Electronic Supplementary Information

ZIF-67-Derived Co-N-C Supported Nickel Cobalt Sulfide as a Bifunctional Electrocatalyst for Sustainable Hydrogen Production via Alkaline Electrolysis

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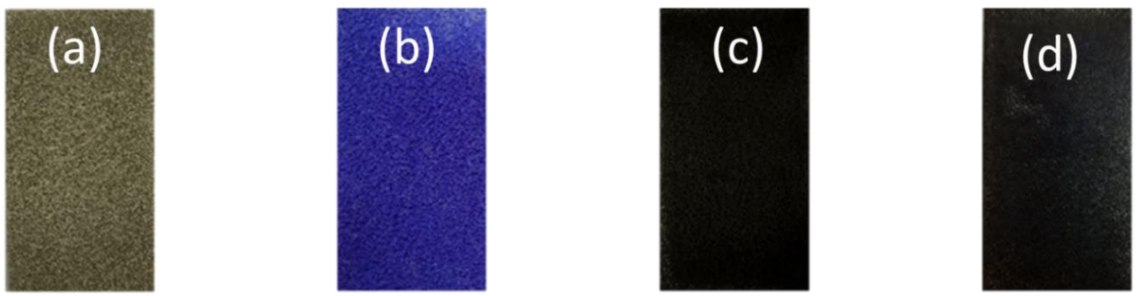

Fig. S1 Digital images of (a) bare NF, (b) NF@ZIF-67, (c) NF@ZIF-67@$NiCo_2S_4$, (d) NF@Co-N-C@$NiCo_2S_4$.

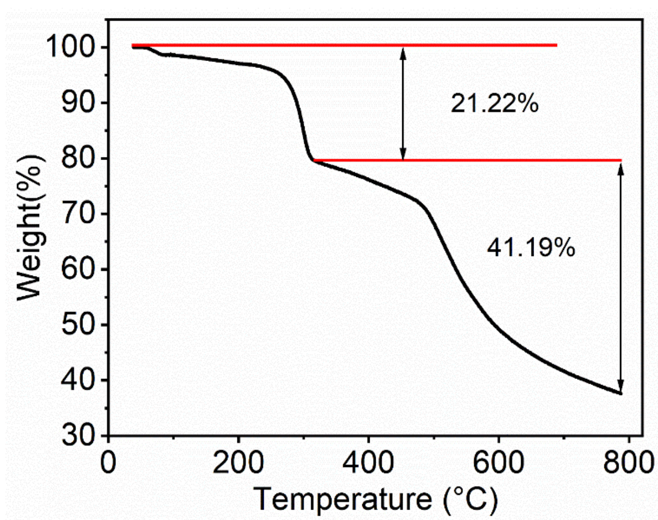

Fig. S2 TGA analysis of ZIF-67.

