Supporting Information for

Facile fabrication of Co_2CuS_4 nanoparticle anchored N-doped graphene for high-performance asymmetric supercapacitors

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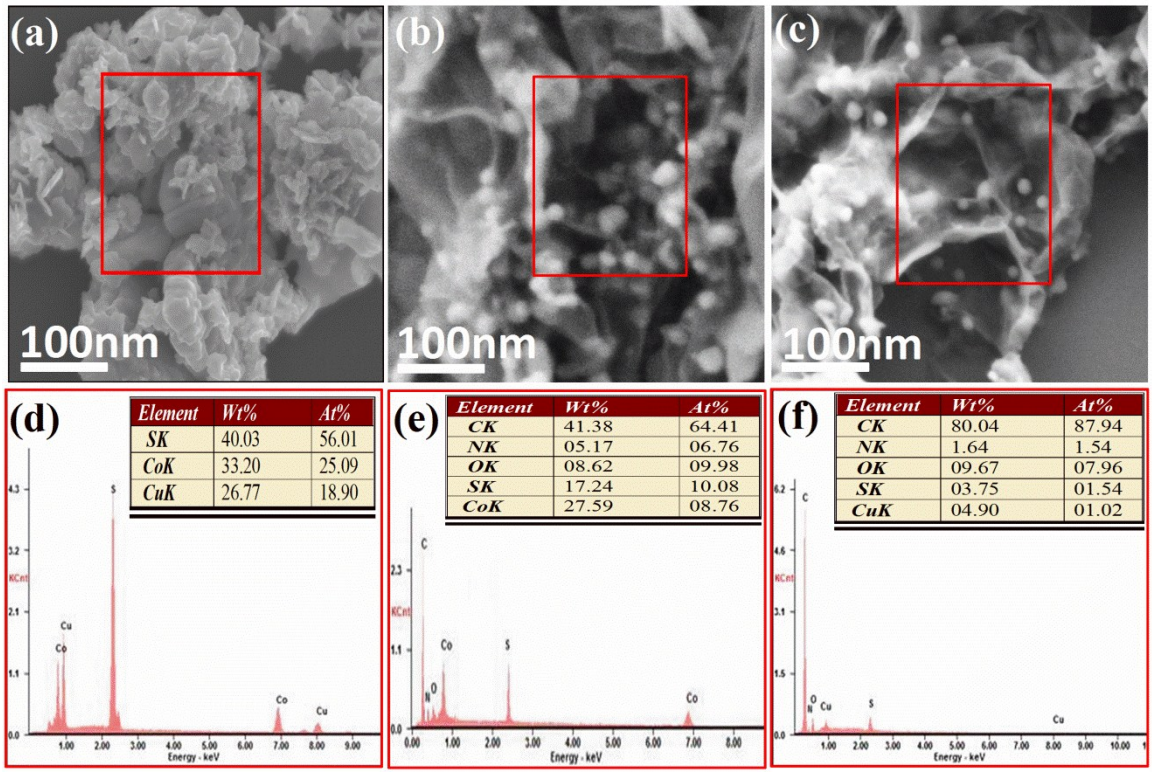

Fig. S1 (a-c) FE-SEM images, and (d-f) EDAX spectrum of pure Co_2CuS_4, CoS/NG and Cu_2S/NG, respectively.

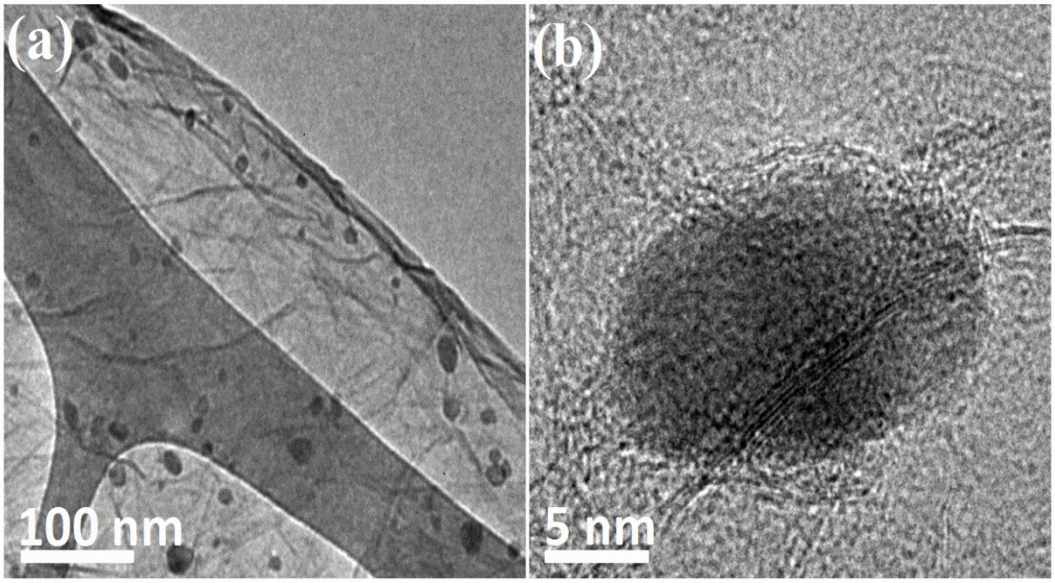

Fig. S2. TEM image with different magnification of Co_2CuS_4/NG composite (after 5 h strong ultrasonication and 12 h stirring in ethanol).

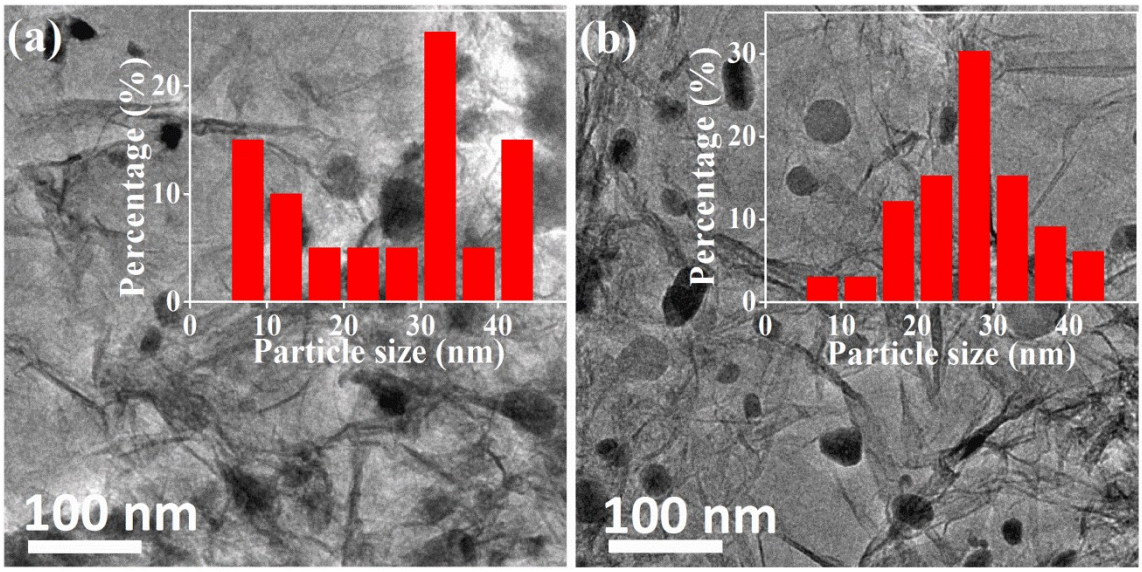

Fig. S3 TEM images of (a) CoS/NG, and (b) Cu_2S/NG composites.

