Electronic Supplementary Material (ESI) for Sustainable Energy & Fuels.

Supporting Information

Synthesis and electrochemical performance of $Co_{1-x}Ni_xS$ QDs as electrode material for high performance supercapacitor

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Experiment section

Materials characterization

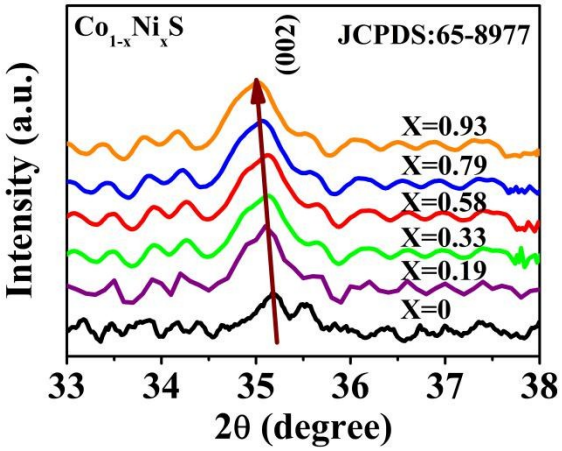

Fig. S1. The enlarged XRD patterns of CoS and $Co_{1-x}Ni_xS$ (x=0.19, 0.33, 0.58, 0.79, 0.93) QDs at (002) plane.

Table S1. The volume of each solution in the six reactive solutions.

The reactive solutions of six samples	$Co(COOCH_3)_2$·$4H_2O$ solution	$Ni(COOCH_3)_2$·$4H_2O$ solution	PVP solution	deionized aqueous	Total volume
CoS	100 ml	0 ml	1 ml	399 ml	500 ml
$Co_{1-x}Ni_xS$ (x=0.19)	100 ml	10 ml	1 ml	389 ml	500 ml
$Co_{1-x}Ni_xS$ (x=0.33)	100 ml	30 ml	1 ml	369 ml	500 ml
$Co_{1-x}Ni_xS$ (x=0.58)	100 ml	50 ml	1 ml	349 ml	500 ml
$Co_{1-x}Ni_xS$ (x=0.79)	100 ml	70 ml	1 ml	329 ml	500 ml
$Co_{1-x}Ni_xS$ (x=0.93)	100 ml	90 ml	1 ml	309 ml	500 ml

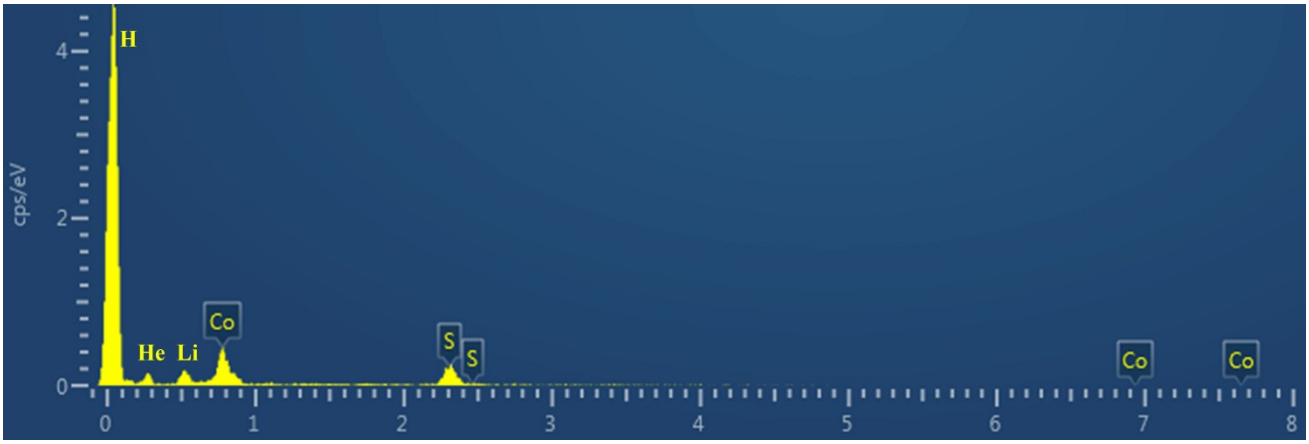

Fig. S2. Energy dispersive X-ray (EDX) spectra of CoS sample.

The EDS spectra only shows the S and Co elements, which indicates that the synthesized samples are pure phase.

Table S2. The composition of each elements of CoS sample.

