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

Supporting Information

Metal–Organic Framework-Derived Hollow Co_9S_8 Nanotube Arrays Coupled with Porous FeCo-P Nanosheets as Efficient Cathode Electrode Material for Hybrid Supercapacitor

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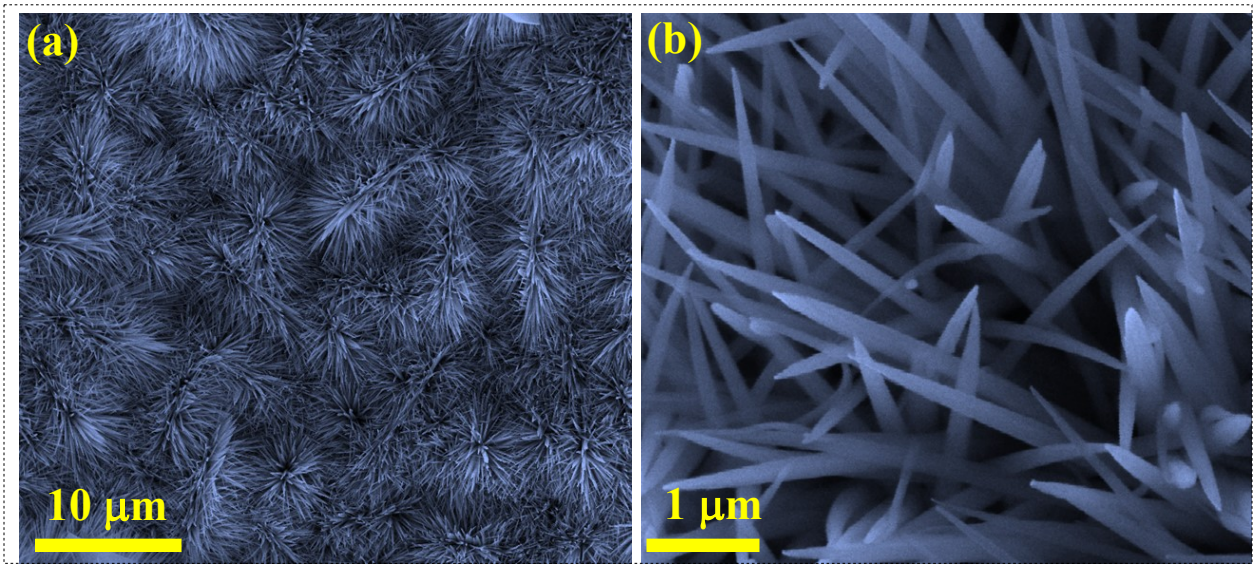


Fig. S1 (a, b) FE-SEM images of the NF/$Co(CO_3)_{0.5}(OH)$ precursors.

