Supporting Information

Indirect Nano-Construction Morphology of Ni3S2 Electrodes Renovates the Performance for Electrochemical Energy Storage

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Calculations

The specific capacity of a single electrode was calculated from discharge profiles of the GCD curves using the following equation:

$$C_s = \frac{I \cdot \Delta t}{m}$$

where C_s is the electrode specific capacity (C g^{-1}), I is the constant discharge current (A), Δt is the discharging time (s), and m is the mass of electrodeposited material (g, combined mass of Ni(Cu) frame and Ni_3S_2).

For the fabrication of asymmetric supercapacitor, the mass ratio of Ni_3S_2/Ni and activated carbon is estimated based on charge balance theory:

$$\frac{m_+}{m_-} = \frac{C_- \times \Delta V_-}{C_+ \times \Delta V_+}$$

where m is the mass of active material, C is the specific capacitance, and ΔV is the potential window, which were obtained based on CV curves at 10 mV s^{-1}. According to calculation, the mass ratio of Ni_3S_2/Ni and activated carbon was 1:3. The device specific capacitance was obtained from discharge curves of the GCD measurement according to the following equation:

$$\mathrm{C} = \frac{I \cdot \Delta t}{\Delta V \cdot m}$$

where C is the device specific capacitance (F g^{-1}), I is the constant discharge current (A), Δt is the discharging time (s), ΔV is the potential window excluding the IR drop (V), and m is the total mass of active materials. The energy density and power density of the asymmetric supercapacitor were estimated by the following equations:

$$E = \frac{1}{2}\mathrm{C} \cdot \Delta V^2$$

$$P = \frac{E}{\Delta t}$$

where E is the energy density (W h kg^{-1}), C is the device capacitance (F g^{-1}) obtained by the GCD curve, ΔV is the potential window excluding the IR drop (V), P is the power density (W kg^{-1}), and Δt is the discharging time (s).

