Supporting Information

P-doped $NiCo_2S_4$ nanotubes as battery-type electrode for supercapacitors

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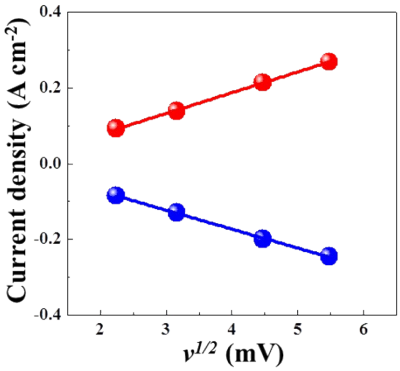

Fig. S1 The corresponding current density (i)–$v^{1/2}$ (scan rate$^{1/2}$) plots of P-$NiCo_2S_4$.

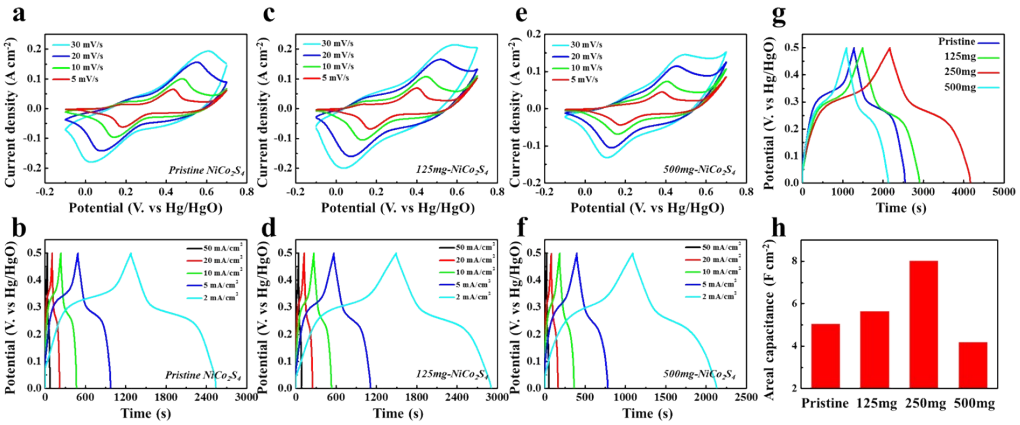

Fig. S2 CV and GCD curves of P-$NiCo_2S_4$ samples with different contents of $NaH_2PO_2{\cdot}H_2O$: (a, b) 0 mg, (c, d) 125 mg and (e, f) 500 mg. (g) The GCD curves at a current density of 2 mA cm^{-2} for P-$NiCo_2S_4$ samples with different contents of $NaH_2PO_2{\cdot}H_2O$. (h) The areal capacitance of P-$NiCo_2S_4$ samples with different contents of $NaH_2PO_2{\cdot}H_2O$ at 2 mA cm^{-2}.

In the second step, we also conducted several experiments to optimize the content of $NaH_2PO_2{\cdot}H_2O$. Different mass loadings of $NaH_2PO_2{\cdot}H_2O$ powder (125 mg, 250 mg and 500 mg) were used as the phosphorus source at the same conditions. The corresponding CV and GCD curves are shown in **Fig. S2a-S2f**. As shown in **Fig. S2g**, P-$NiCoS_4$ samples obtained with 250mg $NaH_2PO_2{\cdot}H_2O$ showed the longest discharge time, suggesting the largest capacitance. Further, as shown in **Fig. S2h**, it can be found that the optimal mass loading of $NaH_2PO_2{\cdot}H_2O$ powder as the phosphorus source is 250 mg.

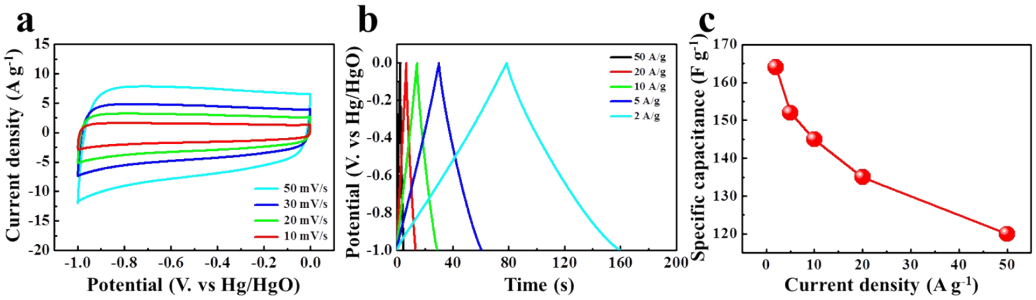

Fig. S3 (a) CV and (b) GCD curves of AC at various scan rate and (c) corresponding specific capacitance

Table S1. Comparison of the electrochemical performance of as-fabricated ASC device with those in previous reports.

Asymmetric supercapacitor	Energy density (Wh kg^{-1})	Corresponding Power density (W kg^{-1})	Reference
$ZnCo_2O_4@Ni_xCo_{2x}(OH)_{6x}$//AC	26.2	511.8	1
CC@Co_3O_4//CC@NC	41.5	6200	2
Co(P,S) nanotubes//CC	39	800	3
Ni_2P//AC	26	337	4
$NiCo_2S_4$ nanotubes//RGO	31.5	156.6	5
$NiCo_2S_4@NiMoO_4$	29.1	172	6
NiCoP nanoplates//graphene	32.9	1301	7
Ni-Co-P//AC	22.8	1432	8
nickel–cobalt phosphate//AC	32.5	600	9
P-$NiCo_2S_4$//AC	42.1	750	This work

Reference

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