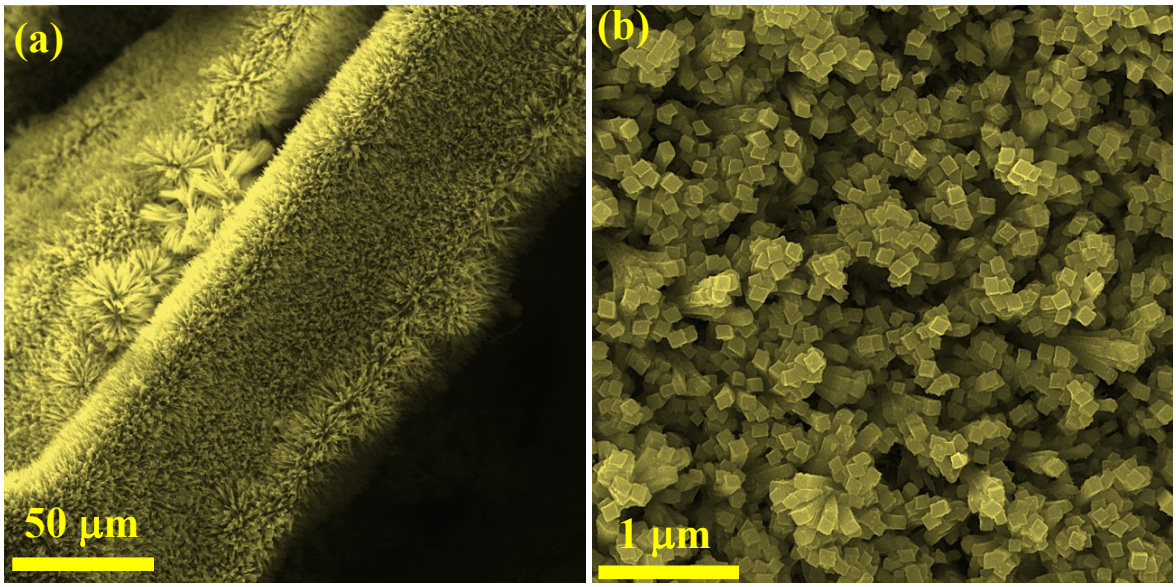


Fig. S2 (a, b) FE-SEM images of the NF/Co-MOF.

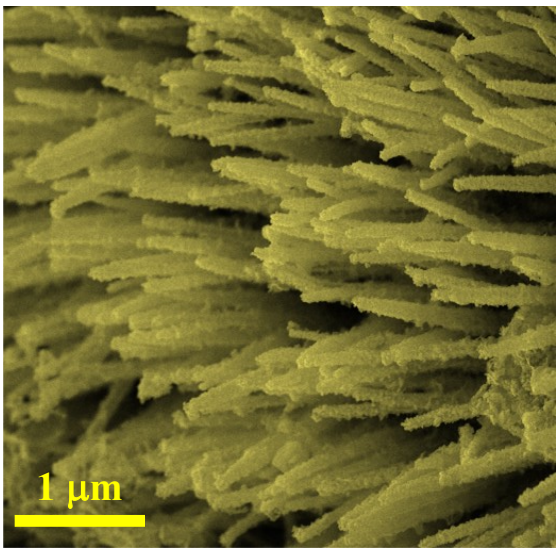


Fig. S3 FE-SEM image of the NF/CS.

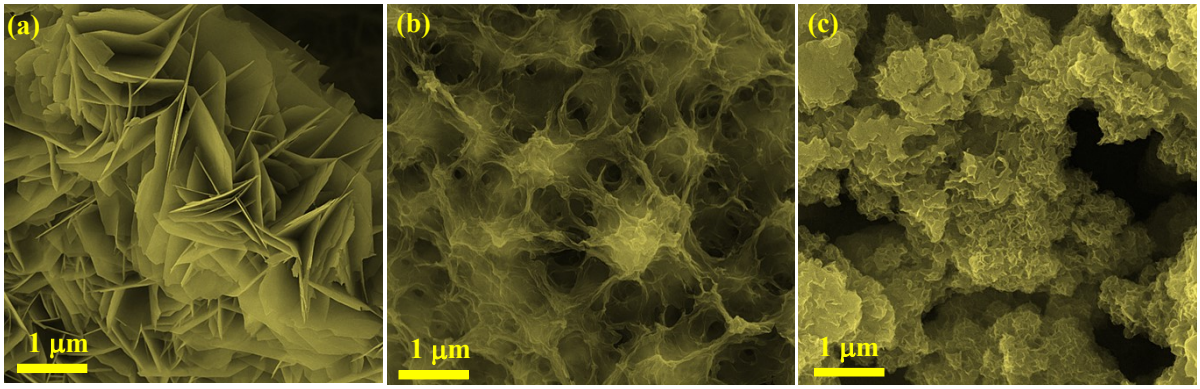
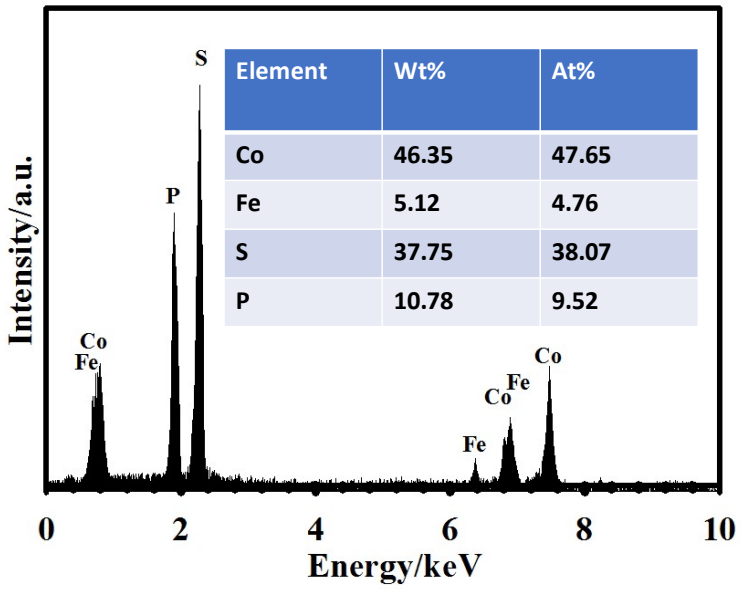


