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Preparation of nitrogen-doped macro-/mesoporous carbon foams as electrode material for supercapacitors

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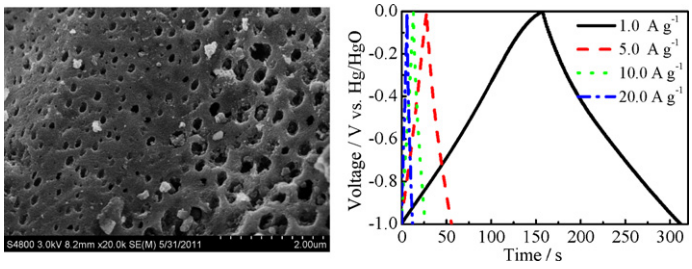
HIGHLIGHTS

- N-MMCFs with dual-sized pore structures were prepared by emulsion-activated method.
- The typical N-MMCF-3 exhibits large specific capacitance at high current density.
- The N-MMCFs sample is an excellent material for use in supercapacitors.

GRAPHICAL ABSTRACT

Nitrogen-doped macro-/mesoporous carbon foams (N-MMCFs) with main macropore of 0.2 μm, mesopore of 2.6–4.0 nm and specific surface areas of 1205–1808 $m^2 g^{-1}$ were prepared by employing oil-in-water emulsion polymerization and activated method. The typical N-MMCFs have a specific capacitance of 159 $F g^{-1}$ at a very high current density of 20.0 $A g^{-1}$.



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ABSTRACT

An oil-in-water (O/W) emulsion system of Span 80–Tween 80/1iquid paraffin/aqueous resorcinol–formaldehyde was manufactured. Nitrogen-doped macro-/mesoporous carbon foams (N-MMCFs) were prepared by the polymerization of this O/W emulsion, followed by carbonization and activation process. As-prepared N-MMCFs were characterized by scanning electron microscopy, infrared (IR) spectra, N_2 adsorption and desorption analysis, and electrochemical workstation. The results indicate that the N-MMCFs have main macropore of 0.2 μm, mesopore of 2.6–4.0 nm and specific surface areas of 1205–1808 $m^2 g^{-1}$. The contact angle of N-MMCFs for water is about 37.5°, obviously lower than that of MMCFs (72.9°), which suggests that the surface wettability of N-MMCFs is greatly improved due to the incorporation of nitrogen into the carbon framework. Electrochemical measurements show that specific capacitance of a typical N-MMCF as electrode material in 6 M KOH aqueous solution is as high as 198 $F g^{-1}$ at a current density of 1.0 $A g^{-1}$. Its specific capacitance can still remain 159 $F g^{-1}$ at a high loading current density of 20.0 $A g^{-1}$ with the retention of 80.3%, which indicates that the typical N-MMCF as electrode material has a good rate capability. The high current charge and discharge capability offers the promising prospects for the application of N-MMCFs as electrode materials in supercapacitors which could meet the need of high power density.

1. Introduction

In recent years, supercapacitors have been attracted considerable interest due to their long cycle life, rapid charge/discharge and high specific power density [1–5]. Because of good reversibility and cyclability, carbon-based materials have been regarded as one of the most promising candidates for supercapacitor electrodes.

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