

Electronic Supplementary Information

**Ni-Co sulfides nanowires on nickel foam with ultrahigh capacitance
for asymmetric supercapacitor**

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Figure captions

Figure S1. Nitrogen adsorption and desorption isotherms of (a) Ni-Co oxides and (b) Ni-Co sulfides. The insets are the corresponding Barrett-Joyner-Halenda (BJH) pore size distribution.

Figure S2. (a) EDS spectrum result and (b) Full XPS of the Ni-Co sulfides. (c) Comparison of XRD patterns of Ni-Co sulfides obtained at different reaction time during the second synthesis process. Triangle and rhombus stand for the peaks of Ni-Co oxides and sulfides, respectively.

After 6 hours reaction, four peaks appear, but the peak intensities are weak. After 12 hours reaction, the peak intensities show increases. For the samples obtained after 24 h and 36 h, the peak positions peak intensities are the same as those of obtained after 12 h.

Figure S3. (a) The linear relations of the square root of the scan rate dependence of the oxidation peak current at different scan rates for Ni-Co sulfides NWAs. (b) Galvanostatic discharge plots of a clean Ni foam conducted under the same condition.

Figure S4. (a and b) SEM images of the Ni-Co sulfides NWAs after 1000 continuous cycling tests. Inset in (a) is a magnified image. (c) Nyquist plots of the Ni-Co sulfides NWAs before and after 1000 cycles.

Figure S5. (a) CV curves of Ni-Co sulfides and activated carbon (AC) electrodes performed in a three-electrode cell at scan rate of 5 mV s^{-1} . (b) CV curves of the asymmetric supercapacitor in different voltage ranges at scan rate of 100 mV s^{-1} .

Table S1. Comparison of electrochemical performance of different electrode materials

Table S2. The values of the elements in equivalent circuit fitted in the Nyquist plots of Figure S4c.

