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Transformation of plant biomass waste into resourceful activated carbon materials for mixed-assembly type electrochemical capacitors

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Activated carbon (AC) was obtained from three different plant biomass wastes sources (coconut shell, pine cones and rice husk) via hydrothermal treatment followed by carbonization at 800 ℃. The morphological and structural characteristics of the transformed carbon material revealed a porous network suitable for energy storage application. The asymmetric cells fabricated exhibited EDLC behaviour in all material sample combinations using all three transformed activated carbons. The mixed assembly device worked comfortably in a voltage window of 1.5 V in a neutral electrolyte. A specific capacitance (Cs) of ~110 F g⁻¹ was obtained with a corresponding energy density of 8.5 W h kg⁻¹ and power density of 380 W kg-1 at a current density of 0.5 A g⁻¹. An excellent stability was exhibited with a coulombic efficiency of a 99.7% and capacitance retention of 80% after 10000 continuous cycling at 5.0 A g⁻¹. Furthermore, subjecting the device to a floating test for ~48 h (2 days) at the optimum voltage (1.5 V) revealed a drop in the initial capacitance value but still without any recorded device failure. Remarkably, the asymmetric design showed a potential for adopting EDLC materials of different carbon sources in order to capture the entire properties for efficient and stable energy storage devices.

Summary

Keywords: Plant waste; Energy storage materials; Activated carbon; Mixed-assembly; Supercapacitors

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Prof. N. Manyala
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Primary author: Dr MOMODU, Damilola (UNIVERSITY OF PRETORIA)

Co-authors: Ms OKAFOR, Chiamaka (African University of Science and Technology, Abuja); Prof. NTSOEN-ZOK, Esidor (Centre National de la Recherche Scientifique, Orleans, France); Dr ZEBAZE-KANA, Martiale Gaetan (Kwara State University); Dr MANYALA, Ncholu (University of Pretoria)

Presenter: Dr MOMODU, Damilola (UNIVERSITY OF PRETORIA)

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