Fig. S4 (a) FE-SEM image of the NF/FCP20. (b) FE-SEM image of the NF/FCP30. (c) (a) FE-SEM image of the NF/FCP40.



Element	Wt%	At%
Co	46.35	47.65
Fe	5.12	4.76
S	37.75	38.07
P	10.78	9.52

Fig. S5 EDX pattern of the CS4-FCP30 sample.

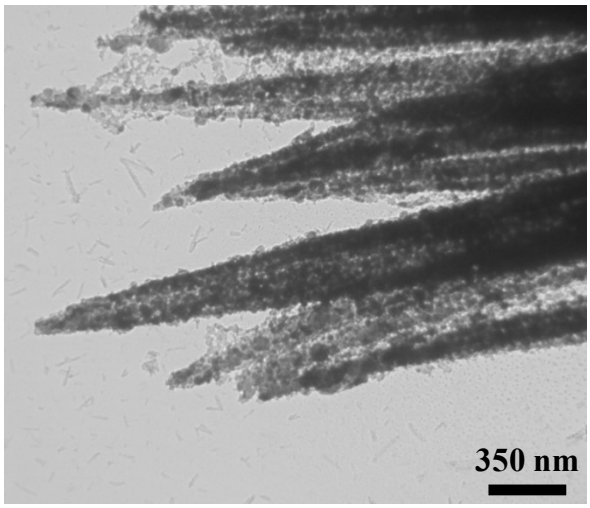


Fig. S6 TEM image of the CS sample.