Supplementary data

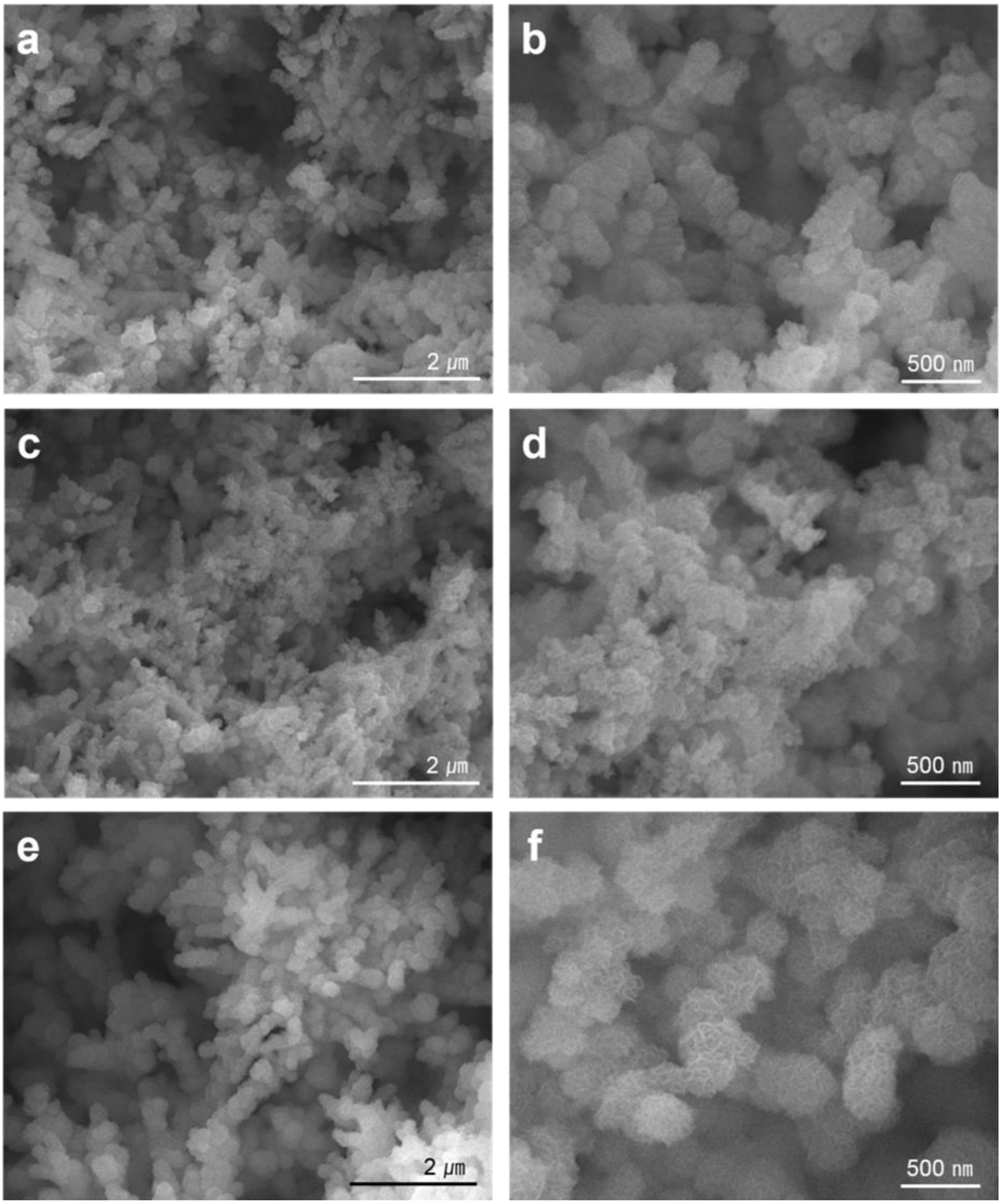

Figure. S1 Low magnification SEM images of (a) Ni_3S_2/Ni 2 min, (c) Ni_3S_2/Ni 4 min, and (e) Ni_3S_2/Ni 8 min electrodes. High magnification SEM images of (b) Ni_3S_2/Ni 2 min, (d) Ni_3S_2/Ni 4 min, and (f) Ni_3S_2/Ni 8 min electrodes.

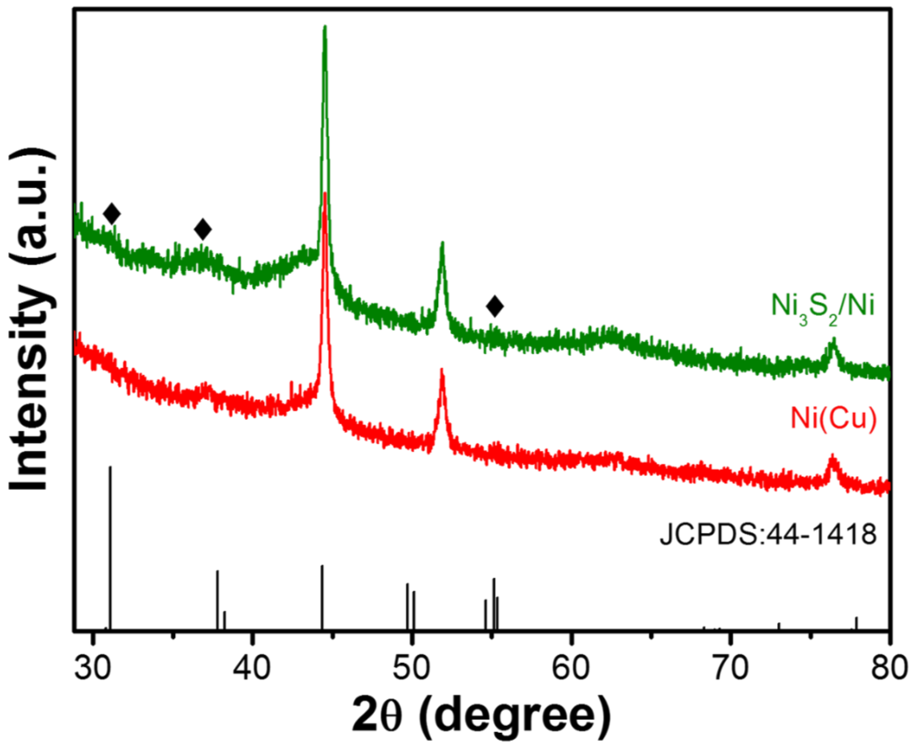

Figure. S2 XRD patterns of the Ni(Cu) frame and Ni_3S_2/Ni electrode after annealing under a nitrogen atmosphere at 300 ℃ for 30 min.