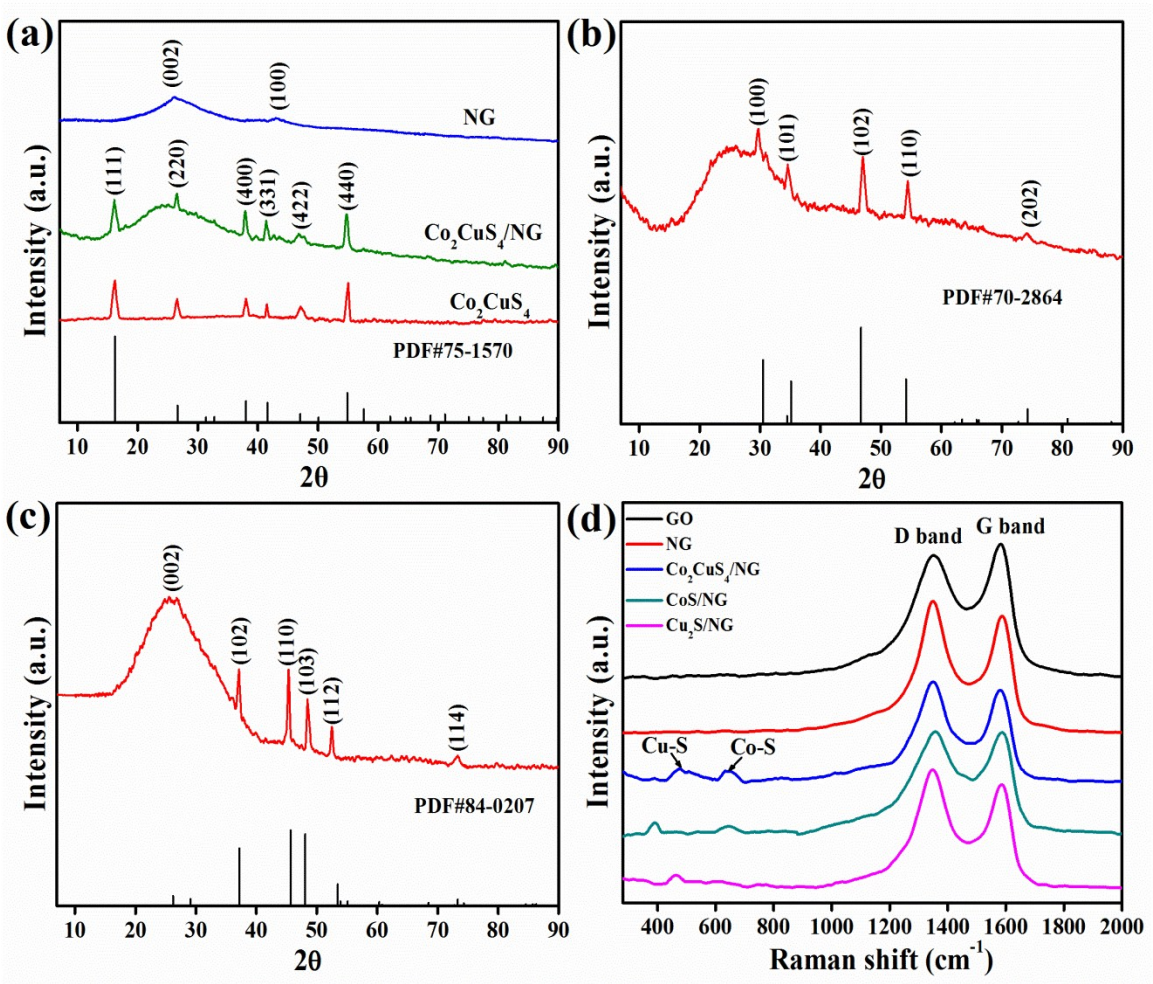

Fig. S4 XRD pattern of (a) NG, pure Co_2CuS_4 and Co_2CuS_4/NG composite, (b) CoS/NG and (c) Cu_2S/NG, (d) Raman spectra of GO, NG, CoS/NG, Cu_2S/NG and Co_2CuS_4/NG.

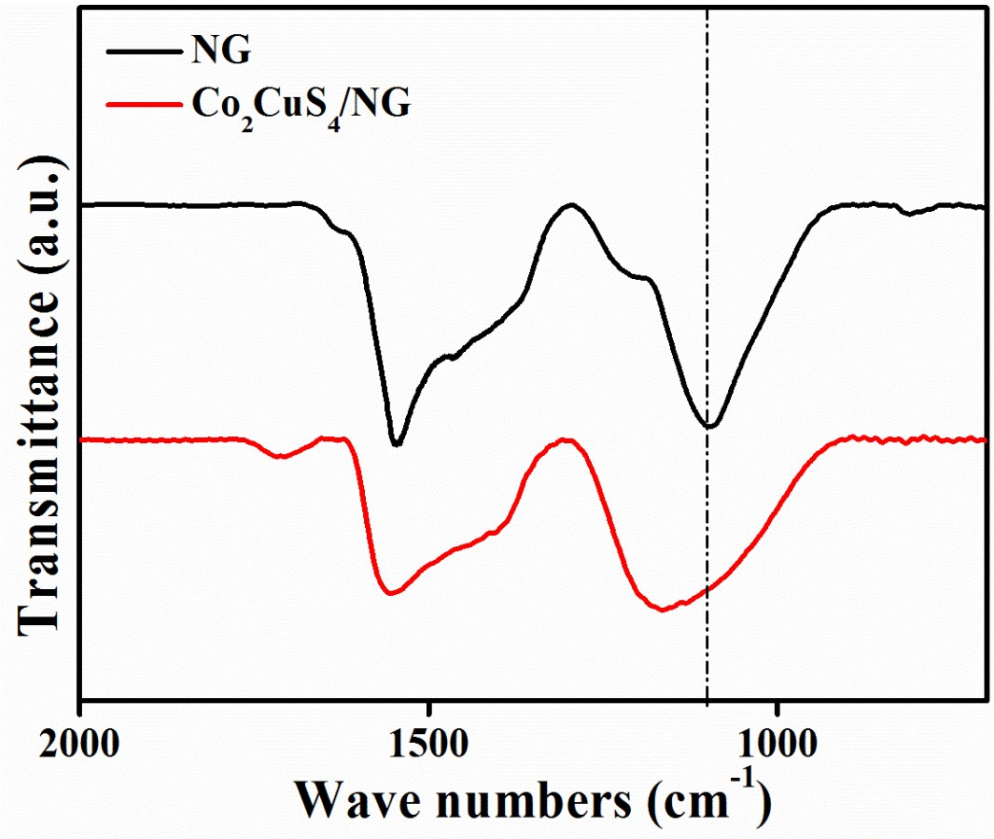

Fig. S5 FT-IR spectra of NG and Co_2CuS_4/NG composite.

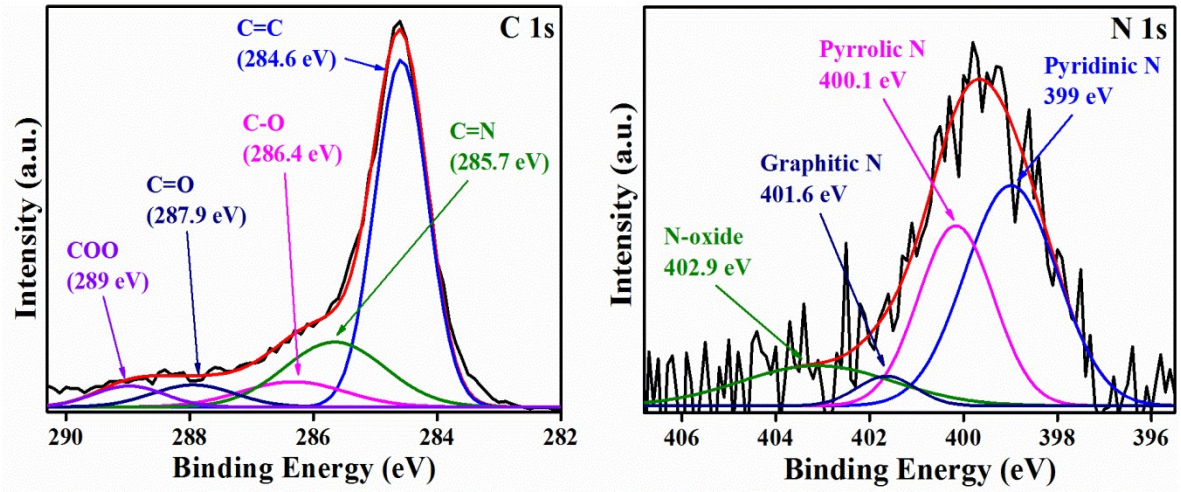

Fig. S6 High-resolution (a) C 1s spectrum, (b) N 1s spectrum of NG.

