Electronic Supplementary Information

Integrating three-dimensional graphene/Fe_3O_4@C composite and mesoporous $Co(OH)_2$ nanosheets arrays/graphene foam into a superior asymmetric electrochemical capacitor

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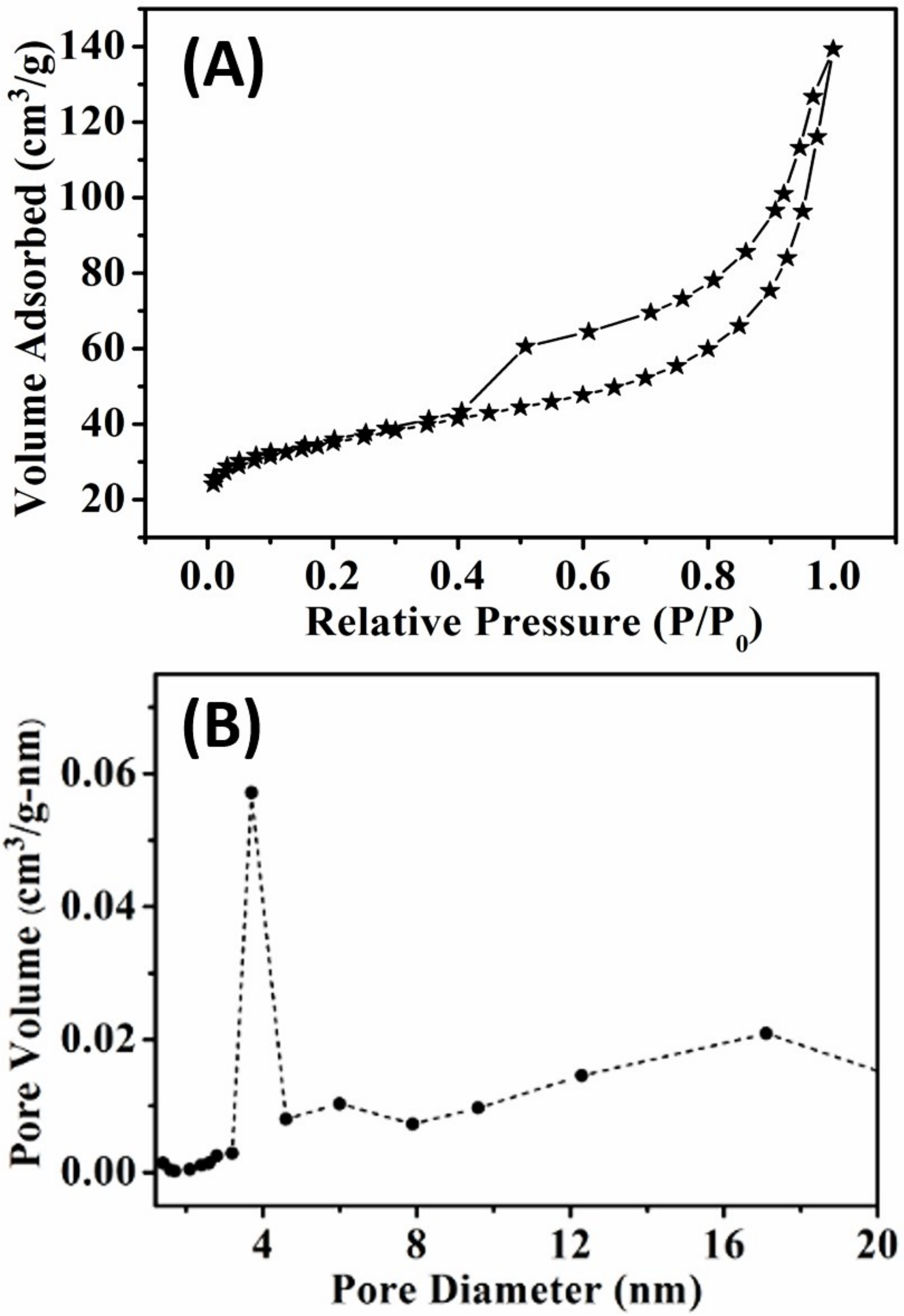

Figure S1 Nitrogen adsorption-desorption isotherms (A) and pore size distributions (B) for graphene/Fe_3O_4@C composite.

