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Modified Activation Process for Supercapacitor Electrode Materials from African Maize Cob

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Abstract: In this work, African maize cobs (AMC) were used as a rich biomass precursor to synthesize carbon material through a chemical activation process for application in electrochemical energy storage devices. The carbonization and activation were carried out with concentrated Sulphuric acid at three different temperatures of 600, 700 and 800 °C, respectively. The activated carbon exhibited excellent microporous and mesoporous structure with a specific surface area that ranges between 30 and 254 $m^2 \cdot g^{-1}$ as measured by BET analysis. The morphology and structure of the produced materials are analyzed through Field Emission Scanning Electron Microscopy (FESEM), Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), Boehm titration, X-ray Photoelectron Spectroscopy (XPS) and Raman Spectroscopy. X-ray photoelectron spectroscopy indicates that a considerable amount of oxygen is present in the materials. The functional groups in the activated carbon enhanced the electrochemical performance and improved the material's double-layer capacitance. The carbonized composite activated at 700 °C exhibited excellent capacitance of 456 F g^{-1} at a specific current of 0.25 A g^{-1} in 6 M KOH electrolyte and showed excellent stability after 10,000 cycles. Besides being a low cost, the produced materials offer good stability and electrochemical properties, making them suitable for supercapacitor applications.

Keywords: biomass; acid-activation; oxidation; specific capacitance; electrode material

1. Introduction

Electrochemical capacitors (supercapacitors) have recently received significant scientific and technological attention because of their exciting possibilities as energy storage devices. Supercapacitors, however, have low energy density (<10 Wh kg^{-1}) compared to other storage devices such as batteries, limiting their widespread application in hybrid electric vehicles, backup power sources, renewable energy systems and industrial energy management [1]. Several research efforts