Element	Line Type	Atomic Percentage
S	K	50.66
Co	K	49.34
Total		100

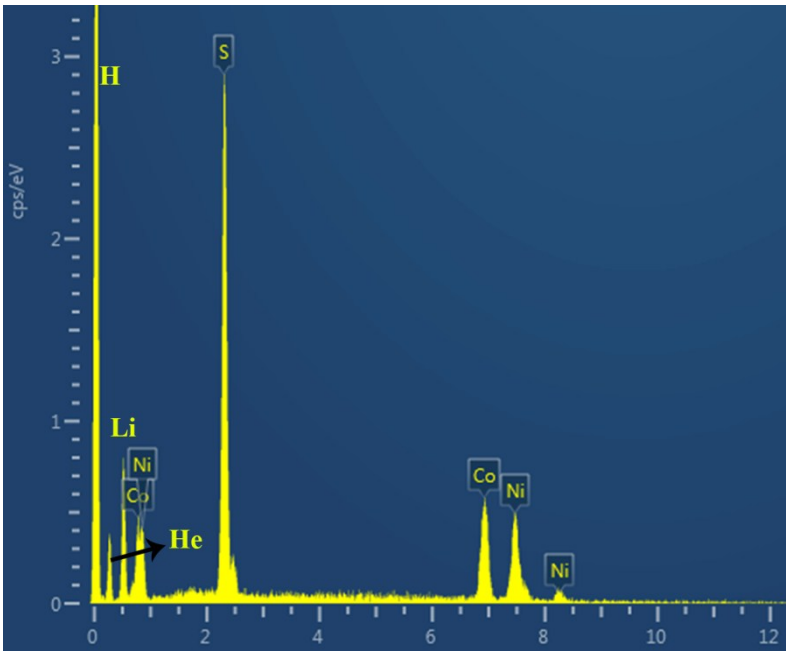

Fig. S3. Energy dispersive X-ray (EDX) spectra of $Co_{1-x}Ni_xS$ (x=0.19) sample.

Table S3. The composition of each elements of $Co_{1-x}Ni_xS$ (x=0.19) sample.

Element	Line Type	Atomic Percentage
S	K	49.34
Co	K	41.03
Ni	K	9.63
Total		100

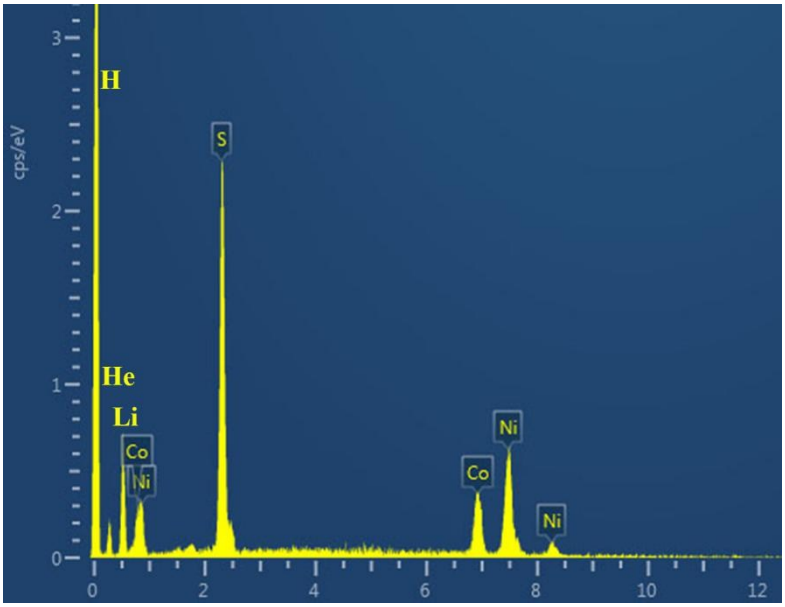

Fig. S4. Energy dispersive X-ray (EDX) spectra of $Co_{1-x}Ni_xS$ (x=0.33) sample.

Table S4. The composition of each elements of $Co_{1-x}Ni_xS$ (x=0.33) sample.