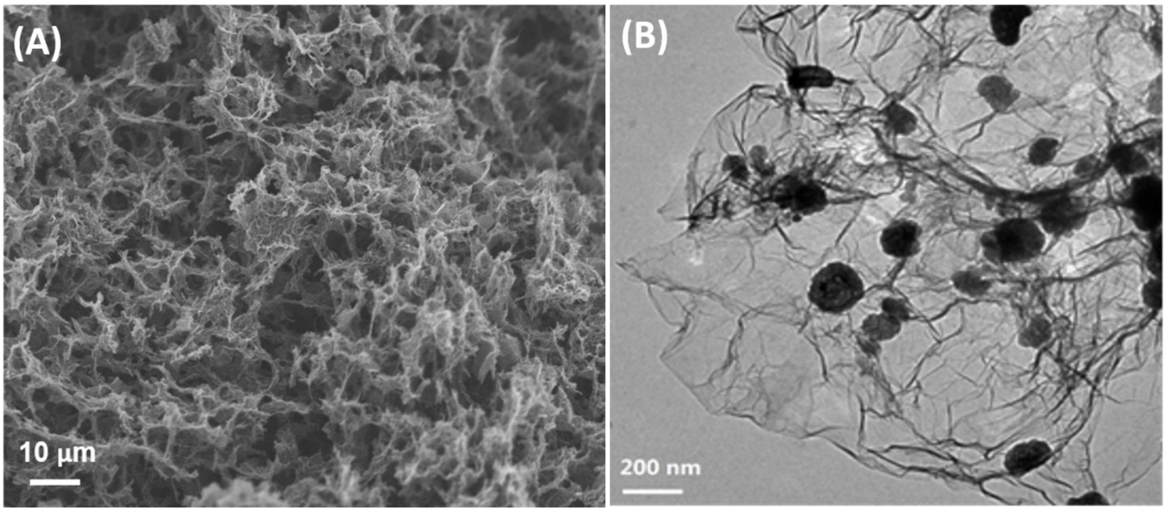

Figure S2 FESEM and TEM images of graphene/Fe_3O_4@C composites after cycling.

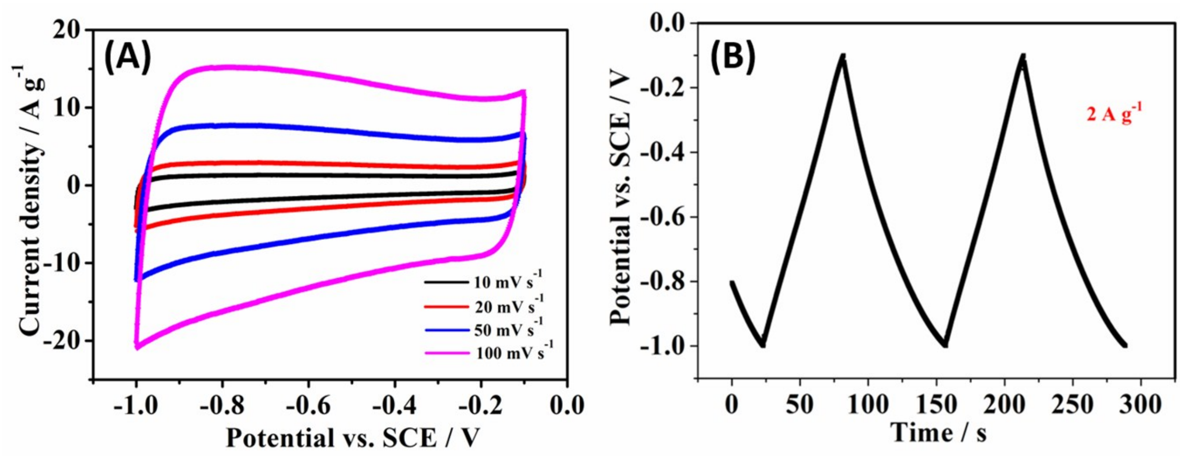

Figure S3 Electrochemical properties of pure graphene. (A) CV curves at different scan rates. (B) galvanostatic charge−discharge curves at 2 A g^{-1}.

