Electronic Supplementary Information

Asymmetric supercapacitors based on nano-architectured NiO/graphene foam and hierarchical porous nitrogen-doped carbon nanotubes with ultrahigh-rate performance

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Calculations of specific capacitance, energy density and power density based on the galvanostatic charge–discharge curves:

(1) In three electrode configuration, specific capacitances derived from galvanostatic tests can be calculated from the equation:

$$C = \frac{I\Delta t}{m\Delta V}$$  \hspace{1cm} (1)

where $I$ is the discharging current, $t$ is the discharge time, $\Delta V$ is the potential drop during discharge, and $m$ is the mass of active material in the working electrode.

(2) In two electrode symmetric cell configuration, specific capacitances derived from galvanostatic tests can be calculated from the equation:

$$C = \frac{2(I\Delta t)}{m\Delta V}$$  \hspace{1cm} (2)

where $I$ is the constant discharge current, $\Delta t$ is the discharging time, $m$ is the mass of one electrode, and $\Delta V$ is the voltage drop upon discharging.

Energy density ($E$) and power density ($P$) derived from galvanostatic tests can be calculated from the following equations:

$$E = \frac{[C(\Delta V)^2]}{8}$$  \hspace{1cm} (3)

$$P = \frac{E}{\Delta t}$$  \hspace{1cm} (4)

where $E$, $C$, $\Delta V$, $P$ and $\Delta t$ are the specific energy, specific capacitance, potential window, specific power and discharge time, respectively.

(3) In two electrode asymmetric cell configuration, specific capacitances derived from galvanostatic tests can be calculated from the equation:

$$C = \frac{I\Delta t}{m\Delta V}$$  \hspace{1cm} (5)
where $I$ is the discharging current, $t$ is the discharge time, $\Delta V$ is the potential drop during discharge, and $m$ is the total mass of the active electrode materials in the positive and negative electrode.

Energy density ($E$) and power density ($P$) derived from galvanostatic tests can be calculated from the following equations:

\[
E = \frac{|C \Delta V|^2}{2} \quad (6)
\]

\[
P = \frac{E}{\Delta t} \quad (7)
\]

where $E$, $C$, $\Delta V$, $P$ and $\Delta t$ are the specific energy, specific capacitance, potential window, specific power and discharge time, respectively.
Fig. S1 (a, b) FESEM and (c, d)TEM images of PPy nanotubes.
**Fig. S2** Electrochemical characterization of the HPNCNTs//HPNCNTs symmetric supercapacitor. (a, b) CV curves of the HPNCNTs//HPNCNTs symmetric supercapacitor at various scan rates in 1M KOH. (c, d) Charge–discharge curves of the HPNCNTs//HPNCNTs symmetric supercapacitor at various current densities (ranging from 1 to 60 A g⁻¹). (e) Specific capacitance of the HPNCNTs//HPNCNTs symmetric supercapacitor as a function of current density. (f) Cycle performance of the HPNCNTs//HPNCNTs symmetric supercapacitor measured at 20 A g⁻¹ for 6000 cycles. (g) Energy and power density of the HPNCNTs//HPNCNTs symmetric supercapacitor.
**Fig. S3** Nyquist plot of the NiO/GF//HPNCNTs asymmetric supercapacitor with the equivalent circuit in the inset.