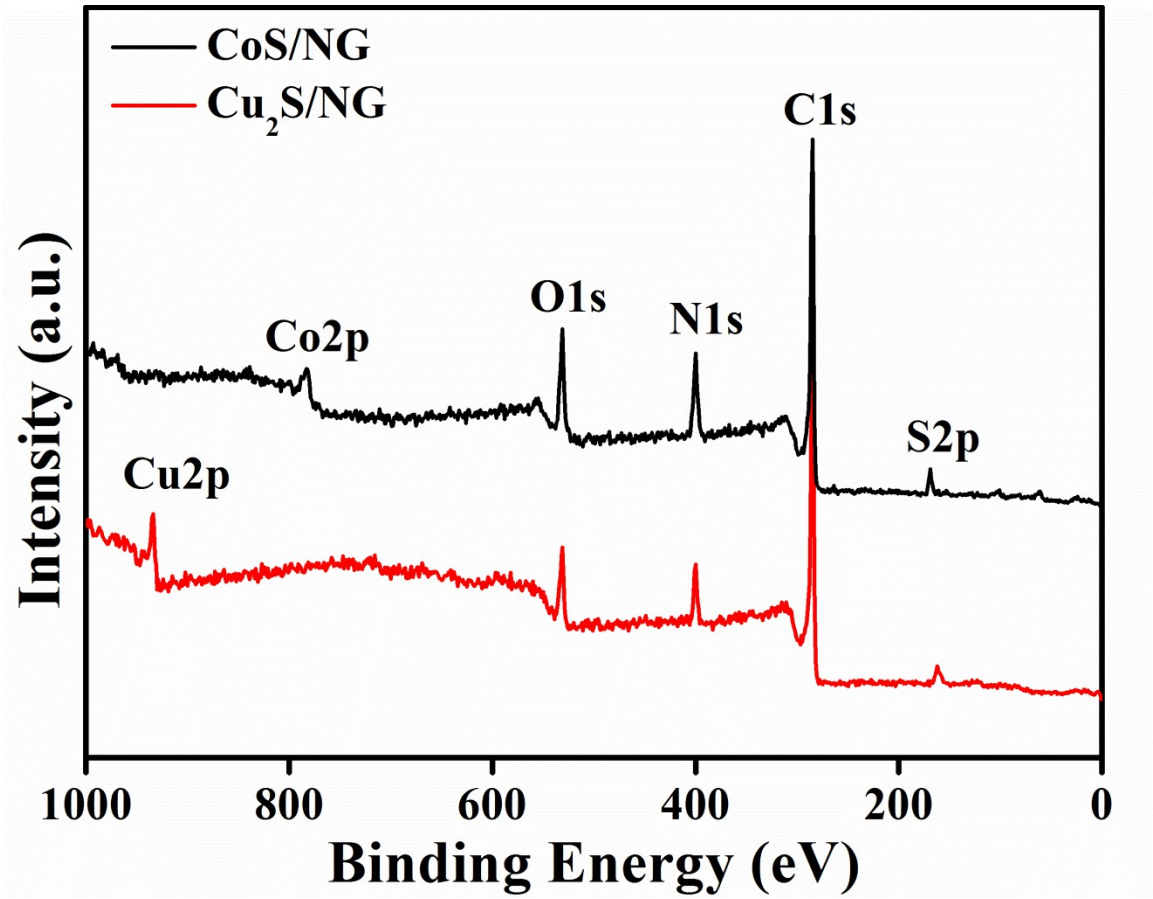

Fig. S7 XPS survey for CoS/NG and Cu_2S/NG.

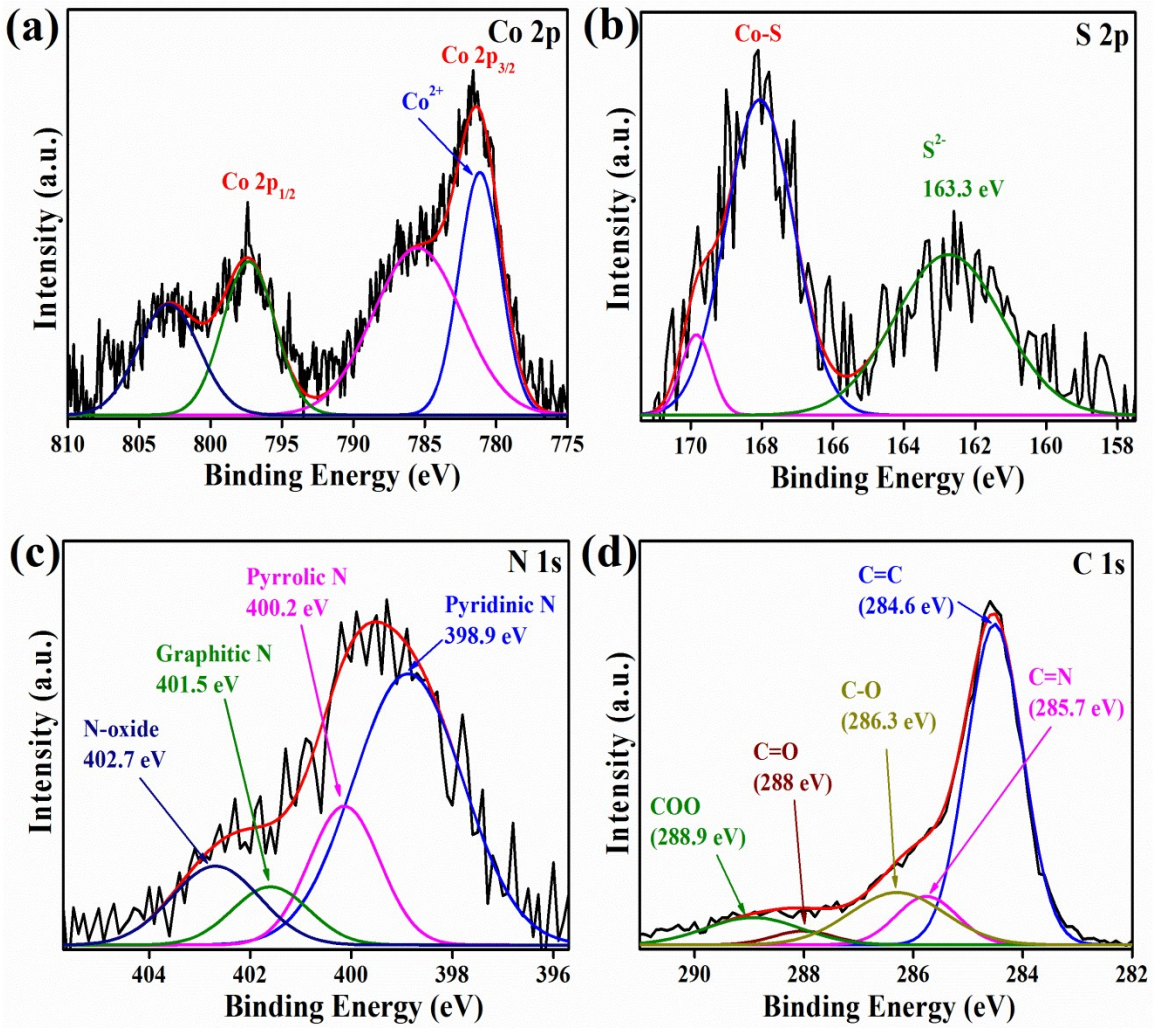

Fig. S8 High-resolution (a) Co 2p spectrum, (b) S 2p spectrum, (c) N 1s spectrum and (d) C 1s spectrum of CoS/NG composite.

