Abstract

Contemporary society faces environmental and energy challenges, including fossil fuel depletion, the greenhouse effect, and pollution, which emphasize the need to explore sustainable energy storage alternatives. This study presents an economical approach to producing electrode materials for supercapacitor applications by converting abattoir blood waste into a porous carbon composite. This technology not only addresses waste management and sanitation issues, but also contributes to the circular economy by repurposing waste into functional materials. The study thoroughly explored the impact of synthesis factors on the electrochemical performance of the produced materials in a two-electrode system. X-ray diffraction data indicate a reduction in crystallinity, leading to the production of amorphous/turbostratic carbon under more intensive activation conditions. Additionally, Raman spectroscopy demonstrates changes in structural disorder and graphitization based on the activation parameters. N_2 sorption indicates that increased KOH ratio decreases surface area and pore volume. The optimal sample, which was carbonized at 800 °C and activated with a 1:1 carbon/KOH ratio at 600 °C for 30 min, exhibited the highest specific capacitances of 128.7 F g^{-1} and 119.6 F g^{-1} at 0.2 A g^{-1} and 5 mV s^{-1}, respectively. The electrode material achieved notable cycling stability, with a coulombic efficiency of 100 % and a capacitance retention of 91 %. Moreover, it demonstrated a promising power density of 200 W kg^{-1} and energy density of 20 Wh kg^{-1}, indicating their potential as a sustainable and efficient energy storage solution. This study demonstrates that activated carbon derived from calf blood waste is a promising, durable, and cost-effective electrode material for supercapacitors, offering a viable solution for energy storage and waste reduction.