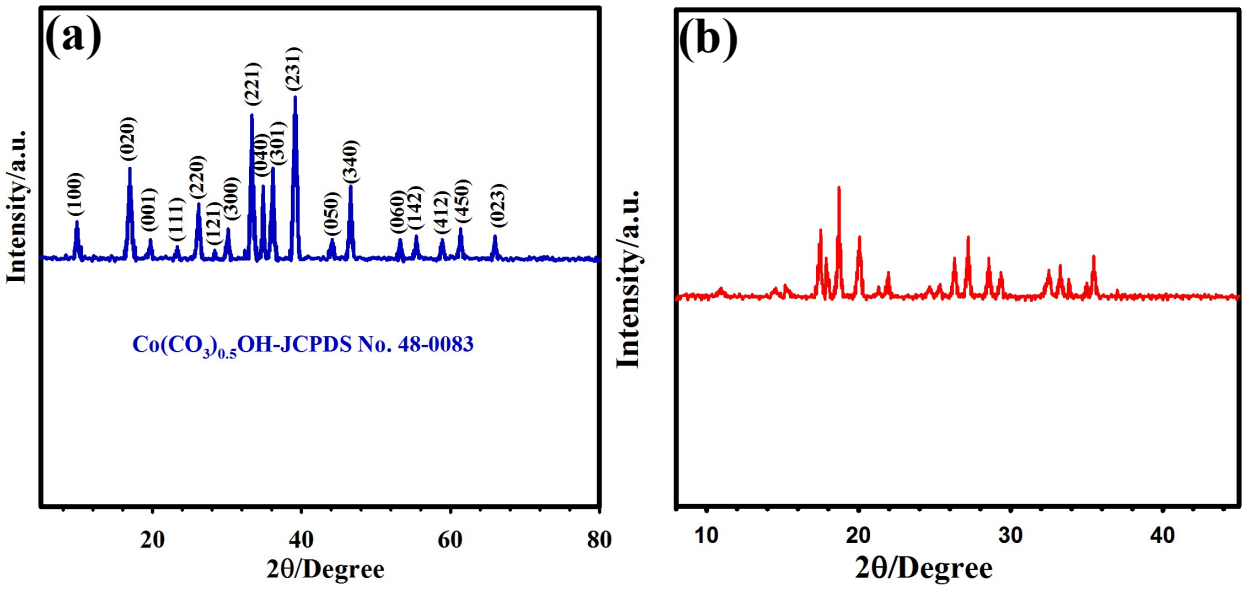


Fig. S7 (a) XRD pattern of the $Co(CO_3)_{0.5}(OH)$. (b) XRD pattern of the Co-MOF.

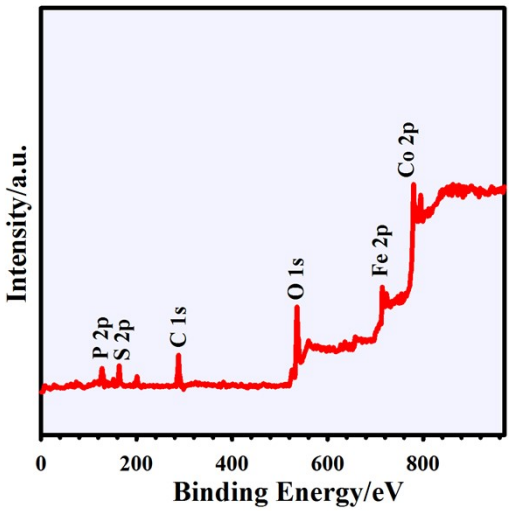


Fig. S8 XPS survey of the CS4-FCP30.

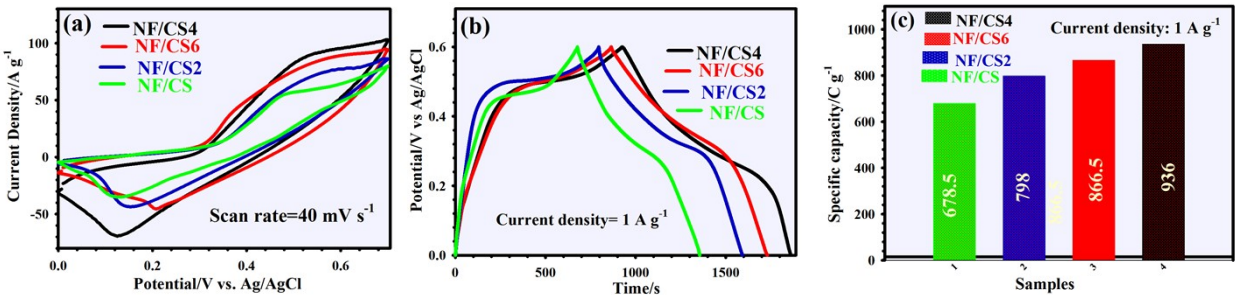


Fig. S9 (a) CVs of the NF/CS, NF/CS2, NF/CS4, and NF/CS6 electrodes at 40 mV s^{-1}. (B) GCD curves of the NF/CS, NF/CS2, NF/CS4, and NF/CS6 electrodes at 1 A g^{-1}. (c) Specific capacities of the NF/CS, NF/CS2, NF/CS4, and NF/CS6 electrodes at 1 A g^{-1}.