Element	Line Type	Atomic Percentage
S	K	50.03
Co	K	33.48
Ni	K	16.49
Total		100

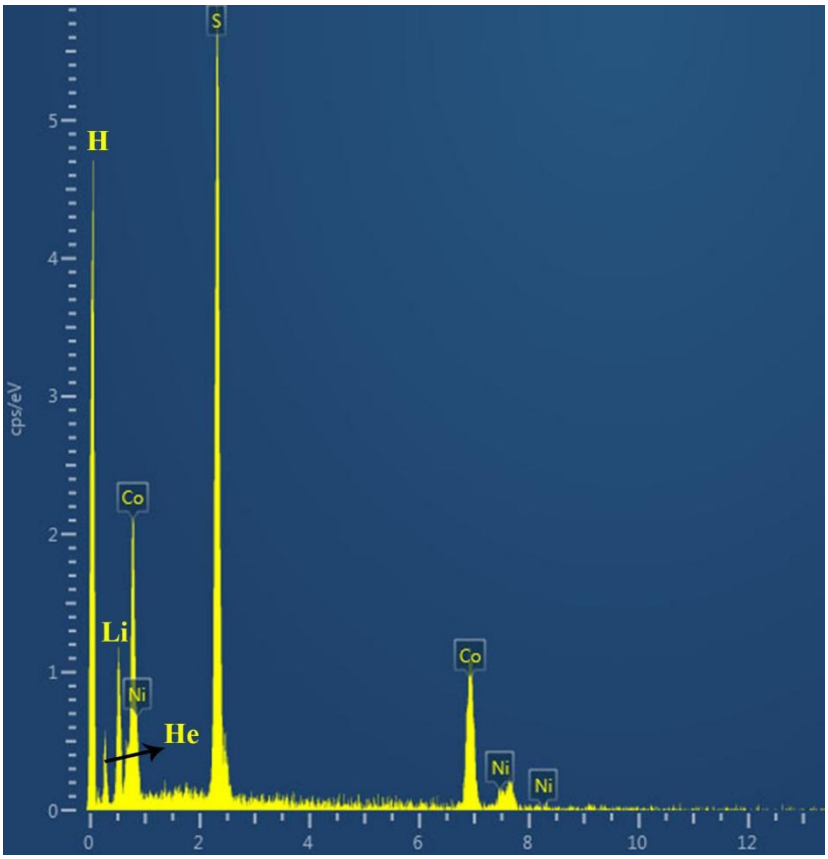

Fig. S5. Energy dispersive X-ray (EDX) spectra of $Co_{1-x}Ni_xS$ (x=0.79) sample

Table S5. The composition of each elements of $Co_{1-x}Ni_xS$ (x=0.79) sample.

Element	Line Type	Atomic Percentage
S	K	50.17
Co	K	10.46
Ni	K	39.37
Total		100

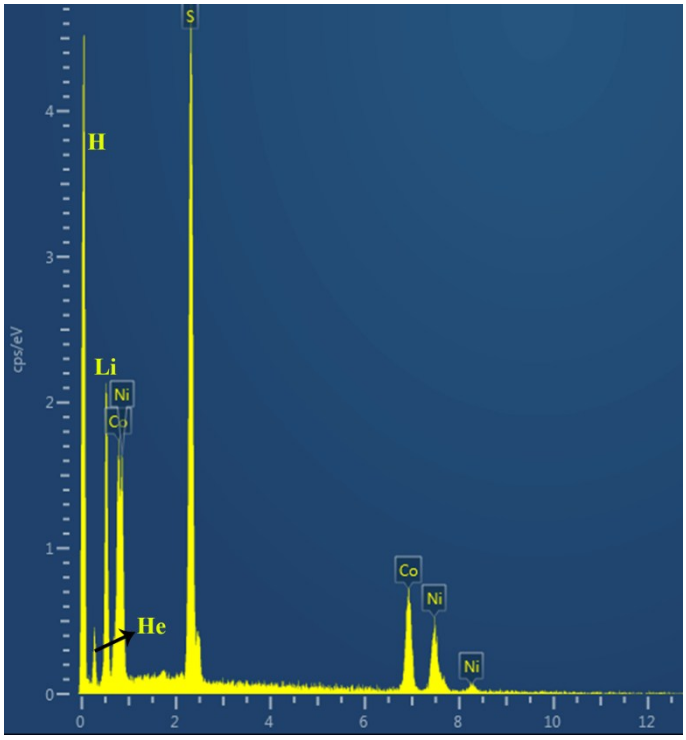

Fig. S6. Energy dispersive X-ray (EDX) spectra of $Co_{1-x}Ni_xS$ (x=0.93) sample

Table S6. The composition of each elements of $Co_{1-x}Ni_xS$ (x=0.93) sample.

