Electronic Supplementary Information (ESI)

Self-Assembling Hybrid NiO/Co$_3$O$_4$ Ultrathin and Mesoporous Nanosheets into Flower-like Architectures for Pseudocapacitance

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Supplementary Figures

Figure S1. A photograph of a large-scale of as-synthesized hybrid NiO/Co$_3$O$_4$ (3:2) flower-like architectures.
**Figure S2.** (a-c) Low- and high-magnification SEM images and TEM image of as-synthesized solvothermal products (using Ni(NO₃)₂·6H₂O as a source material), respectively. (d) TEM image of the resulted NiO flower-like architectures formed by thermal annealing the solvothermal products at 450 °C.
Figure S3. (a-c) Low- and high-magnification SEM images and TEM image of as-synthesized solvothermal products (using a mixture of Ni(NO$_3$)$_2$·6H$_2$O and Co(NO$_3$)$_2$·6H$_2$O with a mole ratio of 4:1 as source materials), respectively. (d) TEM image of the resulted hybrid NiO/Co$_3$O$_4$ flower-like architectures obtained by thermal annealing the solvothermal products at 450 °C.
**Figure S4.** HRTEM image of the composite NiO/Co$_3$O$_4$ (4:1) material, inset showing its corresponding FFT pattern.

**Figure S5.** (a) Co 2p, (b) Ni 2p and (c) O 1s regions of XPS spectrum, (d) XRD pattern of as-synthesized hybrid NiO/Co$_3$O$_4$ (4:1) flower-like architectures.
The Co 2p region exhibits two peaks at 795.5 and 779.8 eV, corresponding to the Co 2p$_{1/2}$ and Co 2p$_{3/2}$ spin-orbit peaks of the spinel Co$_3$O$_4$ phase. The Co 2p$_{1/2}$-Co 2p$_{3/2}$ energy separation is approximately 15.7 eV, and the absence of prominent shake-up satellite peaks in the Co 2p region suggests the formation of the Co$_3$O$_4$ phase.$^{[1,2]}$ Also, two Ni 2p$_{1/2}$ and Ni 2p$_{3/2}$ peaks located at 871.3 and 853.6 eV in the Ni 2p region are both accompanied by two prominent shake-up satellite peaks, which distinctly verify the presence of the NiO phase.$^{[2,3]}$ The O 1s region from the as-synthesized hybrid NiO/Co$_3$O$_4$ (4:1) material can be de-convoluted into two components, suggesting the presence of two types of oxygen-containing species. The band at 529.5 eV is assigned to the lattice oxygen in the M-O (M = Ni or Co), while the band at 531 eV corresponds to the oxygen in hydroxide ions.$^{[4]}$ No signal of water molecules (H-O-H) was detected from the two O 1s spectra, implying the absence of absorbed water in as-synthesized hybrid NiO/Co$_3$O$_4$ (4:1) flower-like architectures.
Figure S6. (a-c) Low- and high-magnification SEM images and TEM image of as-synthesized solvothermal products (using a mixture of Ni(NO$_3$)$_2$·6H$_2$O and Co(NO$_3$)$_2$·6H$_2$O with a mole ratio of 3:2 as source materials), respectively. (d) TEM image of the resulted hybrid NiO/Co$_3$O$_4$ flower-like architectures obtained by thermal annealing the solvothermal products at 450 °C.
Figure S7. XRD pattern of as-synthesized hybrid NiO/Co₃O₄ (3:2) flower-like architectures.
**Figure S8.** (a) XPS survey scan of as-synthesized hybrid NiO/Co$_3$O$_4$ (3:2) flower-like architectures. (b) Co 2p, (c) Ni 2p and (d) O 1s regions, respectively.

![Image](image.png)

**Figure S9.** (a) SEM image of as-synthesized hybrid NiO/Co$_3$O$_4$ (3:2) flower-like architectures. (b-d) Ni, Co and O elemental mappings, respectively.

![Image](image.png)
**Figure S10.** (a) and (b) CV curves of the as-synthesized NiO flower-like architectures and the hybrid NiO/Co$_3$O$_4$ (3:2) flower-like architectures at different scan rates, respectively.

![CV curves of the as-synthesized NiO flower-like architectures](image1)

**Figure S11.** (a), (b) and (c) Discharge curves of as-synthesized NiO flower-like architectures and hybrid NiO/Co$_3$O$_4$ (4:1 and 3:2) flower-like architectures at different current densities, respectively.

![Discharge curves of the as-synthesized NiO flower-like architectures](image2)
Figure S12. (a-c) Nitrogen adsorption-desorption isotherms of as-synthesized NiO flower-like architectures, hybrid NiO/Co$_3$O$_4$ (4:1) flower-like architectures, and hybrid NiO/Co$_3$O$_4$ (3:2) flower-like architectures, respectively. Three insets display their corresponding BJH pore size distribution plots, respectively.

References


