

Abstract No: 183

Physical Sciences

SYNTHESIS OF ACTIVATED CARBON AND TITANIUM DIOXIDE-BASED COMPOSITE FROM COCONUT SHELL FOR OPTIMIZED AND COST-EFFECTIVE SUPERCAPACITORS

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The energy landscape today grapples with two significant challenges - the unsustainability of fossil fuel energy and the mounting costs of energy storage materials. In response, researchers are pioneering the use of economically viable, environmentally benign materials for energy storage applications, with a marked rise in interest in activated carbon, particularly supercapacitor electrodes. In general, the synthesis and raw material cost of activated carbon derived from coconut shell charcoal is lower. The present study aims to prepare cost-effective supercapacitor electrodes by omitting problematic organic binders. This research elegantly employs locally sourced coconut shells, a widely available resource with high carbon content, as an optimized base material for 90 wt.% activated carbon (AC) and 10 wt.% titanium dioxide (AC-TiO₂) composite fabrication. The locally sourced coconut shells underwent a series of transformations, heating, grinding, and a chemical activation involving KOH as an activation catalyst and heating process. The surface morphology was examined through the utilization of scanning electron microscopy (SEM) images. The activated carbon was then coated on a fluorine-doped tin oxide coated (FTO) glass slide using an aqueous and slurry, and its performance was evaluated through cyclic voltammetry (CV) tests over a range of scan rates 2, 5, 10, 20, 50 and 100 mV s⁻¹, and within a potential window between 0.0 and 0.8 V. The highest discharge capacitance value recorded at these scanning rates was 168.0 F g⁻¹ at 2 mV s⁻¹, demonstrating robust capacitive behaviour. Notably, the study achieved an impressive peak specific capacitance of 168.0 F g⁻¹, an energy density of 13.29 W h kg⁻¹, and a power density of 255.85 W kg⁻¹ at the current density of 1 mA cm⁻². The (AC-TiO₂) electrodes synthesized in this study outperformed those documented in prior research, exhibiting the highest specific capacitance. The supercapacitors demonstrated exceptional endurance and rate capability, maintaining approximately 95% of their initial capacitance even after a rigorous cycle of 1000 charges and discharges. As confirmed by cyclic voltammetry, this performance underscores their excellent cycling stability. Nyquist plot of the supercapacitor exhibited represented a semicircle with a diameter of about 11 and a low-frequency spike. Therefore, this work makes a meaningful contribution toward advancing sustainable and cost-effective energy storage solutions.

Financial assistance from the Postgraduate Institute of Science (PGIS), University of Peradeniya (Grant No; PGIS/2020/05) is acknowledged.

Keywords: Activated carbon, Coconut shell, Electrodes, Supercapacitor, Titanium dioxide