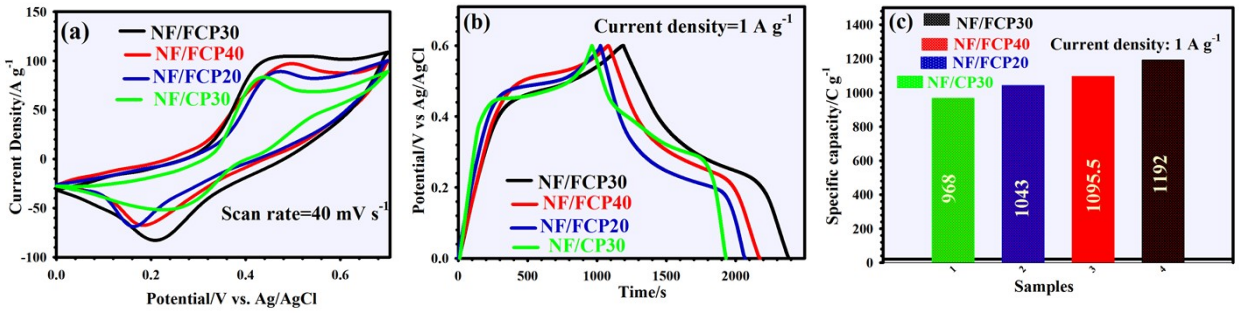


Fig. S10 (a) CVs of the NF/CP30, NF/FCP20, NF/FCP30, and NF/FCP40 electrodes at 40 mV s^{-1}. (B) GCD curves of the NF/CP30, NF/FCP20, NF/FCP30, and NF/FCP40 electrodes at 1 A g^{-1}. (c) Specific capacities of the NF/CP30, NF/FCP20, NF/FCP30, and NF/FCP40 electrodes at 1 A g^{-1}.

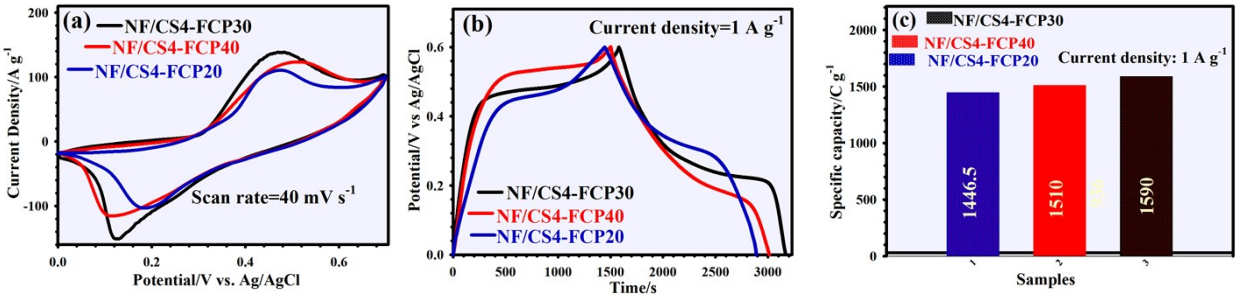


Fig. S11 (A) CVs of the NF/CS4-FCP20, NF/CS4-FCP30, and NF/CS4-FCP40 electrodes at 40 mV s^{-1}. (B) GCD curves of the NF/CS4-FCP20, NF/CS4-FCP30, and NF/CS4-FCP40 electrodes at 1 A g^{-1}. (C) Specific capacities of the NF/CS4-FCP20, NF/CS4-FCP30, and NF/CS4-FCP40 electrodes at 1 A g^{-1}.

