

Abstract

Two-electrode electrochemical tests provide a close performance approximation to that of an actual supercapacitor device. This study presents mesoporous carbon materials successfully derived from *Washingtonia robusta* bark (Mexican fan palm) and their electrical performance in a 2-electrode supercapacitor device. The triad relationship among carbon materials “processing, properties, and performance” was comprehensively investigated. X-ray diffraction reveal that amorphousness increases with activating KOH ratio and decreases with both activation time and temperature. Raman spectroscopy shows an increase in structural defects and degree of graphitization with an increase in KOH ratio, temperature and time while transmission electron microscopy shows conversion of aggregated particles to materials with interconnected porosity and subsequent destruction of porosity with an increase in KOH ratio. A nitrogen-sorption study reveals varying trends between BET, micro and mesopore surface areas, however, pore size and volume and hysteresis loop size decreases with KOH ratio and temperature. Electrochemical studies on the other hand reveal that both the specific capacitance and charge–discharge time increase with KOH ratio, temperature and time while both charge transfer and Warburg resistances decrease and the phase angles increases towards the ideal -90° with an increase in KOH ratio, temperature and time. The device fabricated with the HHPB sample prepared at 700°C , KOH ratio 3 for 60 min attained a specific capacitance of 179.3 and 169 F g^{-1} at a scan rate of 5 mV s^{-1} and current density of 0.5 A g^{-1} , respectively, good cycling stability with 95% capacitance retention and 100% coulombic efficiency when cycled 5000 times at a current density of 2 A g^{-1} . HHPB electrodes reveal perfect EDLC behavior with an energy density of 20 W h kg^{-1} and power density of 2000 W kg^{-1} when used in a symmetric coin supercapacitor cell with 6 M KOH solution. These findings show the potential of fan palm bark as electrode materials with good stability and high-rate capability for supercapacitor application.

Electrode materials processing conditions, electrode properties and supercapacitor device performance show a triad relationship.