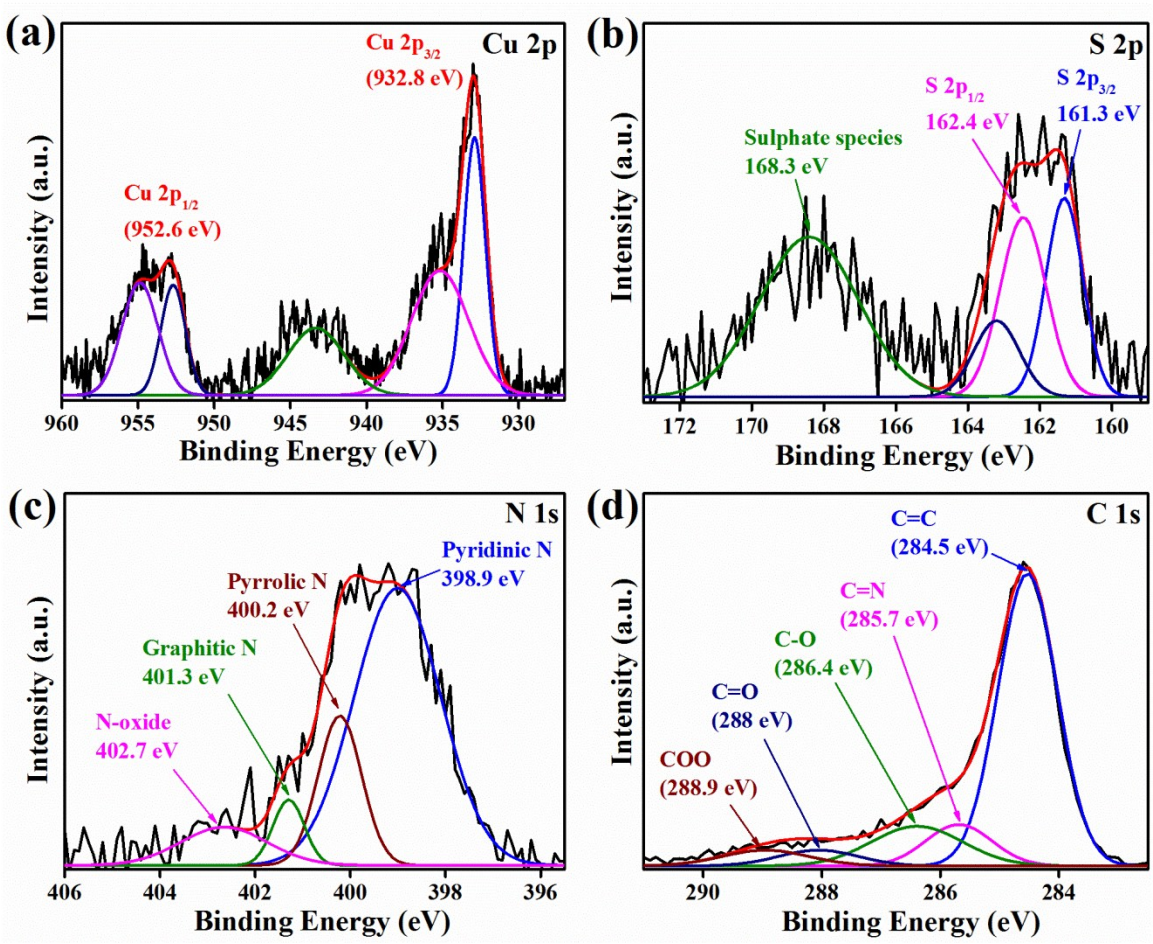

Fig. S9 High-resolution (a) Cu 2p spectrum, (b) S 2p spectrum, (c) N 1s spectrum and (d) C 1s spectrum of Cu_2S/NG composite.

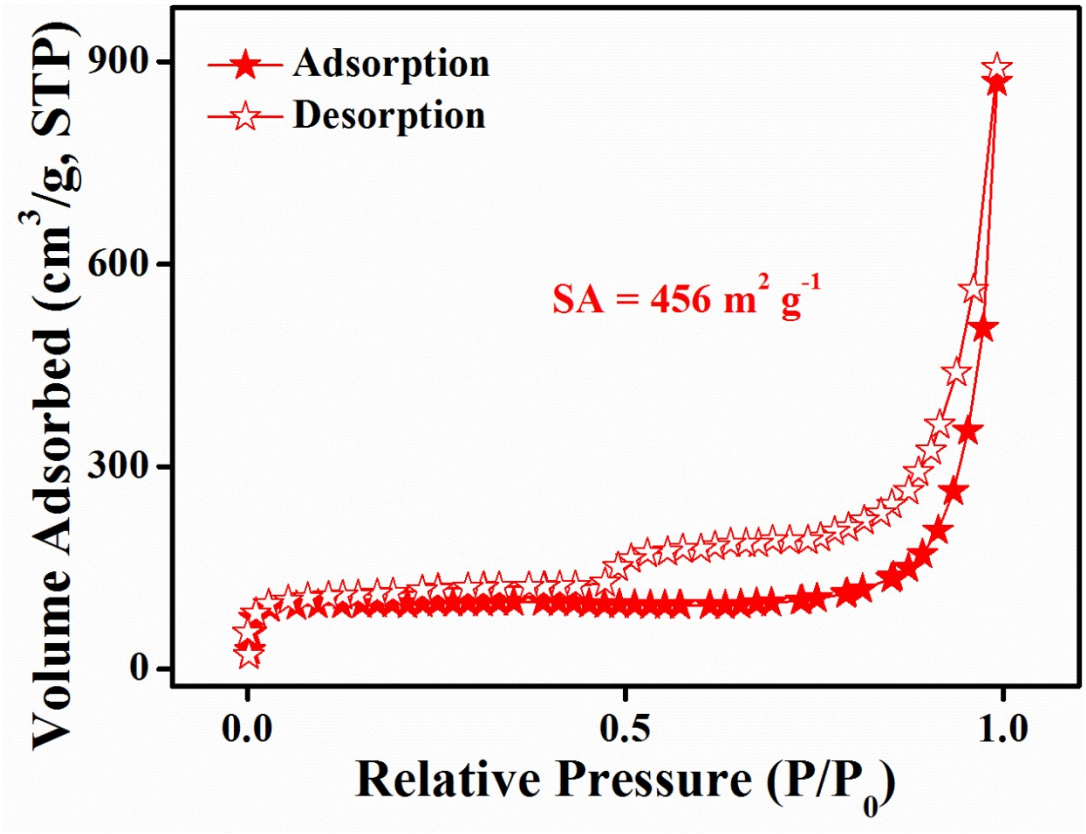

Fig. S10 N_2 adsorption–desorption isotherms of Co_2CuS_4/NG composite.

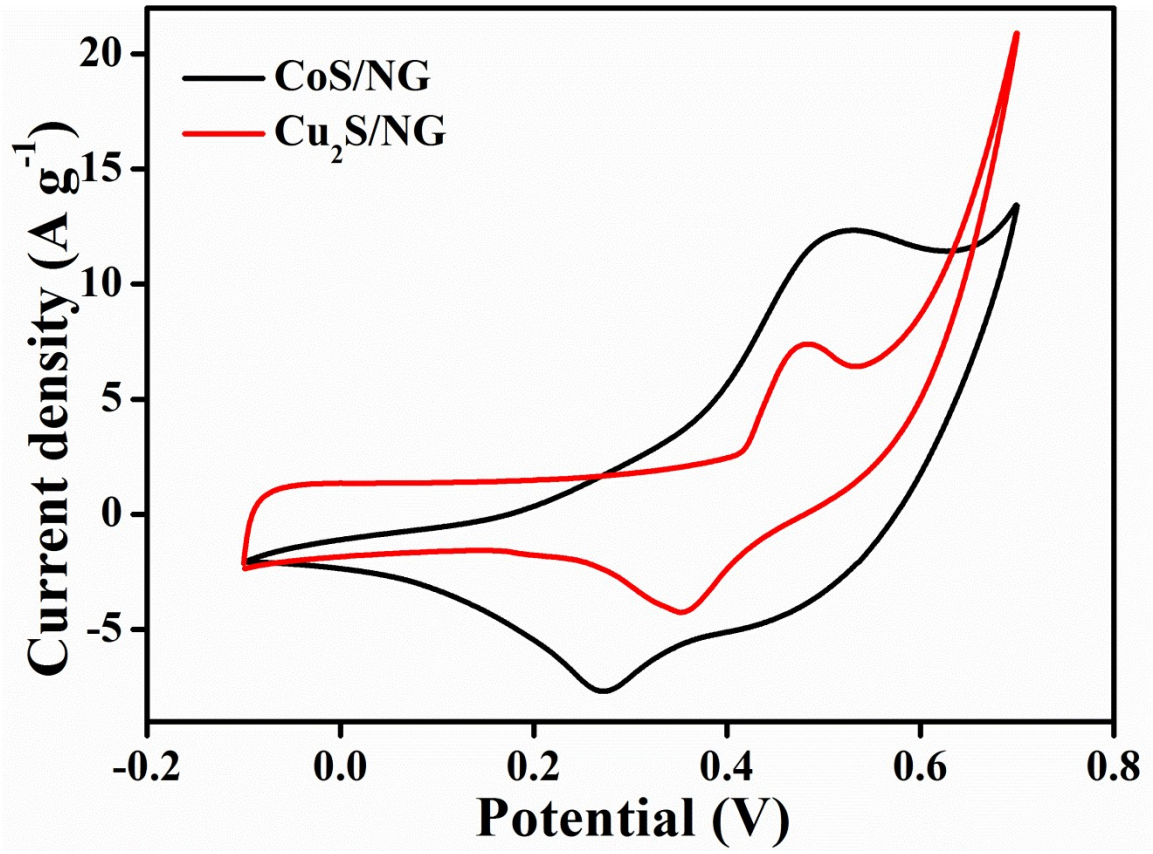

Fig. S11 CV curves of CoS/NG and Cu_2S/NG composite at 10 mV s^{-1}.

