UNIVERSITY OF KELANIYA

Faculty of Graduate Studies

ABSTRACT VOLUME

iprc 2024

24th INTERNATIONAL POSTGRADUATE RESEARCH CONFERENCE (IPRC) 2024

"RESEARCH AND INNOVATION FOR ECONOMIC DEVELOPMENT"

IPRC/24/179 Science, Technology, Mathematics & Medicine

Optimization of sulfuric acid electrolyte concentration for coconut shell charcoal-derived activated carbon-based supercapacitors

A.P.S.P. Jayathilaka[1], R.R.M.M.N.B. Bambaradeniya[1], A.D.T. Medagedara[1,2], and G.R.A. Kumara[1*]

[1]National Institute of Fundamental Studies, Hanthana Road, Kandy, Sri Lanka
[2]Postgraduate Institute of Science, University of Peradeniya, Sri Lanka

Supercapacitors differ from regular capacitors due to their high capacitance values (>1F), whereas the capacitance of regular capacitors is limited to microfarad values. Various factors affect the electrochemical properties of a supercapacitor, such as electrode material, electrolyte, electrolyte concentration, and separator. Among other aqueous electrolytes like KOH and Na_2SO_4, sulfuric acid (H_2SO_4) has several advantages, including high ionic conductivity, cost-effectiveness, and ease of handling. Recent studies have focused on using biomass materials to prepare activated carbon electrodes for supercapacitors because of their renewability, low cost, and abundance. In this study, we prepared activated carbon-based supercapacitors using coconut shell charcoal and optimized the H_2SO_4 electrolyte concentration. First, charred coconut shells were heated at 900 °C for 20 minutes in a low-oxygen environment and then immediately put into a water bath for activation. Next, the activated carbon chips were dried and ground into a fine powder. Afterward, a thin layer of activated carbon suspension (0.05 g of polyvinylpyrrolidone, 10 ml of isopropyl alcohol, and 0.5 g of activated carbon powder) was deposited on two preheated titanium plates (20 × 10 × 0.45 mm) and sintered at 300 °C for 20 minutes. Then, they were immersed in 2.0 M H_2SO_4 for 2 minutes. Finally, the supercapacitor was assembled by sandwiching a medium-retention filter paper (separator) between the electrodes and wetting it with 2.0 M H_2SO_4 electrolyte. Four more supercapacitors were prepared by repeating the last three steps for 2.5 M, 3.0 M, 3.5 M, and 4.0 M H_2SO_4 concentrations. Cyclic voltammetry (5 mV s^{-1} scan rate) and galvanostatic charge-discharge analysis (1.0 A g^{-1} current density) were performed on supercapacitors, resulting in specific capacitance values of 20.17, 22.17, 29.77, 14.94, and 12.04 F g^{-1} for the 2.0 M, 2.5 M, 3.0 M, 3.5 M, and 4.0 M supercapacitors, respectively. Hence, the 3.0 M supercapacitor exhibited the highest specific capacitance of 29.77 F g^{-1} with the highest energy density of 4.14 Wh kg^{-1}, lower power density of 342.09 W kg^{-1}, and long cycle stability with a capacity retention of 69.67% after 1000 charge-discharge cycles. These results warrant that 3.0 M is the optimal H_2SO_4 electrolyte concentration for the coconut shell charcoal-derived activated carbon-based supercapacitors.

Keywords: Coconut shell charcoal-derived activated carbon, Concentration, Electrolyte, Sulfuric acid, Supercapacitor

*grakumara2000@yahoo.com
ORCiD ID: https://orcid.org/0000-0001-9804-2652