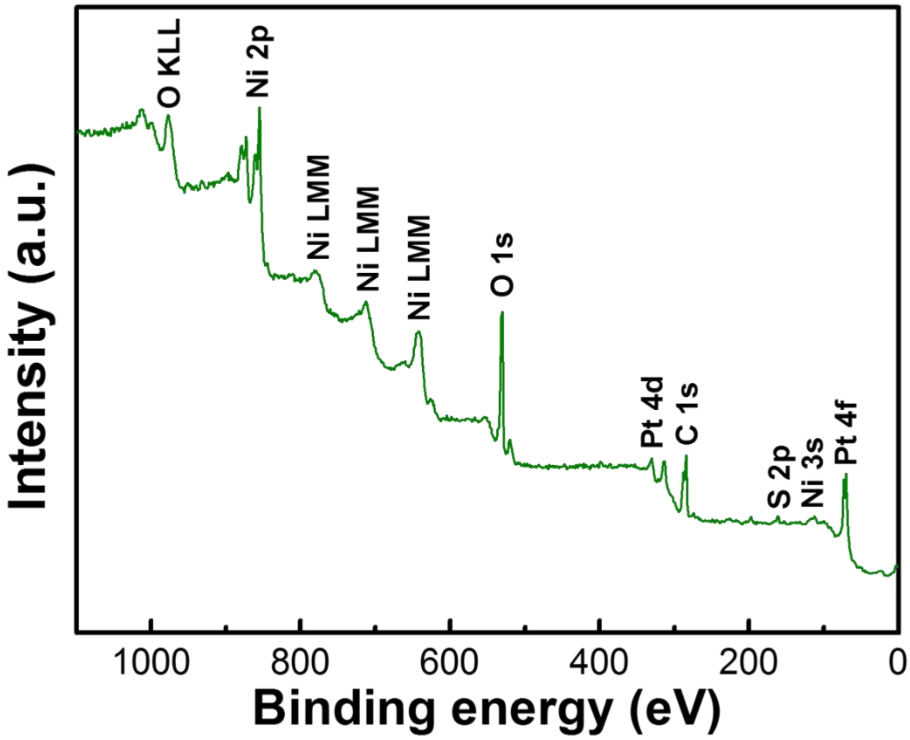

Figure. S3 XPS survey spectrum of the Ni_3S_2/Ni 6 min electrode.

Elemental peaks are observed for Ni, S, C, O, and Pt, which indicates the high purity of the electrodeposited Ni_3S_2/Ni.