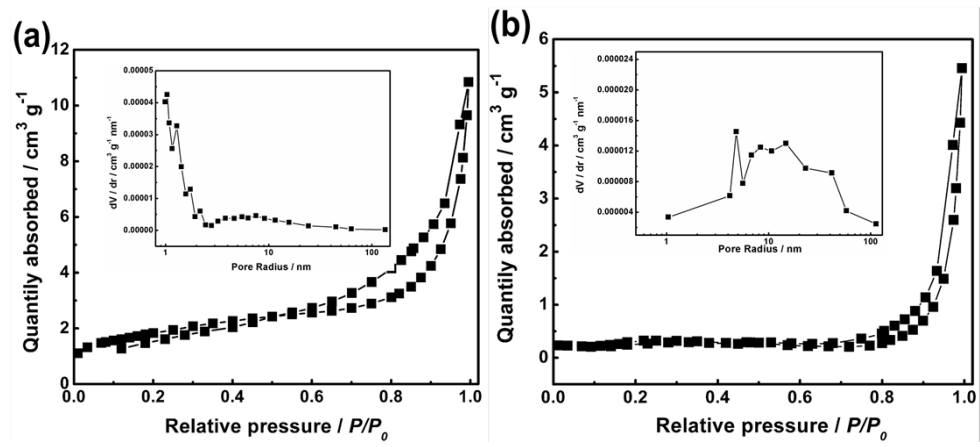


Figure S1

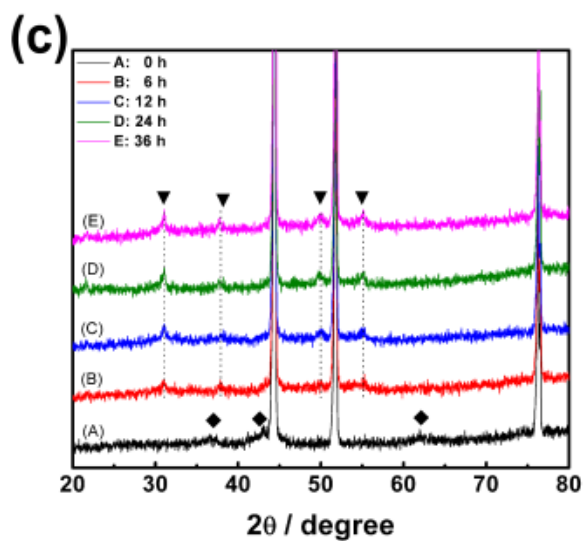
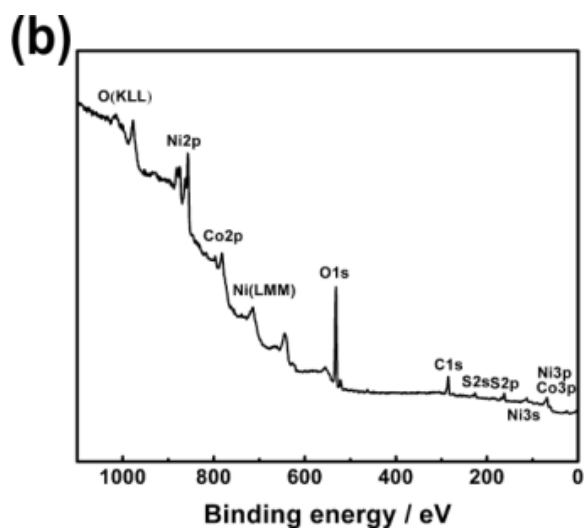
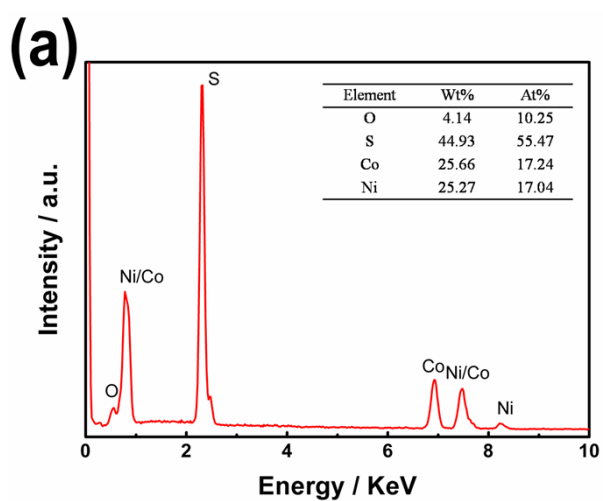


