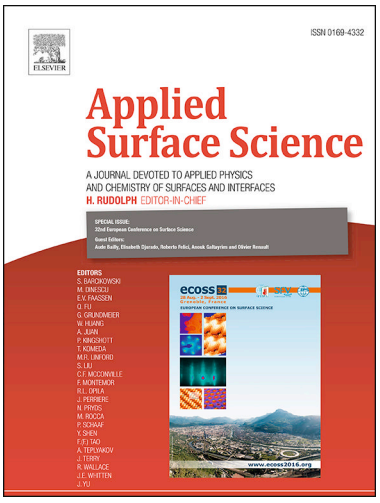

Full Length Article

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Kelp-derived three-dimensional hierarchical porous N, O-doped carbon for flexible solid-state symmetrical supercapacitors with excellent performance

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Abstract

Three-dimensional (3D) porous N, O-doped carbon with hierarchical structures composed of micropores, mesopores and macropores were synthesized by the direct carbonization of kelp with a "self-activation" process. The as-obtained 3D N, O-doped carbon remained abundant N and O functional groups and the BET specific surface area measured 656 $m^2 \cdot g^{-1}$. 3D hierarchical porous structures with the pore size ranged from several nanometers to hundred nanometers and lots of pores were attributed to mesopores with the average pore size of about 5.4 nm. Electrochemical properties of the 3D hierarchical porous N, O-doped carbon as a supercapactior (SC) electrode were investigated and it delivered excellent capacitance of 669 mF cm^{-2} at 1 mA cm^{-2} due to its 3D hierarchical porous structures with high specific surface area which is beneficial for improving ionic storage and transportation in electrodes. This kelp-derived carbon exhibited excellent cyclic performance with the retention of 104% after 10000 cycles. A flexible solid-state symmetric SC (SSC) device was fabricated using the 3D hierarchical porous N, O-doped carbon and delivered an excellent capacitance of 412 mF cm^{-2} at 2 mA cm^{-2} and satisfying cyclic stability with the retention of 85 % after 10000 cycles. The areal energy density of the SSC device reach up to 0.146 mWh cm^{-2} at the power density of 0.8 mW cm^{-2}. This facile route for low-cost carbonaceous materials with novel architecture and functionality can be as a promising alternative to synthesize biomass carbon for practical SC application.

Keywords: Kelp; Biomass; 3D porous carbon; Hierarchical structures; Supercapacitor; Electrochemical performance