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Carbon-Coated Mesoporous NiO Nanoparticles as an Electrode Material for High Performance Electrochemical Capacitors

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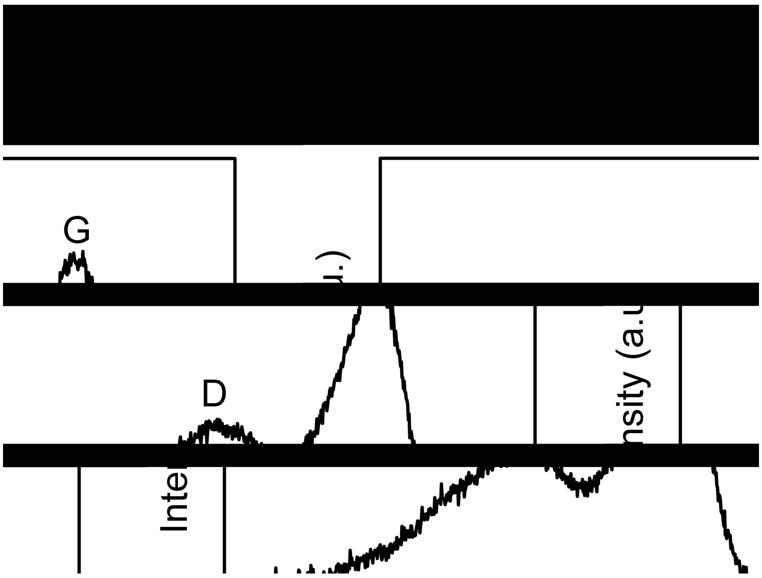

Fig. S1 The Raman spectrum of the mesoporous NiO@C nanocomposites.

The D peak G peak are observed and demonstrate the successful introduction of amorphous carbon.[1-4]

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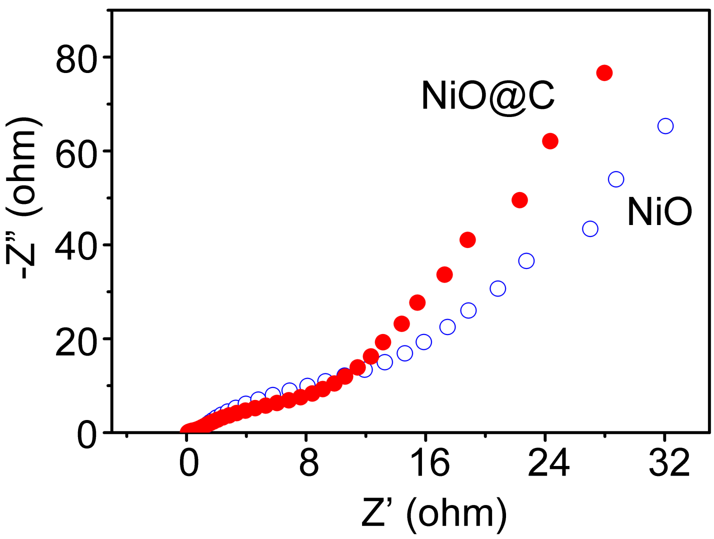

Fig. S2 EIS spectra of the mesoporous NiO and NiO@C electrode materials.

Electrochemical impedance spectroscopy (EIS) has been applied to investigate electrical conductivity of the supercapacitor electrodes. Fig. S2 shows the Nyquist impedance spectra of the mesoporous NiO and NiO@C electrode materials. The EIS spectra are composed of three distinct regions.[1,2] First, the intercept on the real axis in the high frequency range provides the equivalent series resistance (ESR) (Rs), which includes the inherent resistances of the electro active material, bulk resistance of electrolyte, and contact resistance at the interface between electrolyte and electrode.

Second, the charge transfer resistance (Rct), which results from diffusion of electrons, can be calculated from the diameter of semicircle in the high frequency range. Third, Warburg resistance, which describes the diffusion of redox species in the electrolyte, can be reflected from the slope of the EIS curve in the low frequency range. The magnitude of Rs obtained for the NiO and NiO@C electrode materials are 0.19 and 0.09Ω, respectively. And also the diameter of semicircle for NiO@C is smaller than NiO, which indicates that the NiO@C provide an ideal pathway for ion and electron transport without kinetic limitations. The above results demonstrate that a thin carbon shell within these nanocomposites can improve electron conductivity of the overall electrode.

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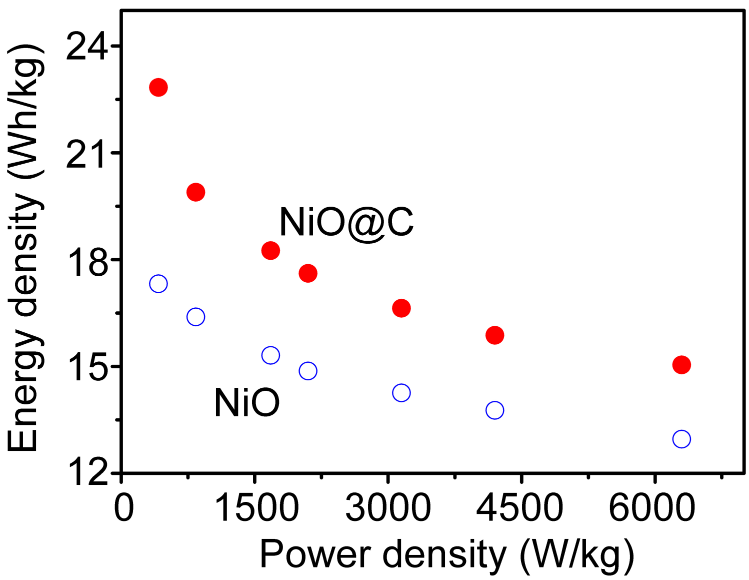

Fig. S3 Ragone plots of the mesoporous NiO and NiO@C electrode materials.

The power density and energy density have been calculated from the following equations, respectively: $E=0.5\ C\ \Delta V^2$, $P=E/t$, where E (Wh kg^{-1}) is the energy density, P (W kg^{-1}) is the power density, C (F g^{-1}) is the specific capacitance, ΔV (V) is the potential window of discharge, t (s) is the discharge time.[1] Fig. S3 shows the Ragone plots of the mesoporous NiO and NiO@C electrode materials. At a power density of 420 W kg^{-1}, the mesoporous NiO@C electrode materials deliver an energy density as high as 22.8 Wh kg^{-1}, which is larger than that of the mesoporous NiO electrode materials. More importantly, the energy density of the NiO@C electrode materials is still as high as 15 Wh kg^{-1} even at a high power density of 6300 W kg^{-1}.

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