Figure S2

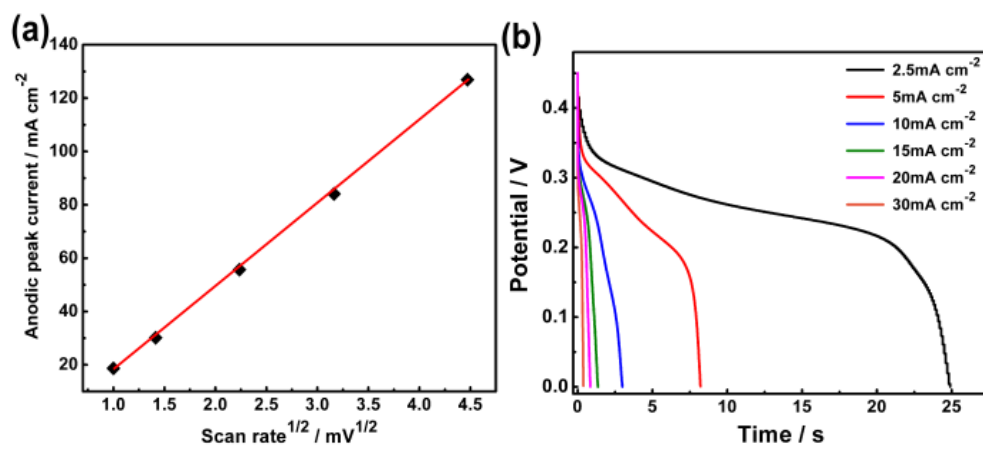


Figure S3

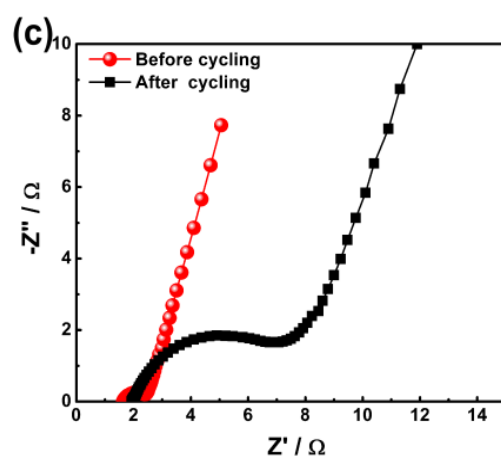
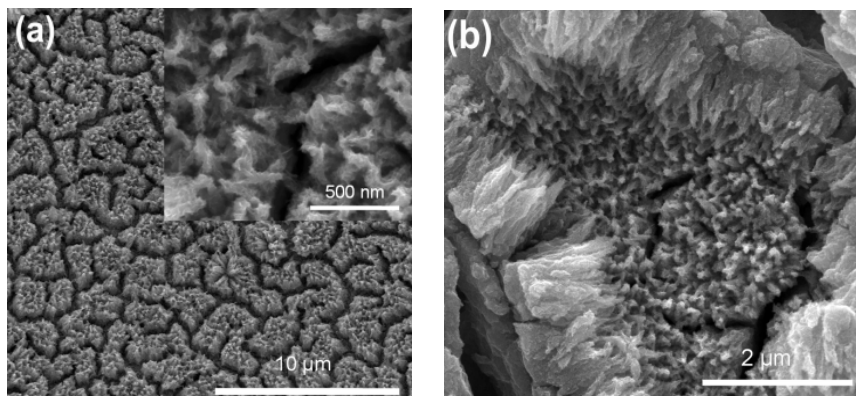


Figure S4

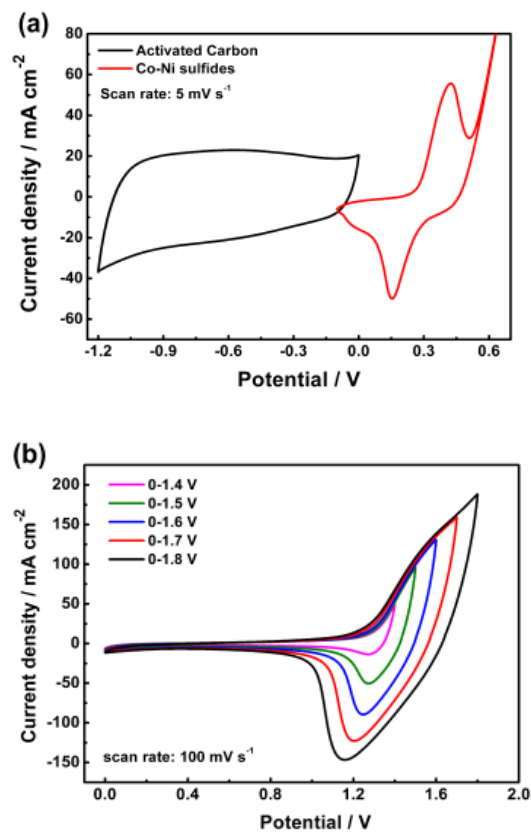


Figure S5

Table S1. Comparison of electrochemical performance of different electrode materials