Table S1. Specific capacitances of recently published state-of-the-art FeO_x-based materials, tested in three-electrode configuration.

FeO_x electrode	Electrolyte	Potential range (V vs. SCE)	Specific capacitance (F g^{-1})	Rate capability	Ref
graphitic nanoflake/Fe_3O_4	2M KOH	−1.2 to −0.6 V	299 at 0.5 A g^{-1}	131 at 0.5 A g^{-1}	S1
Fe_3O_4 film	1M Na_2SO_4	−0.55 to 0.05 V	105 at 20 mV s^{-1}	Not reported	S2
Fe_3O_4 powders	0.1M K_2SO_4	−0.8 to 0.25 V	75 at 10 mV s^{-1}	Not reported	S3
C-dots/Fe_3O_4	1M Na_2SO_3	−1 to 0 V	208 at 1 A g^{-1}	80 at 20 A g^{-1}	S4
Fe_2O_3 nanotube	1M Li_2SO_4	−0.8 to 0 V	138 at 1.3 A g^{-1}	91 at 12.8 A g^{-1}	S5
FeOOH rods	1M Li_2SO_4	−0.85 to −0.1 V	116 at 0.5 A g^{-1}	93 at 1.5 A g^{-1}	S6
Octadecahedron Fe_3O_4	1M Na_2SO_3	−1 to 0.1 V	118 at 2 A g^{-1}	50 at 3.3 A g^{-1}	S7
Fe_3O_4 nanoparticles	1M Na_2SO_3	−0.9 to 0.1 V	207.7 at 0.4 A g^{-1}	90.4 at 10 A g^{-1}	S8
Fe_3O_4/CNF composite	1M Na_2SO_3	−0.9 to 0.1 V	127 at 10 mV s^{-1}	53 at 10 mV s^{-1}	S9
Fe_3O_4/CNT composite	6M KOH	−1 to 0 V	129 at 2.5 mA cm^{-1}	103 at 40 mA cm^{-1}	S10
Fe_3O_4/carbon nanosheets	1M Na_2SO_3	−0.8 to −0.2 V	163.4 at 1 A g^{-1}	113 at 10 A g^{-1}	S11
Fe_3O_4/carbon black	1M Na_2SO_3	−0.75 to 0.5 V	510 at 15 mA g^{-1}	Not reported	S12
Fe_2O_3 nanotubes/rGO	1M Na_2SO_4	−1 to 0 V	215 at 2.5 mV s^{-1}	88 at 100 mV s^{-1}	S13
FeO_x/carbon foams	2.5M Li_2SO_4	−0.8 to 0.2 V	343 at 5 mV s^{-1}	Not reported	S14
Fe_3O_4 particles-graphene	1M KOH	−1 to 0.1 V	220.1 at 0.5 A g^{-1}	134.6 at 5 A g^{-1}	S15
FeOOH/graphene	1M LiOH	−1.15 to 0.1 V	326 at 0.5 A g^{-1}	293 at 10 A g^{-1}	S16
Au-Fe_3O_4 nanoparticles	6M KOH	−1 to 0.4 V	464 at 1 A g^{-1}	120 at 10 A g^{-1}	S17
Fe_3O_4-f-HEG	1M Na_2SO_4	−0.5 to −0.5 V	180 at 10 mV s^{-1}	160 at 100 mV s^{-1}	S18