Element	Line Type	Atomic Percentage
S	K	50.02
Co	K	3.50
Ni	K	46.48
Total		100

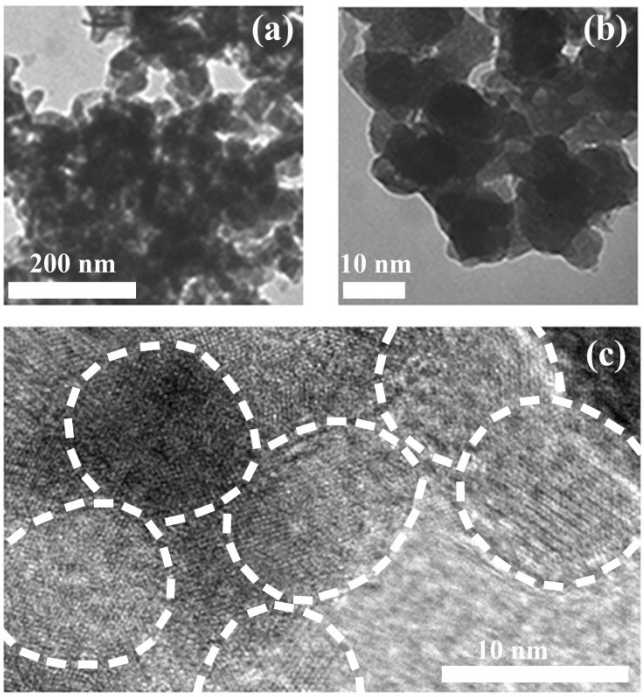

Fig. S7. (a) low magnification and (b) high magnification TEM image of CoS QDs. (c) The HRTEM image record from CoS QDs.

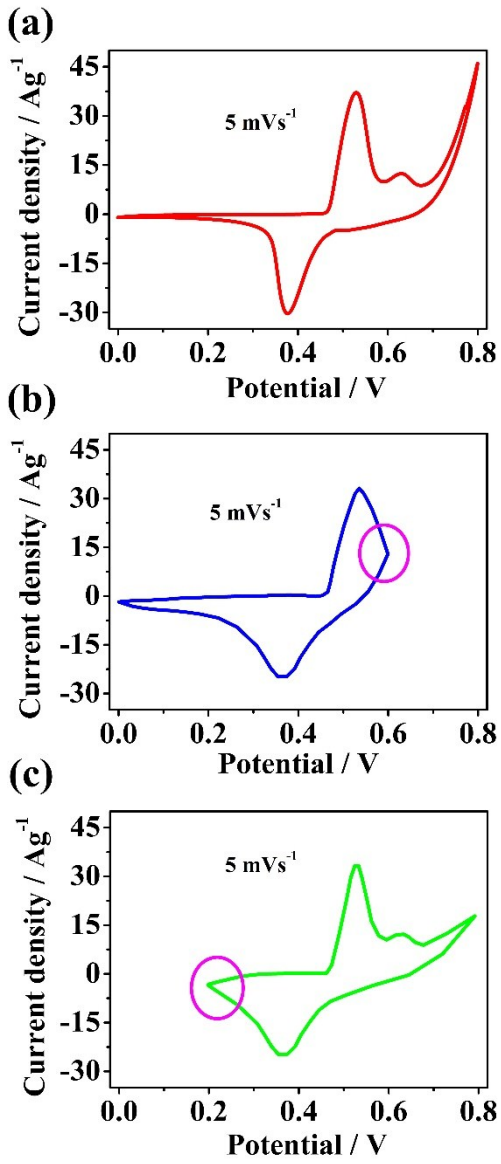

Fig. S8. (a) CV curves of $Co_{1-x}Ni_xS$ (x=0.58) electrode material with the potential window from 0 to 0.8 V. (b) CV curves of $Co_{1-x}Ni_xS$ (x=0.58) electrode material with the potential window from 0 to 0.6 V. (c) CV curves of $Co_{1-x}Ni_xS$ (x=0.58) electrode material with the potential window from 0.2 to 0.8 V.

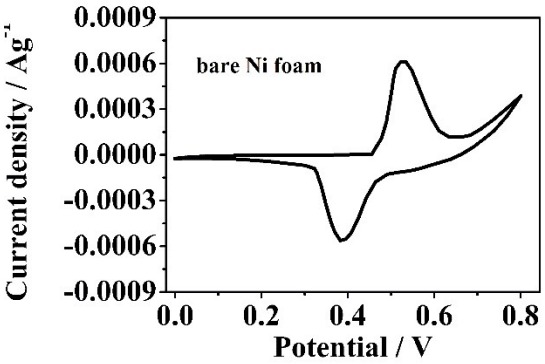

Fig. S9. CV curves of bare Ni foam with the potential window from 0 to 0.8 V.