Electrode materials	Capacitance	Rate capacitance retention	Capacitance retention after cycling	Reference
Ni-Co sulfides (in this article)	2053 F g ⁻¹ (5.1 F cm ⁻²) at 5 mA cm ⁻²	57% from 5 to 30 mA cm ⁻²	78.5% after 3000 cycles at 15 mA cm ⁻²	/
Co ₉ S ₈ nanorods	783.3 F g ⁻¹ (2.35 F cm ⁻²) at 5 mV s ⁻¹	24% from 5 to 200 mV s ⁻¹	92% after 2000 cycles at 10 mA cm ⁻²	Ref. 40
Co ₃ S ₄ hollow nanospheres	522.4 F g ⁻¹ at 0.5 A g ⁻¹	66% from 0.5 to 5 A g ⁻¹	54.5% after 1000 cycles at 0.5 A g ⁻¹	Ref. 41
NiS hollow spheres	927 F g ⁻¹ at 4.08 A g ⁻¹	62.8% from 4.08 to 10.2 A g ⁻¹	71.3% after 1000 cycles at 4.2 A g ⁻¹	Ref. 42
Flaky Ni ₃ S ₂	717 at 2 A g ⁻¹	57.3% from 2 to 32 A g ⁻¹	62% after 1000 cycles at 4 A g ⁻¹	Ref. 43
NiCo ₂ O ₄ nanoneedles	3.12 F cm ⁻² at 1.11 mA cm ⁻²	31.7% from 1.11 to 5.56 mA cm ⁻²	89.3% after 2000 cycles at 5.56 mA cm ⁻²	Ref. 11
NiCo ₂ O ₄ nanowires	743 F g ⁻¹ at 1 A g ⁻¹	78.6% from 1 to 40 A g ⁻¹	93.8% after 3000 cycles based on the maximum value at 20 mV s ⁻¹	Ref. 6
NiCo ₂ O ₄ nanosheets	2010 F g ⁻¹ at 2 A g ⁻¹	72% from 2 to 20 A g ⁻¹	94% after 2400 cycles	Ref. 9
Ni _{0.3} Co _{2.7} O ₄	960 F g ⁻¹ at 0.625 A g ⁻¹	74.2% from 0.625 to 6.25 A g ⁻¹	98.1% after 3000 cycles at 0.625 A g ⁻¹	Ref. 3

NiO/NiCo ₂ O ₄ /Co ₃ O ₄ composite	1717 F g ⁻¹ at 5 mA cm ⁻²	70.9% from 5 to 50 mA cm ⁻²	94.9% after 1000 cycles at 20 mA cm ⁻²	Ref. 44
Co ₃ O ₄ /Ni(OH) ₂ nanosheets	1144 F g ⁻¹ at 5 mV s ⁻¹	66 % from 5 to 100 mV s ⁻¹	93.4% after 500 cycles based on the maximum value at 5 mV s ⁻¹	Ref. 45
Urchin-like NiCo ₂ S ₄	1149 F g ⁻¹ at 1 A g ⁻¹	66.2% from 1 to 50 A g ⁻¹	91.4% after 5000 cycles at 20 A g ⁻¹	Ref. 21
NiCo ₂ S ₄ nanosheets	~1300 F g ⁻¹ at 3 A g ⁻¹	~30.7% from 3 to 20 A g ⁻¹	82% after 2000 cycles at 5 A g ⁻¹	Ref. 24
Co ₃ O ₄ @Co(OH) ₂ nanowires	1095 F g ⁻¹ at 1 A g ⁻¹	74% from 1 to 40 A g ⁻¹	88.5% after 2000 cycles at 2 A g ⁻¹	Ref. 47
Co ₃ O ₄ @NiO nanowires	853 F g ⁻¹ at 2 A g ⁻¹	85% from 2 to 40 A g ⁻¹	95.1% after 6000 cycles at 2 A g ⁻¹	Ref. 48
CoO@NiHON nanowires	798.3 F g ⁻¹ at 1.67 A g ⁻¹	84% from 1.67 to 13.33 A g ⁻¹	96.7% after 2000 cycles at 10 A g ⁻¹	Ref. 38
NiCo ₂ S ₄ nanotube	2398 F g ⁻¹ at 5 mA cm ⁻²	67.7% from 5 to 150 mA cm ⁻²	92% retention after 5000 cycles at 50 mA cm ⁻²	Ref. 46

Table S2. The values of the elements in equivalent circuit fitted in the Nyquist plots of Figure S4c.

Electrodes	R_s (Ω)	R_{ct} (Ω)	CPE_1	CPE_2
Before cycling	1.628	0.8266	0.04325	1.082
After cycling	1.947	5.58	0.02053	0.6679