Supercapacitors using Binderless Activated Carbon Monoliths Electrodes consisting of a Graphite Additive and Pre-carbonized Biomass Fibers

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Varying amounts of graphite powder (0 to 20 wt%) are mixed as an additive with self-adhesive carbon grains, which are produced from pre-carbonized powder derived from the fibers of oil palm empty fruit bunches, a by-product from palm oil mills. The mixtures are treated with KOH and converted into green monoliths (GMs). The GMs are carbonized and activated via a multistep heating profile to produce activated carbon monolith (ACM) electrodes. X-ray diffraction, field emission scanning electron microscopy and nitrogen adsorption-desorption isotherm analysis demonstrate that the addition of graphite influences the structure, microstructure and porosity of the ACM electrode materials. Electrochemical impedance spectroscopy, cyclic voltammetry and galvanostatic charge-discharge studies show that the best frequency response of the electrodes is obtained using 4 wt% of graphite. A tremendous decrease in the equivalent series resistance (~70%) and response time (~87%) leads to an improvement of specific power by 39 % and an 8-fold increase in the maximum operating frequency (from ~0.13 Hz to ~1 Hz). Furthermore, the cells incorporating the electrodes with 4 wt% of graphite retain 50% of their capacitance up to 1 Hz. These findings show that the cheap graphite powder can be a useful additive for preparing supercapacitor electrodes from activated carbon.

Keywords: Oil palm empty fruit bunches, self-adhesive carbon grains, graphite, activated carbon monoliths, supercapacitor electrode material, electrochemical characteristics

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