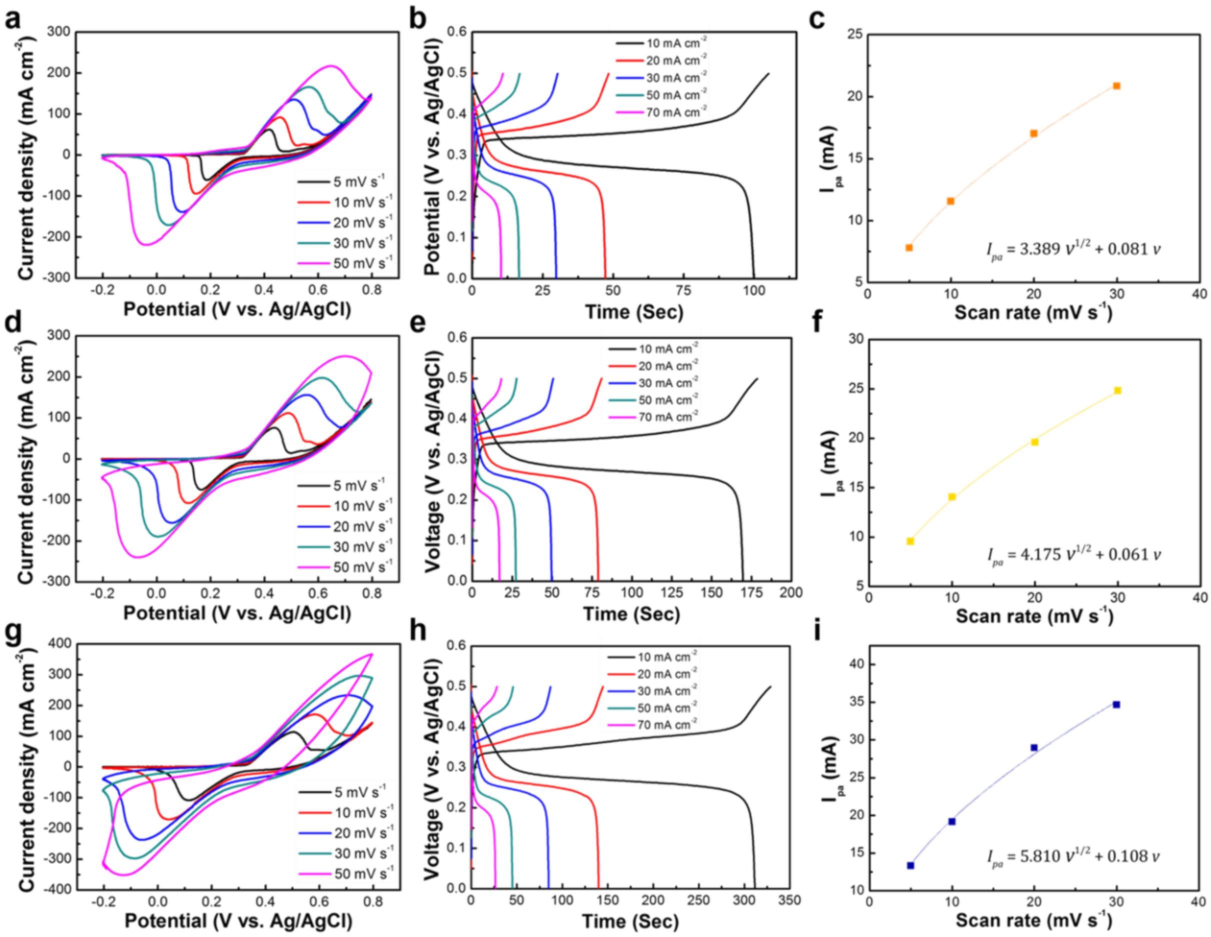

Figure. S4 Electrochemical performances of Ni_3S_2/Ni electrodes. (a) CV curves, (b) GCD curves, and (c) peak current response as a function of scan rate of the Ni_3S_2/Ni 2 min electrode. (d) CV curves, (e) GCD curves, and (f) peak current response as a function of scan rate of the Ni_3S_2/Ni 4 min electrode. (g) CV curves, (h) GCD curves, and (i) peak current response as a function of scan rate of the Ni_3S_2/Ni 8 min electrode.

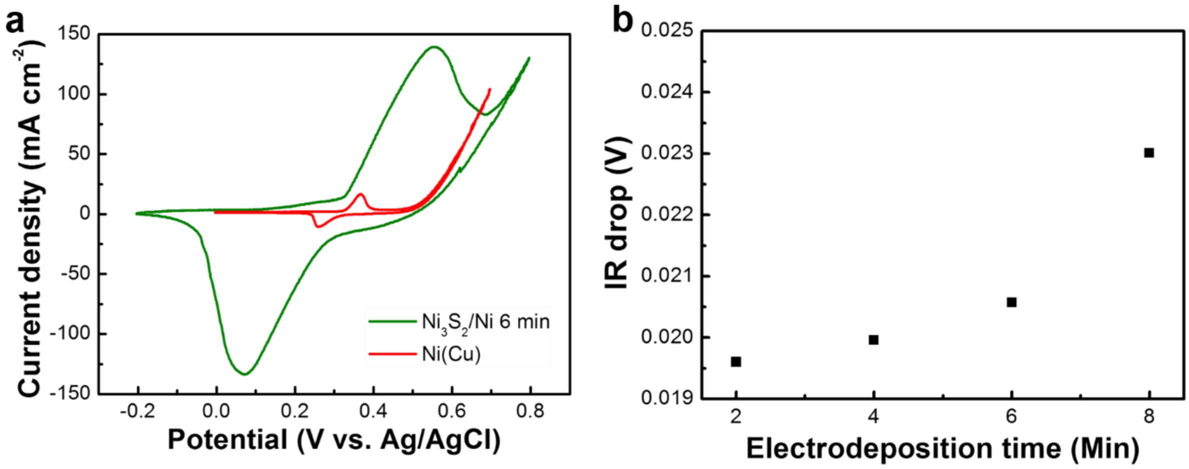

Figure. S5 (a) CV curves of the Ni(Cu) frame and Ni_3S_2/Ni 6 min electrode at a scan rate of 10 mV s^{-1}. (b) IR drop of the Ni_3S_2/Ni electrodes as a function of electrodeposition time at a current density of 10 mA cm^{-2}.