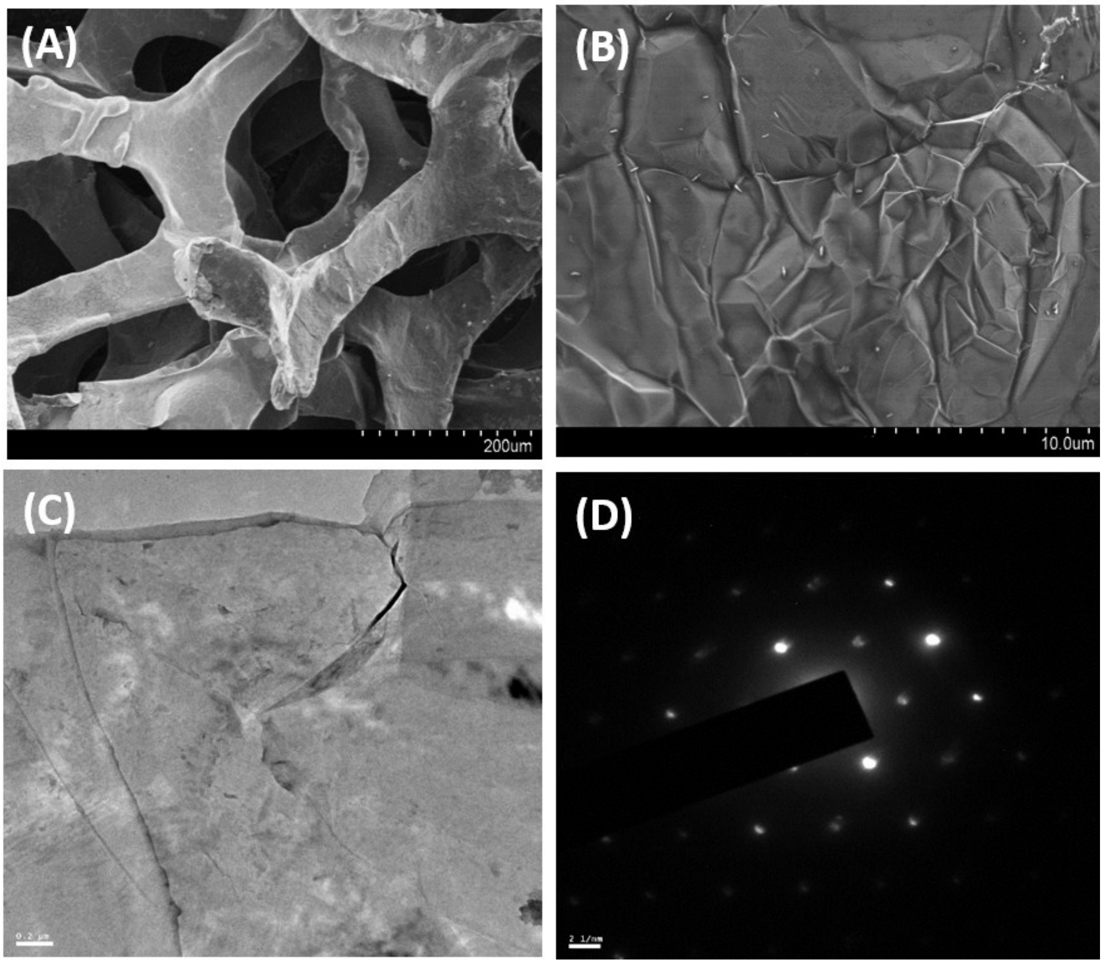

Figure S4 FESEM images (A, B) and TEM images (C) and the SAED pattern (D) of graphene foam.

