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SOLID STATE DOUBLE LAYER CAPACITOR WITH EFFICIENT NATURAL GRAPHITE AND COCONUT SHELL CHARCOAL COMPOSITE ELECTRODES

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Abstract

The growing demand for electronic devices has significantly increased the need for efficient and sustainable power sources. Supercapacitors, including electrochemical double layer capacitors (EDLCs) and pseudocapacitors, have gained more attention due to their high power density, longer lifespan, and energy densities surpassing conventional capacitors. EDLCs are widely used in backup power systems owing to their durability and rapid charge-discharge capabilities. Various carbon-based materials are commonly employed as electrodes in EDLC fabrication. This study focuses on the development of an EDLC utilizing a gel polymer electrolyte (GPE) composed of polyvinylidene fluoride-hexafluoropropylene (PVdF-HFP), ethylene carbonate (EC), propylene carbonate (PC), and zinc acetate [Zn $(CH3COO)_2$]. The GPE was synthesized via solvent casting, while electrodes were fabricated using a composite of coconut shell charcoal powder, natural graphite, and PVdF binder. Optimization of the electrode composition was achieved by varying the ratios of coconut shell charcoal and natural graphite, aiming to maximize specific capacitance. The optimal electrode composition was found to be 10 wt. % PVdF, 40 wt. % of natural graphite, and 50 wt. % of coconut shell charcoal. The optimized EDLC exhibited a highest single electrode specific capacitance of 1.82 μF/g[at the scan rate of 0.1v/s], determined through equivalent circuit analysis using NOVA 1.11 software. Electrochemical impedance spectroscopy (EIS), cyclic voltammetry (CV), and charge-discharge testing were conducted to evaluate the performance of the EDLC, while EIS and DC polarization tests assessed the ionic conductivity of the GPE. The temperature-dependent conductivity variation confirmed that the GPE functions as a purely ionic conductor. This research contributes to the development of sustainable, cost-effective energy storage devices by utilizing natural and renewable carbon materials, supporting advances in eco-friendly supercapacitor technologies.

Keywords: *Supercapacitors, EDLC, Gel Polymer Electrolyte, PVdF-HFP, Coconut Shell Charcoal, Specific Capacitance, Ionic Conductivity*