Support information

Synthesis of C/Co₃O₄ composite mesoporous hollow spheres sandwich

graphene films for high-performance supercapacitors

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Figure S1. (a) Nitrogen adsorption–desorption isotherms for C/Co_3O_4 MHSs and (b) the corresponding pore size distribution plots.



Figure S2. TGA curves of GCCO-2 films (a) and C/Co₃O₄ MHSs (b).



Figure S3. (a) CV curve comparison of Nickel foam (support material) and C/Co_3O_4 MHSs (2 mV s⁻¹); (b) CV curve comparison of Co_3O_4 spheres and C/Co_3O_4 MHSs (2 mV s⁻¹); (c) CV curves of negative electrode (rGO) at different scan rates; (d) A SEM image and a physical photo of rGO films.



Figure S4. (a) CV curve comparison of rGO/Co_3O_4 (2:1) and $rGO/C/Co_3O_4$ (GCCO-2) composite films at 2 mV s⁻¹; (b) GCD curve comparison of rGO/Co_3O_4 and GCCO-2 films at 1 A g⁻¹.

Volumetric capacitance of GCCO-2 films and the ASCs at different current densities were calculated.

Table S1. Volumetric capacitance of GCCO-2 films with different current densities in three-electrode system.

Three- electrode system (GCCO-2)	Area (cm ²)	Thickness (μm)	Mass capacitance (F g ⁻¹)	Area capacitance (F cm ⁻²)	Volumetric capacitance (F cm ⁻³)
1 A	1.0	2.8	1266	2.026	7.24*10 ³
2 A	1.0	2.8	985	1.576	5.63*10 ³
3 A	1.0	2.8	882	1.411	5.04*10 ³
5 A	1.0	2.8	756	1.209	4.32*10 ³
10 A	1.0	2.8	534	0.855	3.05*10 ³

Table S2. Volumetric capacitance of rGO//GCCO-2 with different current densities in two-electrode system.

Two-electrode system (rGO//GCCO-2)	Volumetric (cm ⁻³)	Mass capacitance (F g ⁻¹)	Volumetric capacitance (F cm ⁻³)
1 A	4.87*10-4	92.00	7.56*10 ²
2 A	4.87*10-4	78.63	6.46*10 ²
3 A	4.87*10-4	67.31	5.53*10 ²
5 A	4.87*10-4	45.63	3.48*10 ²
8 A	4.87*10-4	26.00	2.14*10 ²

Values of columbic efficiency for the charge/discharge curves were calculated.

Three-electrode	Charging time (s)	Discharge time (s)	Columbic
system	at 1 A g ⁻¹	at 1 A g ⁻¹	efficiency (100%)
C/Co ₃ O ₄	47.3	43.7	92.40%
GCCO-3	571.8	383.	67.00%
GCCO-2	700.0	510.0	72.90%
GCCO-1	204.5	168	82.20%

Table S3. Columbic efficiencies of electrode materials at 1 A g⁻¹ with different mass ratios of rGO in three-electrode system.

Table S4. Columbic efficiencies of GCCO-2 films with different current densities in three-electrode system.

Three-electrode system (GCCO-2)	Charging time (s)	Discharge time (s)	Columbic efficiency (100%)
1 A	700.0	510.0	72.90%
2 A	213.2	201.2	94.30%
3 A	125.2	119.3	95.30%
5 A	63.0	62.7	99.50%
10 A	22.3	21.7	97.34%

Table S5. Columbic efficiencies of ASCs (GCCO-2//rGO) with different currentdensities in two-electrode system.

Two-electrode system (GCCO-2)	Charging time (s)	Discharge time (s)	Columbic efficiency (100%)
1 A	167.0	147.0	88.40%

2 A	66.3	62.9	94.90%
3 A	37.1	35.9	96.80%
5 A	15.3	14.6	95.40%
8 A	5.0	4.85	97.00%



Figure S5. 5,000 cycles of testing at 10 A g⁻¹ in a three-electrode system (GCCO-2).



Figure S6. 10,000 cycles of testing at 5 A g^{-1} in a two-electrode system (GCCO-2 //rGO).