Upgrading of pine tannin biochars as electrochemical capacitor electrodes

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Abstract
Biochar derived from the pyrolysis of pine tannin is a green and available by-product of oil manufacturing that presents interesting features after having been activated by KOH at 650 °C. Different weight ratios of KOH to biochar were used and the resulting activated carbons (ACs) presented highly developed specific surface areas of up to 2190 m^2 g^{-1}, well-connected porosity and high oxygen content, leading to enhanced electrochemical performance when used as electrochemical capacitor electrodes in a 1 M H_2SO_4 aqueous electrolyte. Galvanostatic charge/discharge experiments evidenced that the best material achieved a maximum electrode capacitance of up to 232 F g^{-1} (at 0.5 A g^{-1}) with a capacitance retention of 70% at 10 A g^{-1} using commercial mass loadings (i.e., approx. 10 mg cm^{-2}). In addition, long cycling stability with a residual capacitance of 92 to 94% after 10,000 cycles at 5 A g^{-1} was achieved. These results prove that ACs derived from pine tannin biochars have great potential for their commercial use as electrochemical energy storage devices.

Author keywords
Biochars; Electrochemical capacitors; KOH activation; Pyrolysis; Tannin