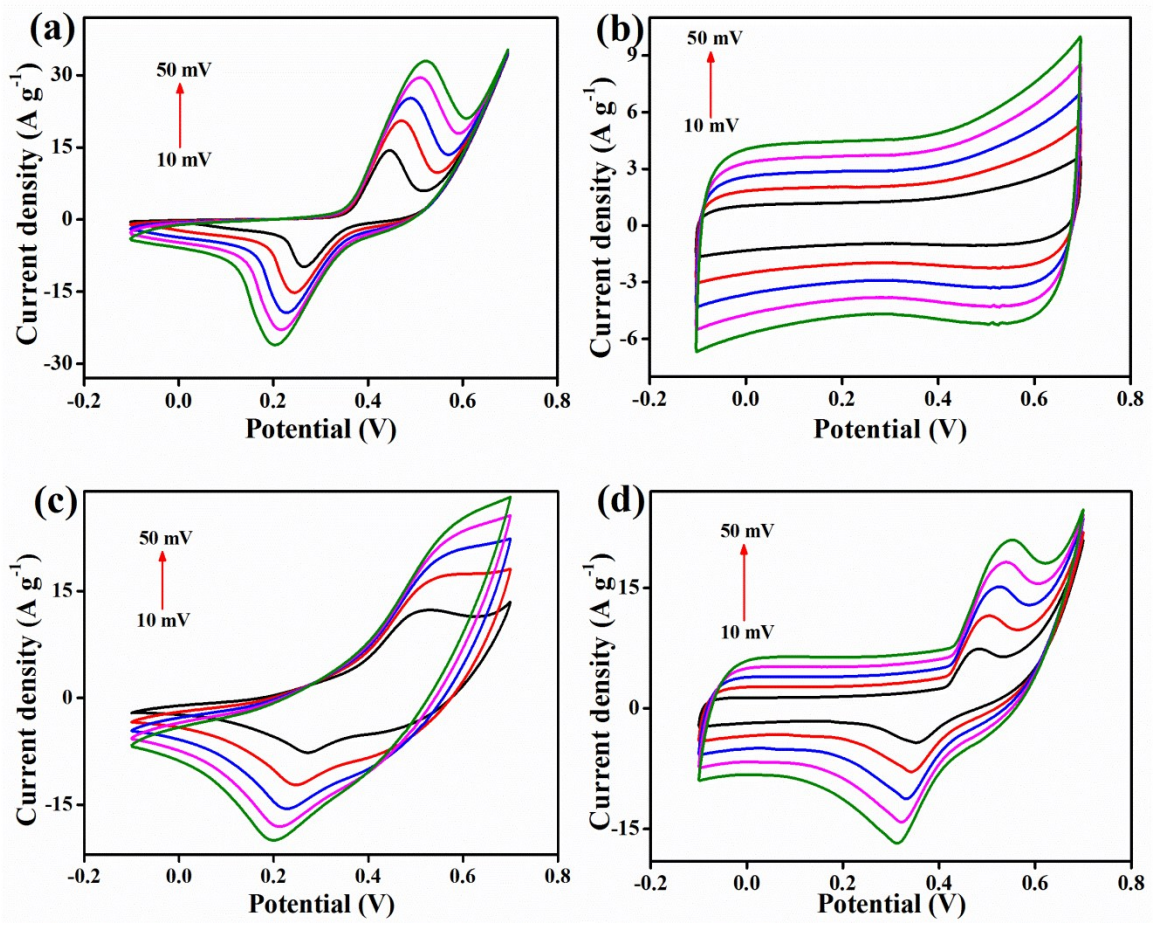

Fig. S12 CV curves at different sweep rates (10-50 mV s^{-1}) of (a) pure Co_2CuS_4, (b) NG, (c) CoS/NG and (d) Cu_2S/NG.

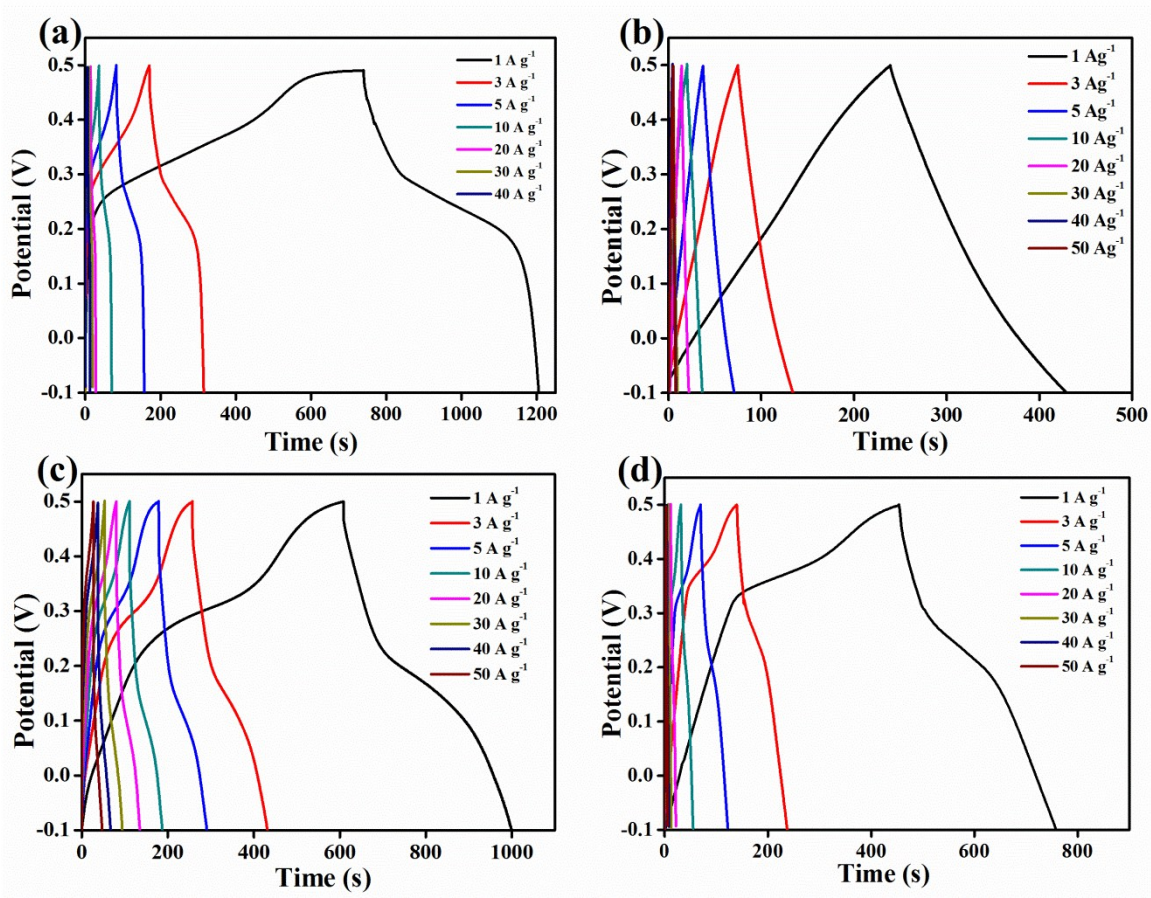

Fig. S13 Galvanostatic charge–discharge curves at different current densities of (a) pure Co_2CuS_4, (b) NG, (c) CoS/NG and (d) Cu_2S/NG.