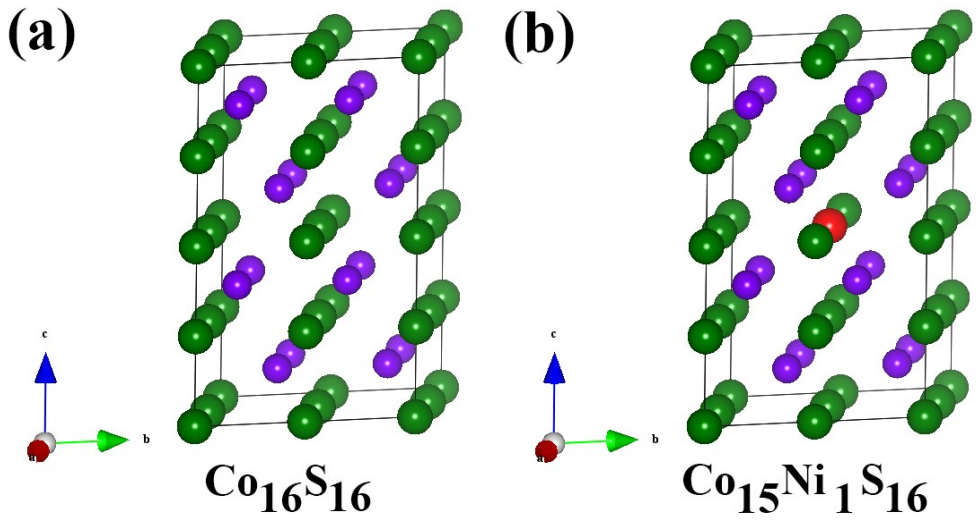

Fig. S10. The models of (a) $Co_{16}S_{16}$, (b) $Co_{15}Ni_1S_{16}$ respectively.

The vectors a, b, and c represent the direction of the lattice constants. The green, purple and red ball represent the S, Co and Ni atoms, respectively. All models have been optimized by VASP.

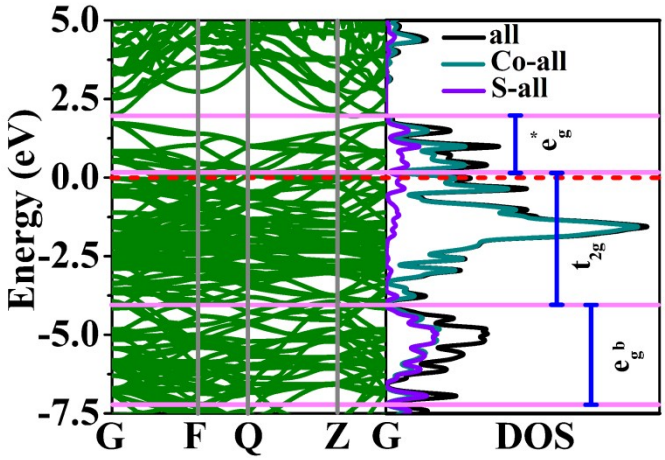

Fig. S8. The band and DOS of $Co_{16}S_{16}$ model.

Table S7. Comparison of the specific capacitance of $Co_{1-x}Ni_xS$ electrode with some recently reported materials.

Materials	Current density	Electrolyte	Specific capacitance	Reference
Mo-doped CoS	0.5 A g^{-1}	2 M KOH	781.0 F g^{-1}	[1]
CoS	1 A g^{-1}	1 M HCL	366.0 F g^{-1}	[2]
CoS hierarchitectures	1 A g^{-1}	6 M KOH	586.0 F g^{-1}	[3]
CoS nanospheres	1 A g^{-1}	3 M NaOH	632.0 F g^{-1}	[4]
CoS	5 A g^{-1}	3 M NaOH	932.0 F g^{-1}	[5]
CoS/rGO	0.5 A g^{-1}	6 M KOH	813.0 F g^{-1}	[6]
$Co_{1-x}Ni_xS$ (x=0.58)	5 A g^{-1}	6 M KOH	1305.53 F g^{-1}	This work

Reference

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