functional groups to allow for better wettability and electrochemical performance.
The cell was assembled through the use of these electrodes and the gel electrolyte. Cyclic voltammetry (CV) generated rectangular curves associated with excellent capacitive behaviours and the optimum specific capacitance achieved was 180.8 F/g at 10 mV/s. The galvanostatic charge-discharge (GCD) curves were triangular and symmetry was also observed which gave a specific capacitance of 17.49 F/g at 0.81 mA/g pointing to performance limitations under higher current conditions. The electrochemical impedance spectroscopy (EIS) gave a high series resistance of 719.37 Ω which resulted in a very low ionic conductivity. However, the ionic conductivity of the gel polymer electrolyte was measured at 8.57×10^{-4} S/cm, which falls within the acceptable range for polymer-based systems and supports moderate ion transport. Despite the high internal resistance, the overall results demonstrate the potential of using biodegradable and low-cost materials in supercapacitor applications. Future work will focus on optimizing the electrolyte composition and introducing pseudocapacitive materials such as Polyaniline (PANI) to improve conductivity and enhance energy storage performance.

Keywords: *Natural rubber-based electrolyte, Activated nano carbon, Bamboo-derived carbon, Sustainable energy storage, Cyclic voltammetry*