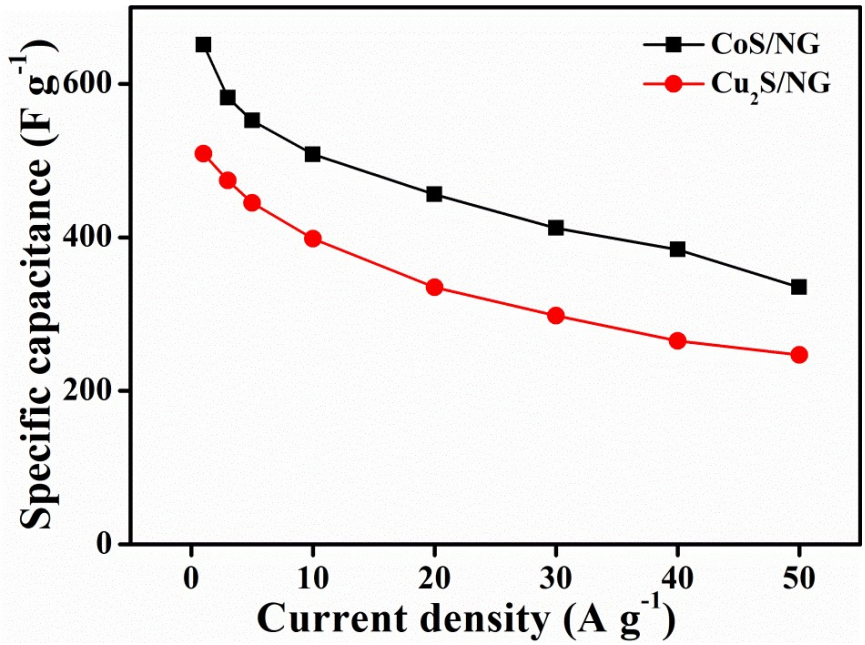

Fig. S14 Specific capacitance *vs.* current density of CoS/NG and Cu_2S/NG.

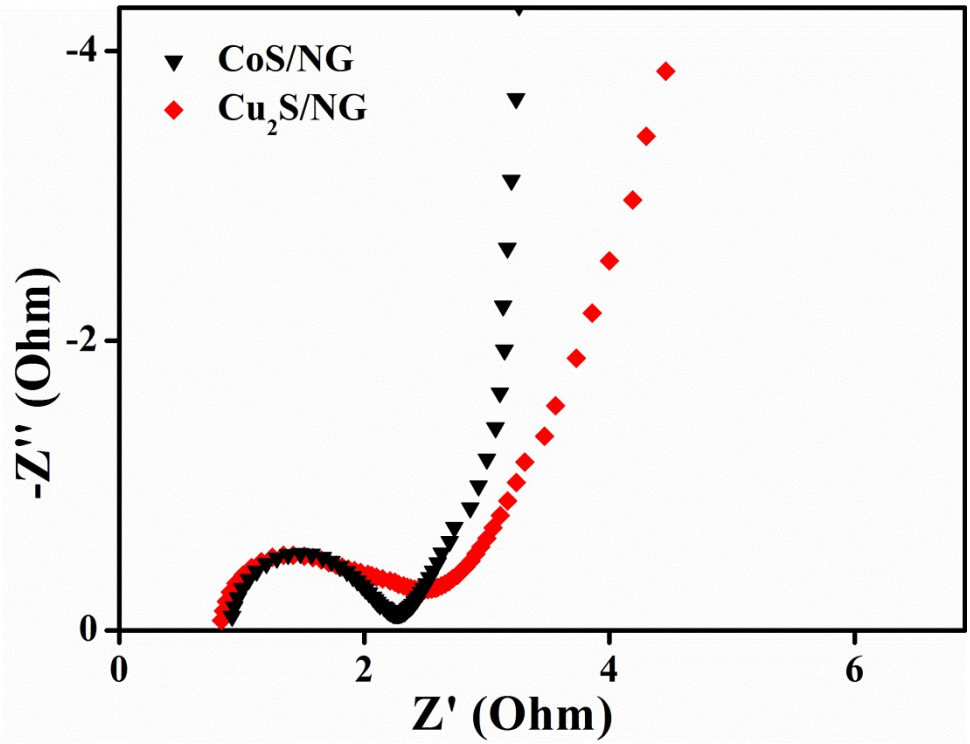

Fig. S15 Nyquist plots of CoS/NG and Cu_2S/NG.

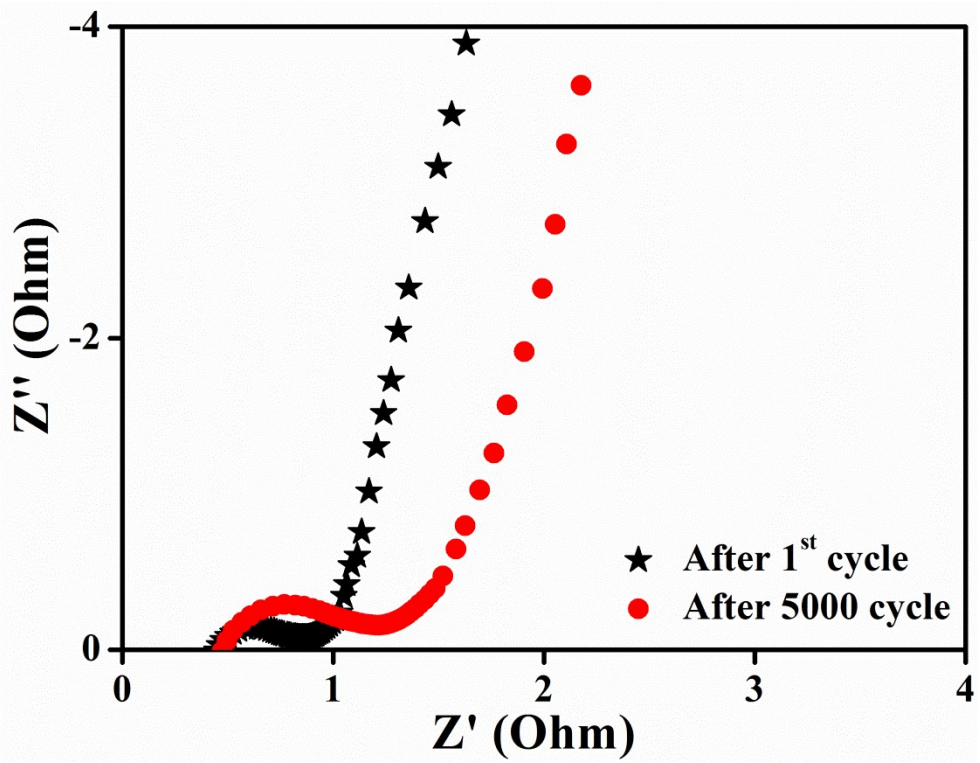

Fig. S16 Nyquist plots of Co_2CuS_4 /NG composite (measured during the cycle life test).

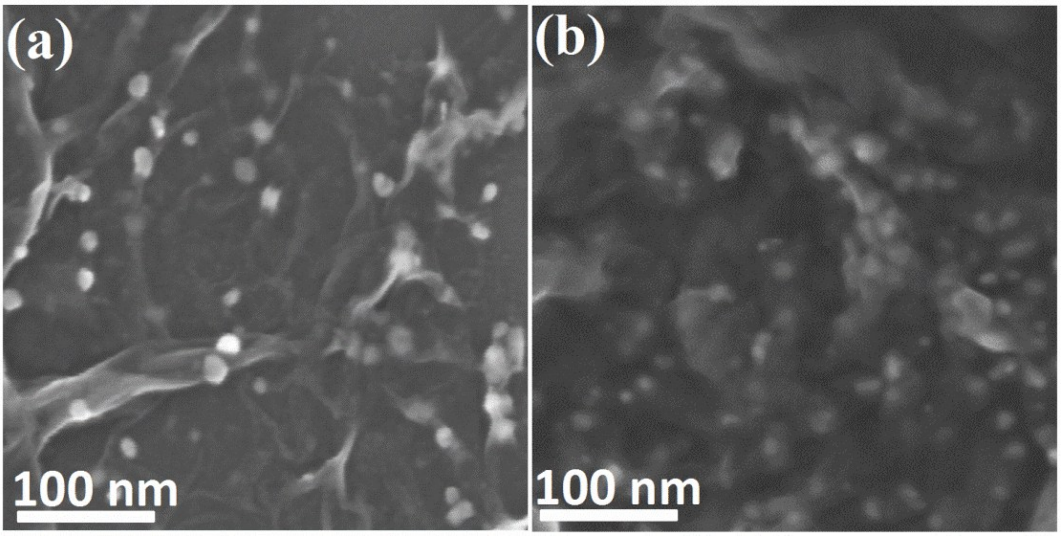

Fig. S17 FE-SEM image of Co_2CuS_4/NG composite (a) before and (b) after 5000 cycles test.