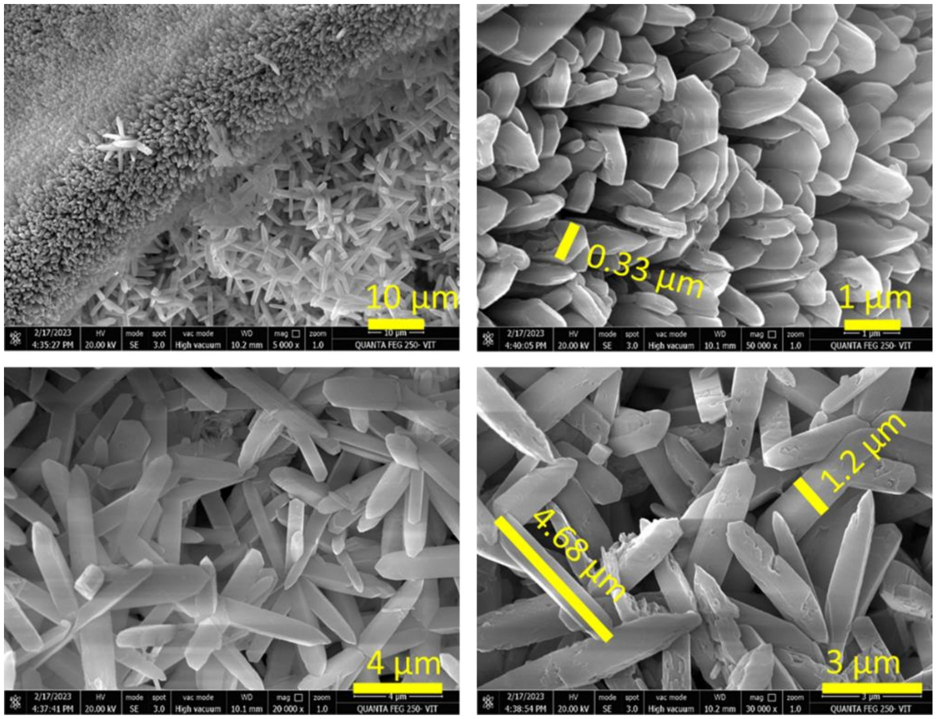

Fig. S3 FESEM images of NF@ZIF-67.

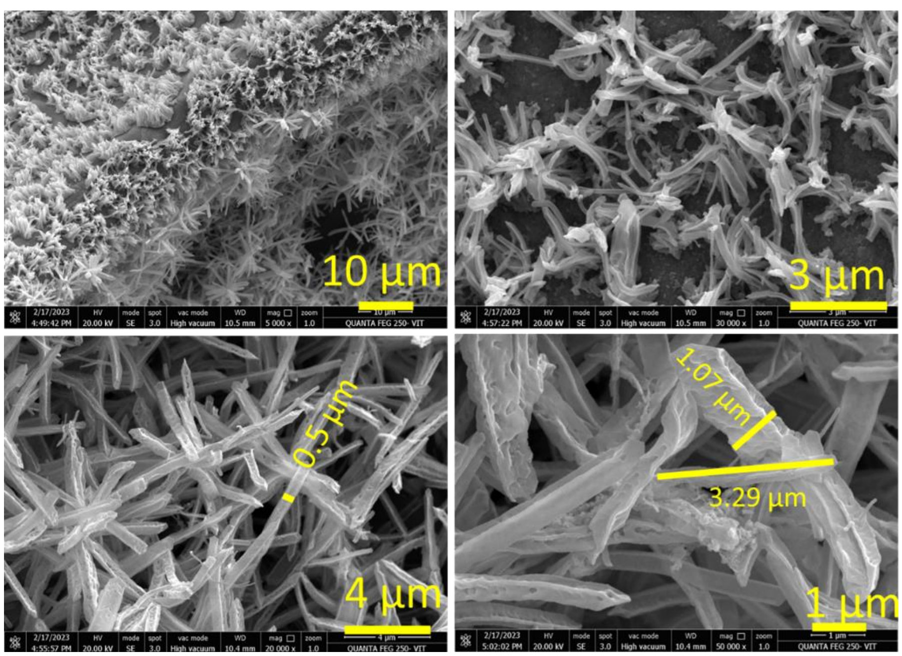

Fig. S4 FESEM images of ZIF-67 after calcination (Co-N-C).

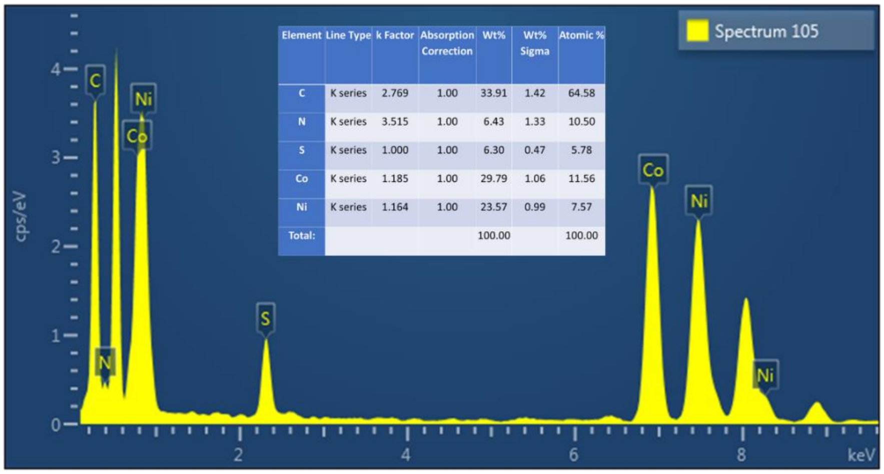

Fig. S5 EDS spectrum of NF@Co-N-C@$NiCo_2S_4$.