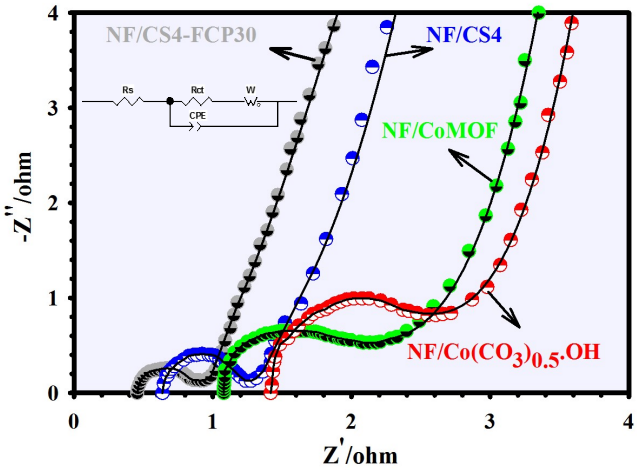


Fig. S12 Nyquist plots of the NF/$Co(CO_3)_{0.5}$(OH), NF/Co-MOF, NF/CS4, and NF/CS4-FCP30 electrodes (inset indicate the equivalent circuit model and magnified Nyquist curves).

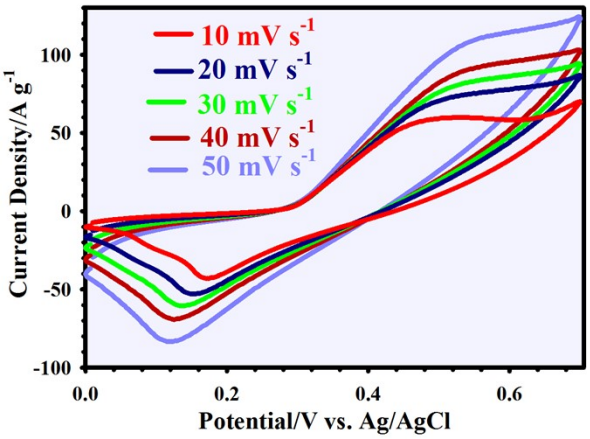


Fig. S13 CV curves of the NF/CS4 electrode at various scan rates from 10 to 50 mV s^{-1}.

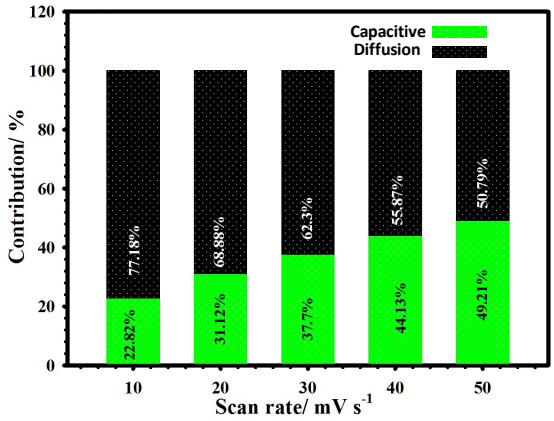


Fig. S14 Relative contribution of the capacitive and diffusion-controlled charge storage at various sweep speeds.

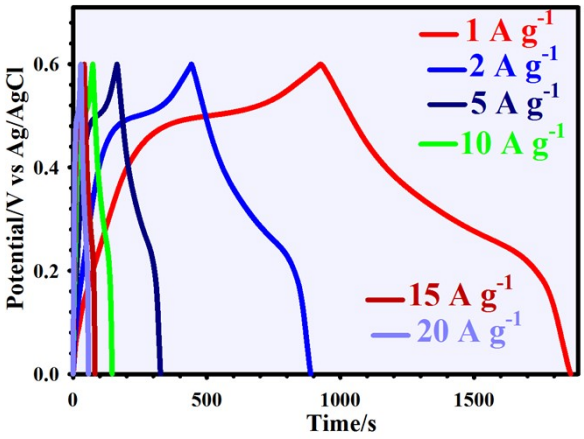


Fig. S15 GCD curves of the NF/CS4 electrode from 1 to 20 A g^{-1}.