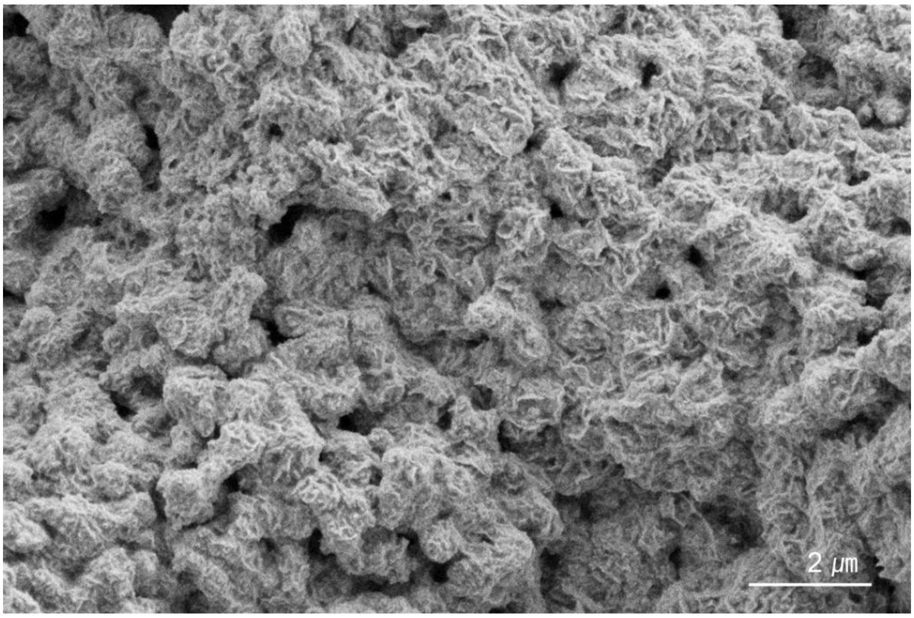

Figure. S6 SEM images of Ni_3S_2/Ni 6 min electrode after cycling stability measurement at a scan rate of 30 mV s^{-1} over 1000 cycles.

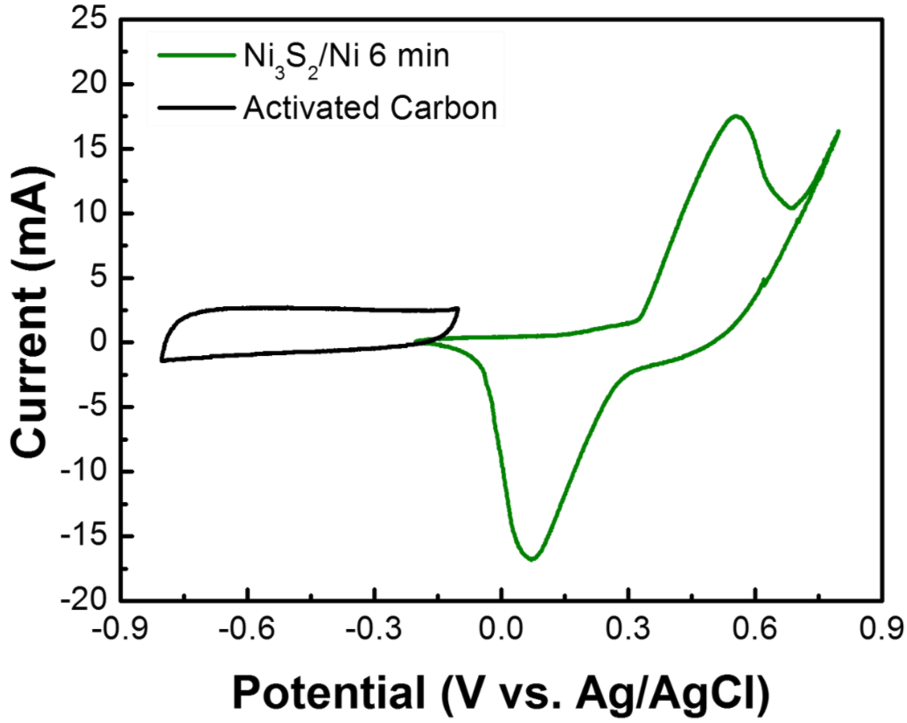

Figure. S7 CV curves of activated carbon and Ni_3S_2/Ni 6 min electrode at a scan rate of 10 mV s^{-1}.