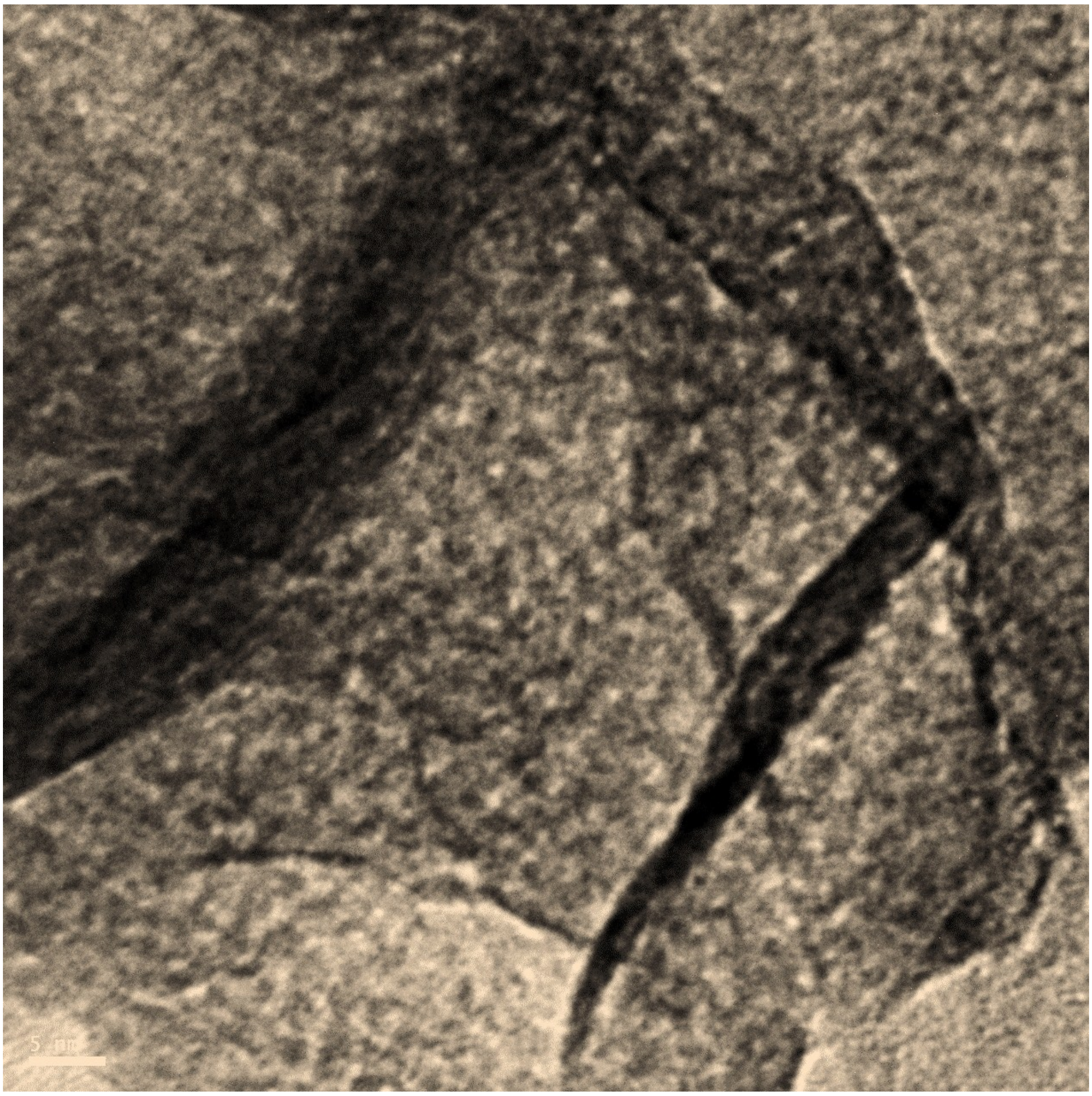

Figure S5 The TEM image of the $Co(OH)_2$ nanosheet on the GFs.