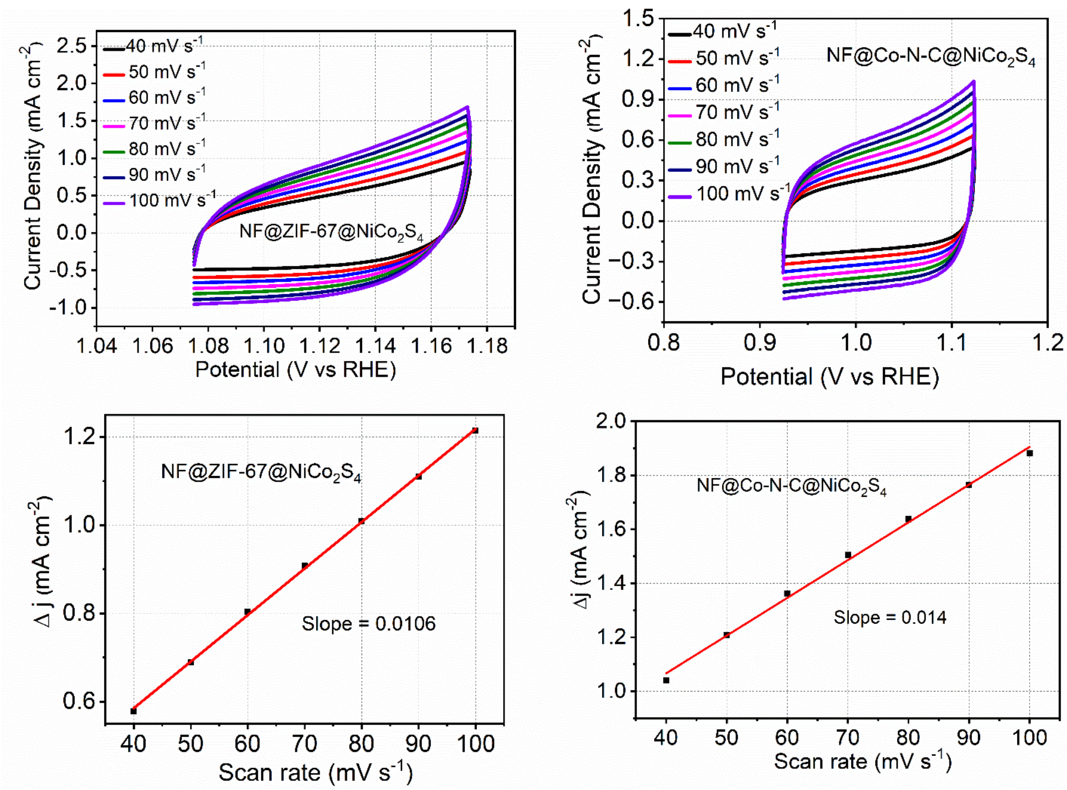

Fig. S6 (a and b) cyclic voltammograms at different scan rates ranging from 40 to 100 mV s^{-1} (c and d) Scan rate dependent current densities of the materials.