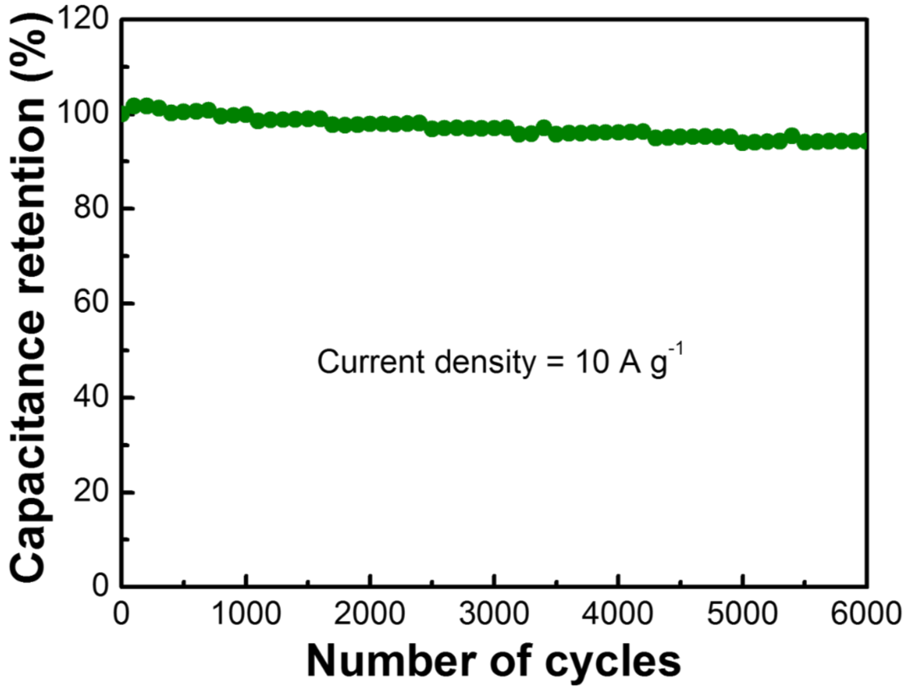

Figure. S8 Cycling stability of the Ni_3S_2/Ni 6 min//AC asymmetric supercapacitor over 6000 cycles.

Table. S1 Comparison with previously reported electrochemical performances of nickel oxides/sulfides based electrode materials.

Electrode materials	Specific capacitance	Rate capability	Capacitance retention	Reference
Ni_3S_2/Ni foam	1051 F g^{-1} at 1.25 mA cm^{-2}	53 % from 2.5 to 30 mA cm^{-2}	108.3 % after 2000 cycles at 20 mA cm^{-2}	[25]
Flaky Ni_3S_2	717 F g^{-1} at 2 A g^{-1}	57.3 % from 2 to 32 A g^{-1}	62 % after 1000 cycles at 4 A g^{-1}	[15]
Ni@NiO dendrites	1928.5 F g^{-1} at 2 mA cm^{-2}	70.8 % from 2.9 A g^{-1} to 58 A g^{-1}	100 % after 70000 cycles at 100 mV s^{-1}	[17]
Ni_3S_2 nanosheet arrays	1370.4 F g^{-1} at 2 A g^{-1}	69.5 % from 2 to 20 A g^{-1}	91.4 % after 1000 cycles at 6 A g^{-1}	[33]
Mesostructured NiO/Ni	522 C g^{-1} at 1 A g_{NiO}^{-1}	78 % from 1 to 50 A g_{NiO}^{-1}	97 % after 10000 cycles at 100 mV s^{-1}	[14]
Ni_3S_2 dendrites	710.4 F g^{-1} at 2 A g^{-1}	66.2 % from 2 to 14 A g^{-1}	100 % after 2000 cycles at 5 A g^{-1}	[35]
NiO nanosheets	993 F g^{-1} (348 C g^{-1}) at 3 A g^{-1}	44.8 % from 3 to 15 A g^{-1}	98.2 % after 500 cycles at 15 A g^{-1}	[36]
Ni_3S_2-NiS nanowires	1077.3 F g^{-1} at 5 A g^{-1}	66.8 % from 5 to 30 A g^{-1}	76.3 % after 10000 cycles at 20 A g^{-1}	[22]
Ni_3S_2/Ni 6 min	786.5 C g^{-1} (1645 F g^{-1}) at 10 mA cm^{-2}	64 % from 10 to 70 mA cm^{-2}	88.6 % after 1000 cycles at 30 mV s^{-1}	Present work