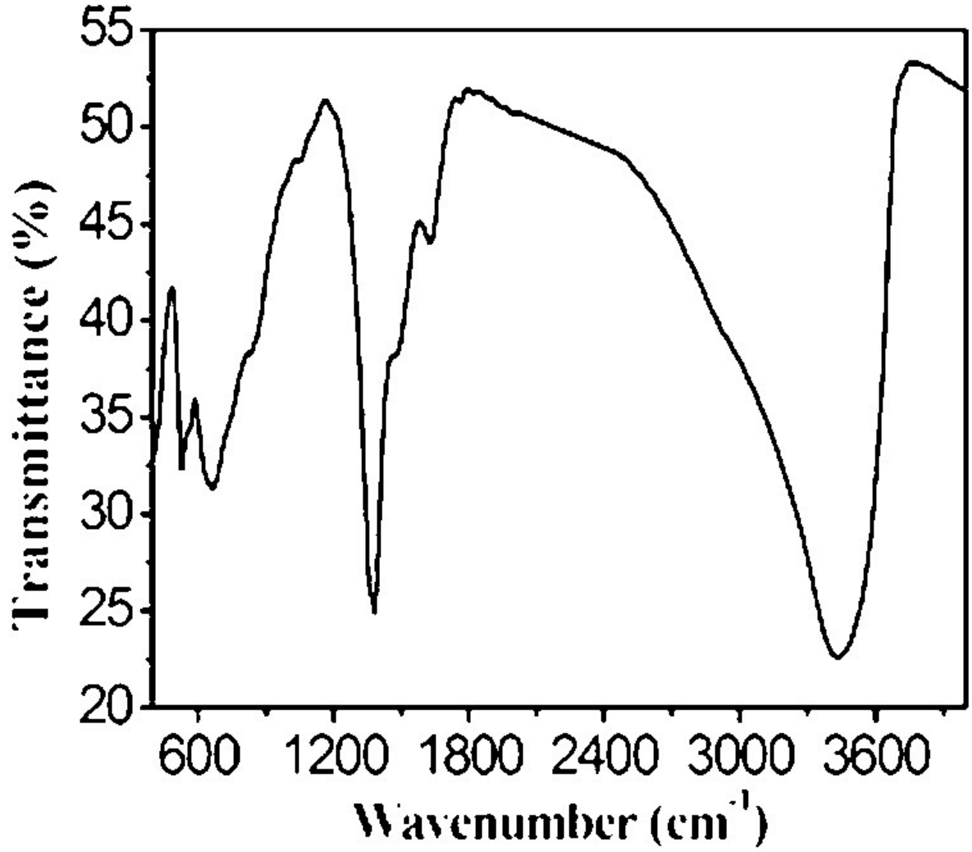

Figure S6 FT-IR spectrum of $Co(OH)_2$ NAs/GF.

