Enhancing the materials circularity: from laboratory waste to electrochemical capacitors

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ABSTRACT

Enhancing the circularity of materials is at the forefront of sustainability; this paper addresses smart reuse of a laboratory waste, i.e., paper towels, as one of the main components (electrodes) in an energy storage device (electrochemical capacitor, EC). We obtained carbon from wastepaper towels by converting them into cellulose through alkali treatment, subsequent enhancement of porosity via nitric acid reflux, and enhancement of chemical purity via controlled annealing. The porous carbon thereby optimized is characterized for chemical structure, surface structure, and morphology as well as electrochemical charge storability. The carbon sample obtained at 800 °C showed graphitization and interconnected morphology displaying a combination of micro and mesopores, superior surface area (∼528 m^2/g), desirable pore diameter for efficient ion adsorption (∼3.3 nm), and specific capacitance ∼230 F/g in 1 M KOH and ∼160 F/g in 1 M Na_2SO_4 electrolytes. Symmetrical electrochemical capacitors are also fabricated using the best performing carbon electrode in the above two electrolytes, which delivered desirable specific energy and specific power with high cycling stability. Given the longer cycling stability of the device and considering the acceptable properties, the present work is a way forward for enhancing the circularity of the laboratory wastepaper towels.

KEYWORDS

Cellulose–carbon conversion; Circular economy; Electrochemical double layer capacitor; Materials sustainability; Supercapacitor

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