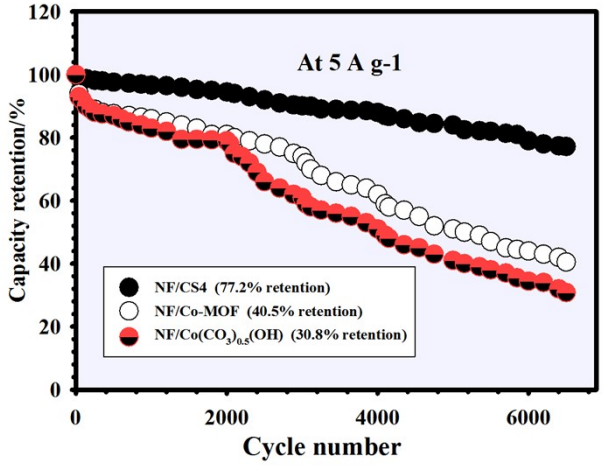


Fig. S16 Durability test of the NF/$Co(CO_3)_{0.5}(OH)$, NF/Co-MOF, and NF/CS4 electrodes

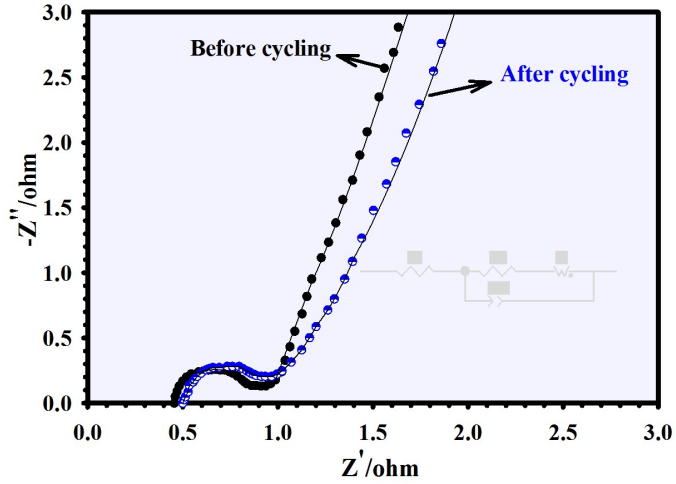


Fig. S17 Nyquist plots of the NF/CS4-FCP30 before and after durability test.

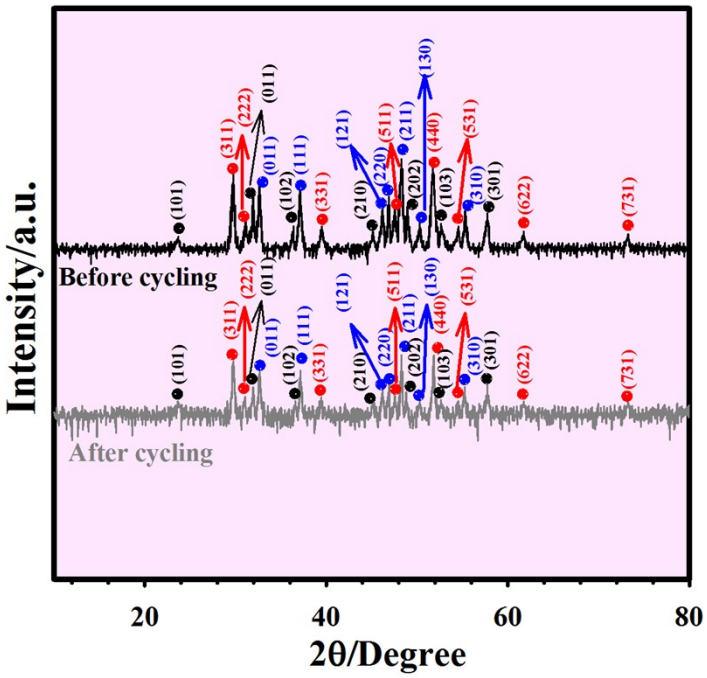


Fig. S18 XRD patterns of the CS4-FCP30 before and after durability test.