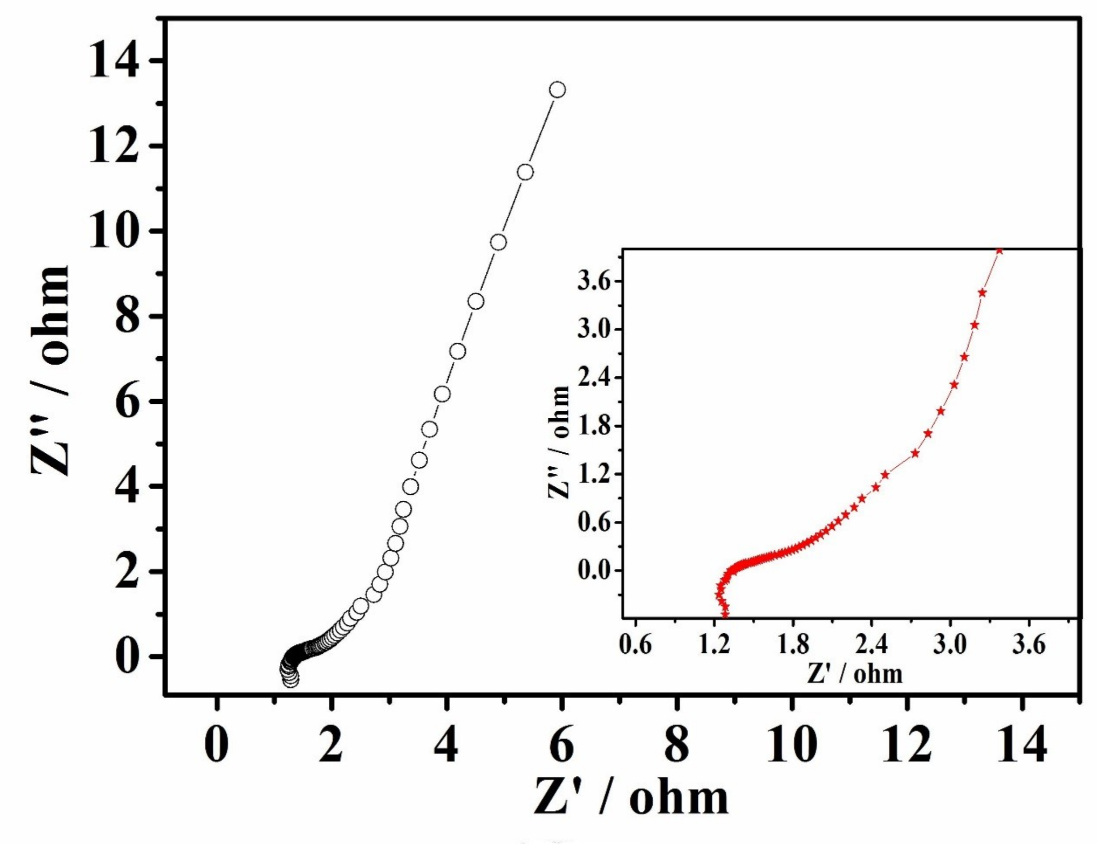

Figure S7 Nyquist plots for the $Co(OH)_2$ NAs/GF//graphene/Fe_3O_4@C ASC. The frequency range is from 10^{-1} to 10^5 at the bias potential of 1.4 V. The lower right inset presents high-frequency region of the plot.

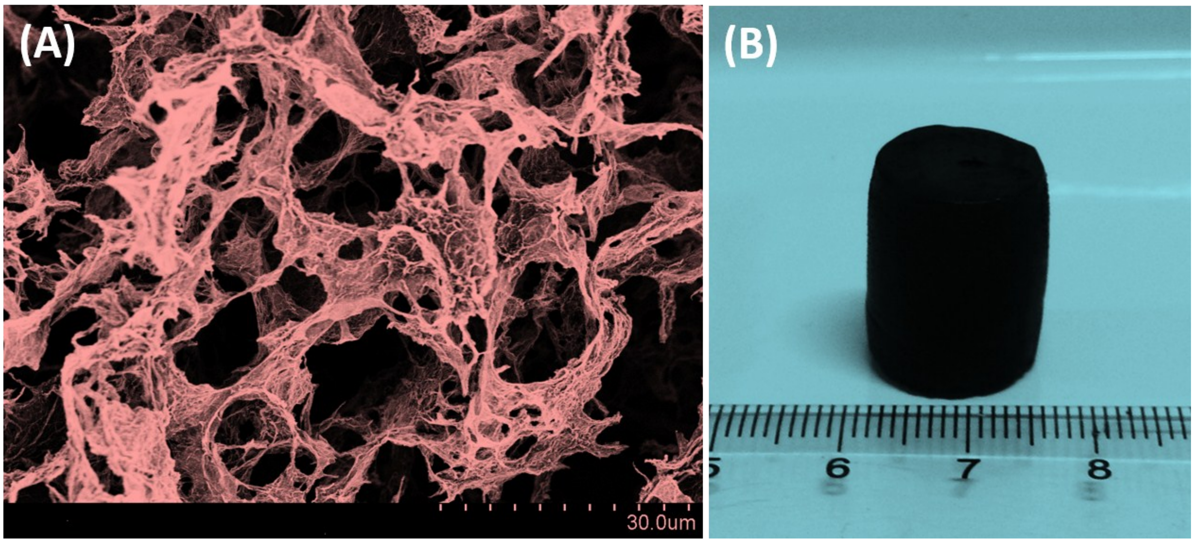

Figure S8 the FESEM image (A) and the photograph (B) of the graphene.

