Abstract

We created unique interconnected partially graphitic carbon nanosheets (10–30 nm in thickness) with high specific surface area (up to 2287 m^2 g^{-1}), significant volume fraction of mesoporosity (up to 58%), and good electrical conductivity (211–226 S m^{-1}) from hemp bast fiber. The nanosheets are ideally suited for low (down to 0 °C) through high (100 °C) temperature ionic-liquid-based supercapacitor applications: At 0 °C and a current density of 10 A g^{-1}, the electrode maintains a remarkable capacitance of 106 F g^{-1}. At 20, 60, and 100 °C and an extreme current density of 100 A g^{-1}, there is excellent capacitance retention (72–92%) with the specific capacitances being 113, 144, and 142 F g^{-1}, respectively. These characteristics favorably place the materials on a Ragone chart providing among the best power–energy characteristics (on an active mass normalized basis) ever reported for an electrochemical capacitor: At a very high power density of 20 kW kg^{-1} and 20, 60, and 100 °C, the energy densities are 19, 34, and 40 Wh kg^{-1}, respectively. Moreover the assembled supercapacitor device yields a maximum energy density of 12 Wh kg^{-1}, which is higher than that of commercially available supercapacitors. By taking advantage of the complex multilayered structure of a hemp bast fiber precursor, such exquisite carbons were able to be achieved by simple hydrothermal carbonization combined with activation. This novel precursor-synthesis route presents a great potential for facile large-scale production of high-performance carbons for a variety of diverse applications including energy storage.