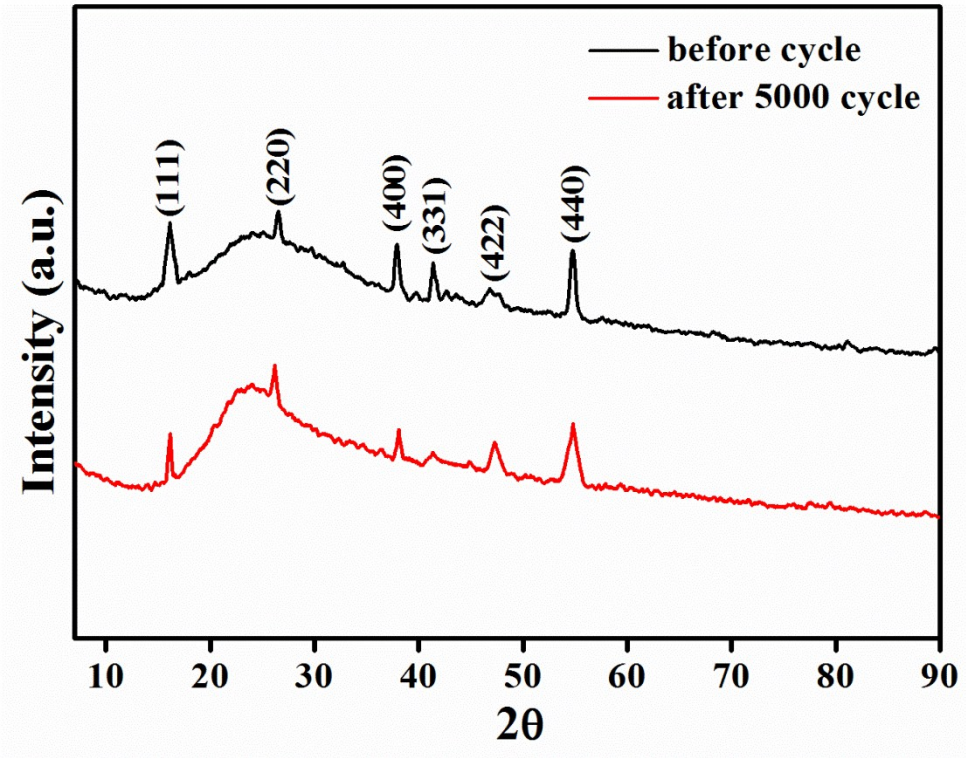

Fig. S18 XRD pattern of Co_2CuS_4/NG composite before and after stability test.

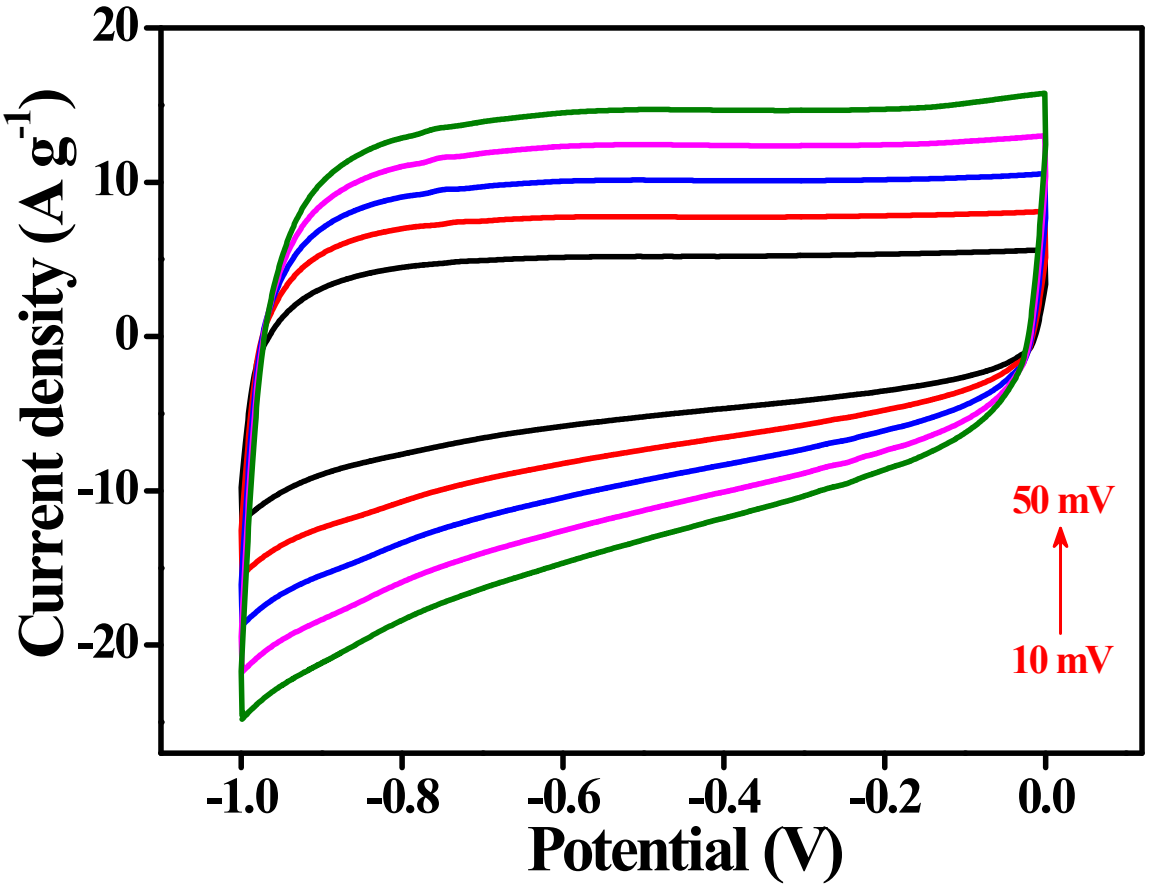

Fig. S19 CV curves of NG at different sweep rates (10-50 mV s^{-1})

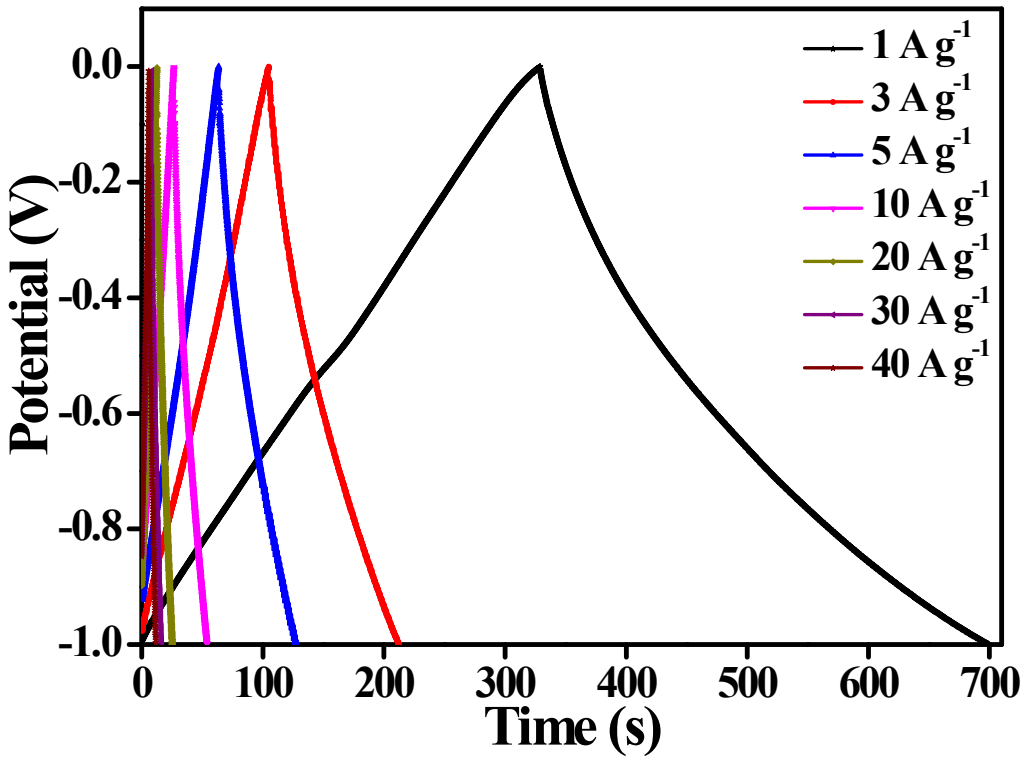

Fig. S20 Galvanostatic charge-discharge curves of NG (negative electrode) at different current densities.