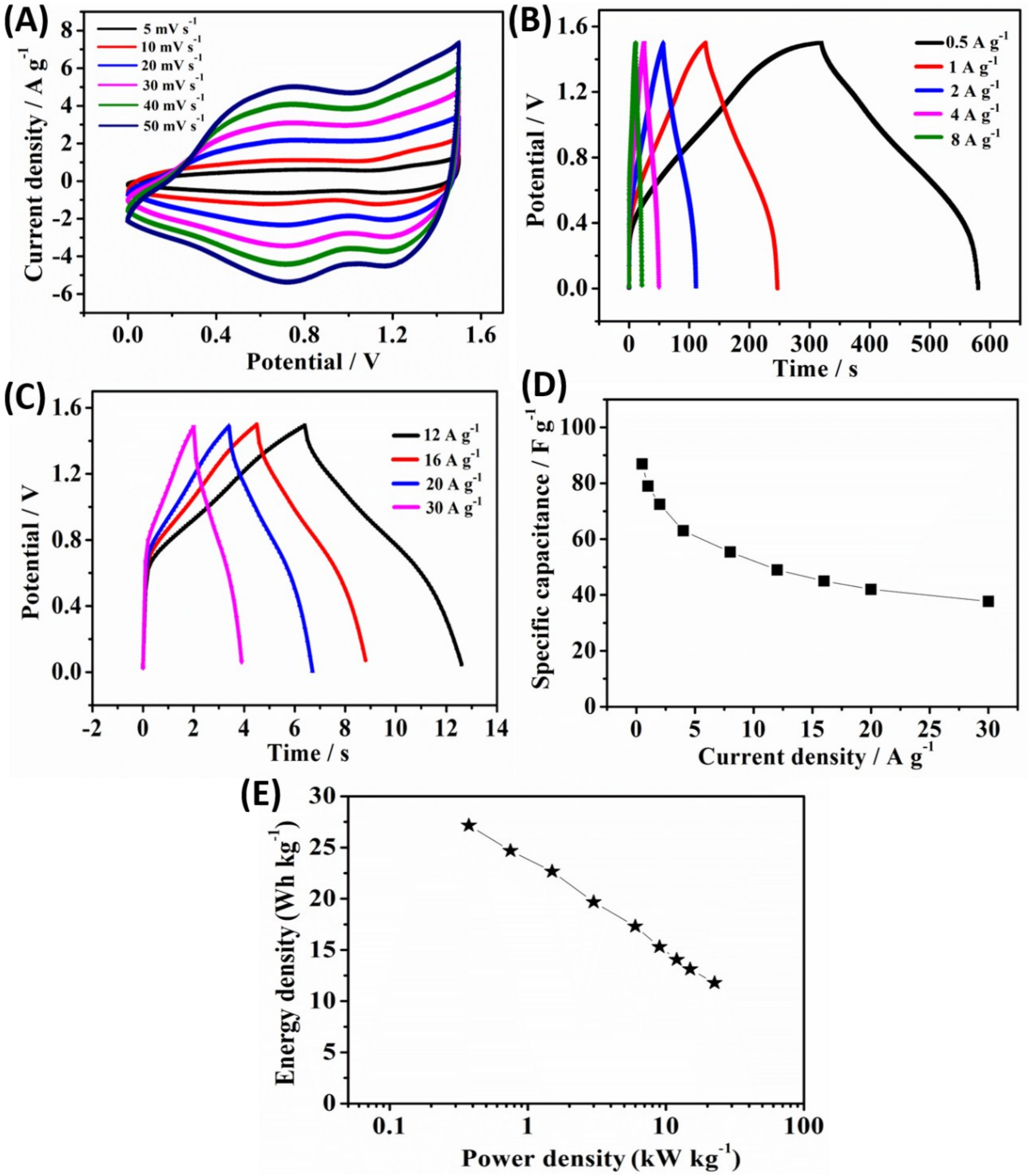

Figure S9 Electrochemical properties of the $Co(OH)_2$ NAs/GF//graphene ASC devise in 1 M KOH electrolyte. (A) CV curves at various scan rates. (B, C) GCD curves at various current densities. (D) Specific capacitances at various current densities. (E) Ragone plot.

The specific capacitances, energy densities, and power densities can be calculated by the following equations on the basis of galvanostatic charge–discharge curves:

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

$$E = \frac{1}{2\times 3.6} C V^2 \quad (2)$$

$$P = \frac{E\times 3600}{\Delta t} \quad (3)$$

Where C (F g^{-1}) is the specific capacitance, E (Wh kg^{-1}) is the energy density, P (W kg^{-1}) is the power density, I (A) is the discharge current, Δt (s) is the discharge time, m (g) is the sum mass of the active material and ΔV (V) is the potential drop during the discharge process.

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