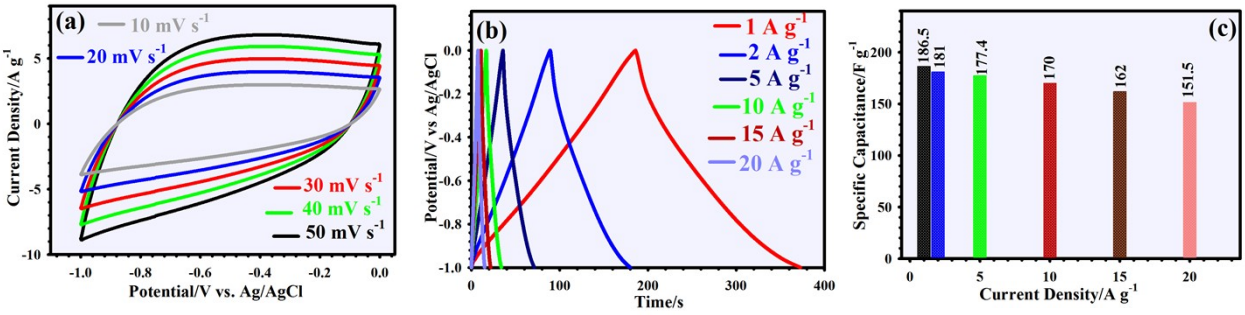


Fig. S19 (a) CV plots of the NF/AC at various scan rates from 10 to 50 mV s^{-1}. (b) GCD plots of the NF/AC@ at various current densities from 1 to 20 A g^{-1}. (c) Rate capability of the NF/AC electrode.

Table S1. Elemental composition of the CS4-FCP30 estimated by ICP-OE.

Element	Wt%	At%
Co	**45.35**	**46.84**
Fe	**4.88**	**4.16**
S	**38.11**	**39.16**
P	**11.66**	**9.84**

Based on the weight of Co (45.35 wt%) and S (38.11 wt%) elements, the content of the Co_9S_8 in the CS4-FCP30 is calculated as about 78.925 wt% [(45.35/10)×9 wt% + 38.11 wt%] and the content of the FeCo-P in the CS4-FCP30 is calculated as about 21.075 wt% (4.88 wt% + 45.35/10 + 11.66 wt%).

Composition	Capacity (C/g)	Cycles, retention	Rate capability	ED (Wh kg^{-1})	Reference
NiCoP	761 at 1 A g^{-1}	50000, 90.2%	91.1% at 20 A g^{-1}	35.6	1
NiCoMn-S-1.5	657.7 at 1 A g^{-1}	50000, 90%	51.61% at 50 A g^{-1}	36.3	2
Co_9S_8	926 at 1 A g^{-1}	8000, 86%	67.4% at 15 A g^{-1}	25.49	3
Co_3S_4/g-C_3N_4-10	415 at 0.5 A g^{-1}	5000, 75.6%	54.5% at 10 A g^{-1}	37.7	4
NiCoMn-S	661 at 1 A g^{-1}	1000, 86.45%	66.56% at 50 A g^{-1}	42.1	5
Ni_2P/NiCoP	741.3 at 1 A g^{-1}	30000, 89.2%	75.5% at 50 A g^{-1}	44.5	6
Ni–Co–P/POx/C	583 at 1 A g^{-1}	5000, 77.3%	62.7% at 30 A g^{-1}	37.59	7
NF/CS4-FCP30	1590 at 1 A g^{-1}	6500, 92.8 (3 E)	73.3% at 20A g^{-1}	66.6	This work

Table S2. Comparison of the performance of the NF/CS4-FCP30 with other previously reported materials.

References

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