Title

Enhancing electrochemical capacitor performance of N-doped tannin-derived carbons by hydrothermal treatment in ammonia

Abstract

This study demonstrates that ammonia concentration when doping carbons using hydrothermal treatment has crucial impact on textural properties. The latter translates into an improvement of the electrochemical performance of carbon materials, when used into electrochemical capacitors, especially at high-rate performance. Nitrogen-doped carbons were synthesized by subjecting tannin to hydrothermal carbonization in ammonia solutions of varying concentrations. After carbonization and CO2 activation, the as-produced activated carbons (ACs) were tested as electrodes for electrochemical capacitors in symmetric configuration using 1 M H2SO4 as aqueous electrolyte. Interestingly, ammonia concentration during the hydrothermal synthesis step did not significantly affect the final N content (ca. 3 and 4 at. %) nor the nitrogen and oxygen functionalities on the surface. However, the use of ammonia had crucial impact on the textural properties developed by CO2 activation, and therefore on the electrochemical performance of the ACs. The best-performing N-doped AC showed specific electrode capacitance values, based on carbon material, of 212 F g−1 at 0.5 A g−1 and outstanding capacitance retention of ca. 71 % at 40 A g−1. It also showed high cycling stability, with capacitance retention of ca. 96 % after 30,000 cycles. Furthermore, this AC outperformed similar reported materials, achieving a specific energy of 4.6 W h kg−1 at 12.1 kW kg−1. © 2024 Elsevier B.V.

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