Supplementary Information

Design and synthesis of organic (naphthoquinone) and inorganic (RuO$_2$) hybrid graphene hydrogel composite for asymmetric supercapacitors

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1. Calculation formula

The calculation formula for specific capacitance ($C$, F g$^{-1}$), energy density ($E$, W h kg$^{-1}$) and power density ($P$, kW kg$^{-1}$) based on the galvanostatic discharge curves of samples are shown as following:$^{1-4}$

1.1. In three-electrode system, the specific capacitance of an electrode material can be calculated from the equation 1-1:

$$ C = I \cdot \Delta t / \Delta V \cdot m \ (equ. \ 1-1), $$

where $I$, $\Delta t$, $\Delta V$ and $m$ are discharging current, discharge time, practical potential window and mass of active material on the working electrode, respectively.

1.2. The proper mass ratio ($R$) of the positive and negative active materials in two-electrode system can be confirmed by using equation 1-2:

$$ R = \frac{m_+}{m_-} = \frac{C_- \Delta V_-}{C_+ \Delta V_+} \ (equ. \ 1-2) $$

where $m_+$ and $m_-$ refer to mass, $C_+$ and $C_-$ correspond to specific capacitances, while $\Delta V_+$ and $\Delta V_-$ are potential windows of the positive and negative electrodes, respectively.

1.3. In two-electrode system, the specific capacitances of a capacitor can be calculated from the equation 1-3:

$$ C = I \cdot \Delta t / \Delta V \cdot M \ (equ. \ 1-3) $$

where $I$, $\Delta t$, $\Delta V$ and $M$ are the discharge current, discharging time, cell voltage and total mass of anode and cathode materials, respectively.

1.4. Energy and power densities can be calculated from the following equations:

$$ E = C(\Delta V)^2 / 7.2 \ (equ. \ 1-4) $$
\[ \dot{P} = 3600E/\Delta t \quad (\text{equ. } 1-5) \]

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

2. Characterization

2.1 TEM analysis

![Fig. S1 TEM image of pure SGH.](image)

2.2 Cyclic voltammetry test

![Fig. S2 CV curves of MNC//NQ-RuO\(_2\)/SGH and MNC//RuO\(_2\)/SGH ASC in 1 mol L\(^{-1}\) H\(_2\)SO\(_4\).](image)

3. References