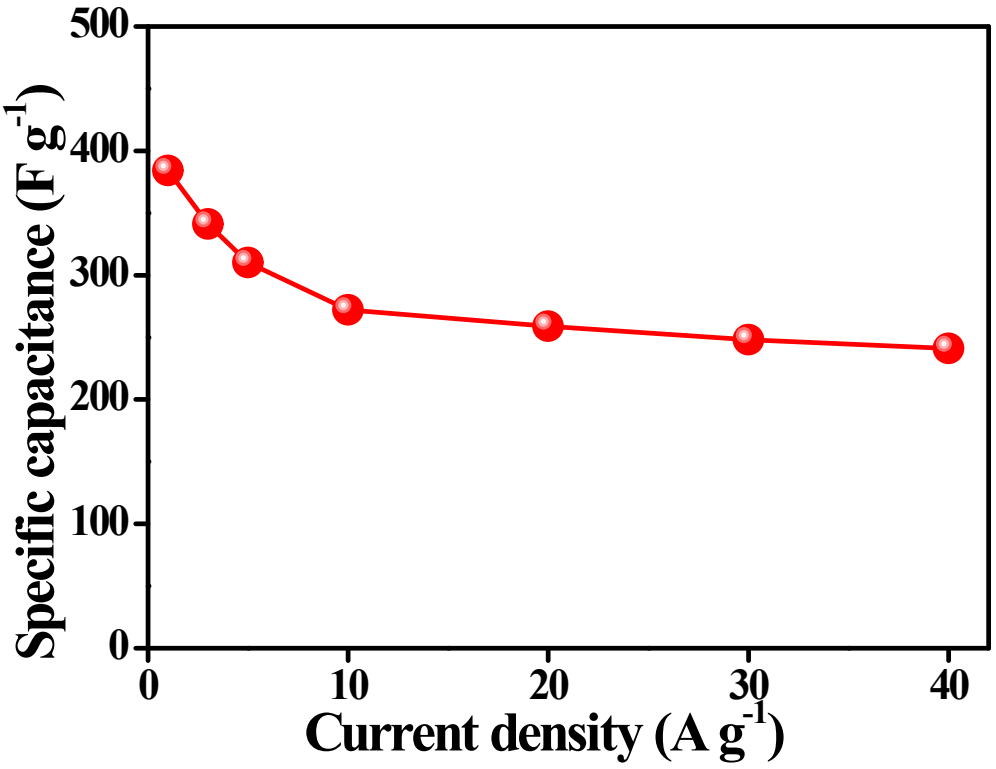

Fig. S21 specific capacitance vs the current density of NG (negative electrode).

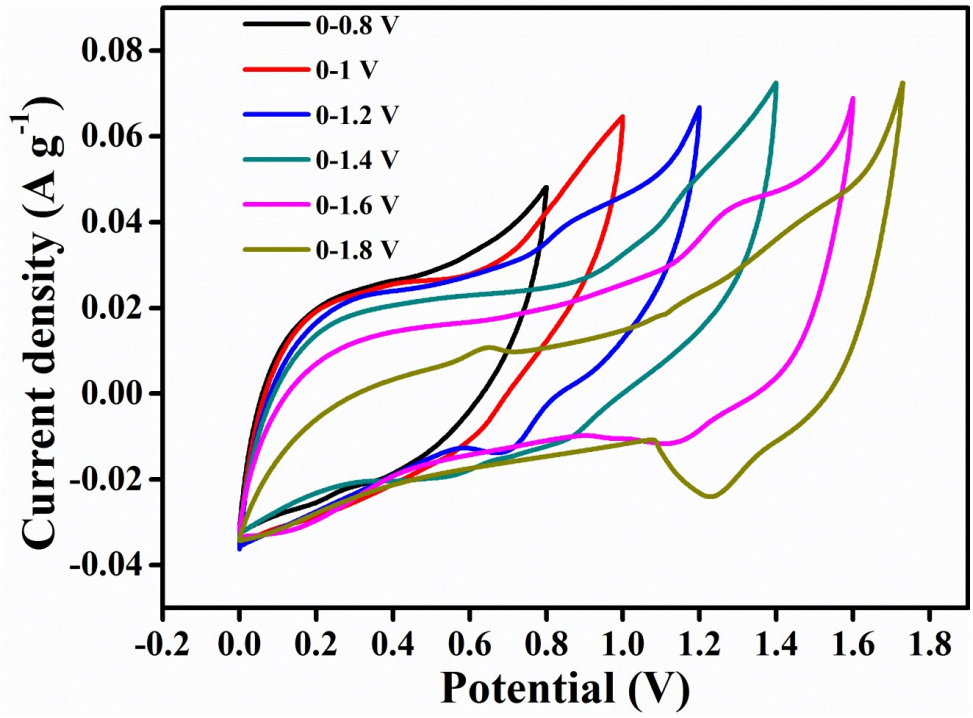

Fig. S22 CV curves (50 mV s^{-1}) of Co_2CuS_4/NG//NG asymmetric supercapacitors at different potential windows.

Table S1. Chemical composition of NG, Co_2CuS_4/NG, CoS/NG and Cu_2S/NG measured from XPS analysis.

Sample	C (at. %)	N (at. %)	O (at. %)	S (at. %)	Co (at. %)	Cu (at. %)
NG	85.22	7.63	7.16	-	-	-
Co_2CuS_4/NG	69.9	9.39	10.13	5.06	1.27	4.25
CoS/NG	74.36	7.83	13.22	2.17	2.43	-
Cu_2S/NG	78.72	6.56	9.09	1.63	-	3.99

Table S2. Comparison of the electrochemical performance of the reported materials for supercapacitors.

Materials	**Specific capacitance (F g^{-1})**	**Current density**	**Electrolyte**	**Voltage window (V)**	**Stability**	**References**
NiS	845	1 A g^{-1}	6 M KOH	0-0.55	-	1
MCs@GNS@NiS	775	0.5 A g^{-1}	6 M KOH	0-0.4	88.1% (1000 cycles)	2
TNT/cobalt sulfide	400	5 mA cm^{-2}	Na_2SO_3	-1-0	80% (1000 cycles)	3
$NiCo_2S_4$-carbon fiber	1154	1 A g^{-1}	2 M KOH	-0.1-0.5	92.8% (8000 cycles)	4
Bi_2S_3-rGO	396	1 A g^{-1}	2 M KOH	-0.2-0.45	75%	5
CNF@$NiCo_2O_4$	906	2 A g^{-1}	2 M KOH	0-0.55	96.4% (2400 cycles)	6
$NiCo_2S_4$ nanotube	933	1 A g^{-1}	6 M KOH	-0.1-0.5	99% (1000 cycles)	7
$Ni_xCo_{1-x}S_{1.097}$ microsphere	1152	0.5 A g^{-1}	2 M KOH	0-0.5	-	8
CoS_2 ellipsoid	1040	0.5 A g^{-1}	2 M KOH	-0.1-0.4	66% (1000 cycles)	9
PPy/MoS_2	553.7	1 A g^{-1}	1 M KCl	-0.5-0.3	90% (500 cycles)	10
Co_2CuS_4/NG	1005	1 A g^{-1}	6 M KOH	-0.1-0.5	96.3% (5000 cycles)	This work

MCs@GNS@NiS - graphene nanosheets/nickel sulfide based on make-up cottons; TNT – titania nanotube

Notes and References

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