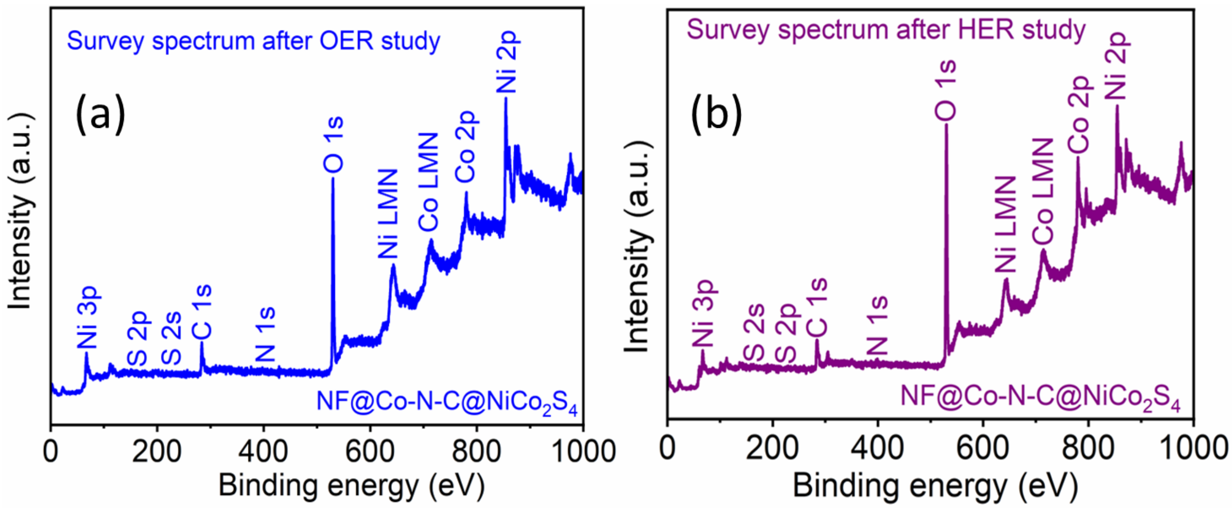

Fig. S7 XPS survey spectrum of NF@Co-N-C@$NiCo_2S_4$ after (a) OER and (b) HER studies.

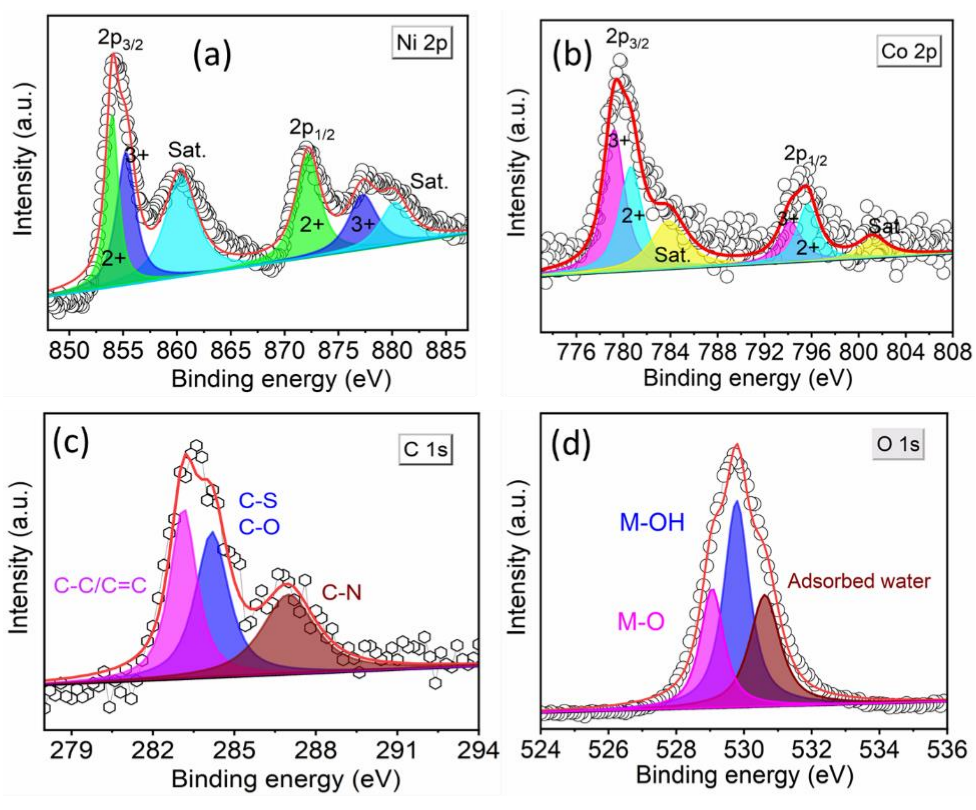

Fig. S8 XPS high-resolution spectra of NF@Co-N-C@$NiCo_2S_4$ for (a) Ni 2p, (b) Co 2p, (c) C 1s, (d) O 1s after OER study.

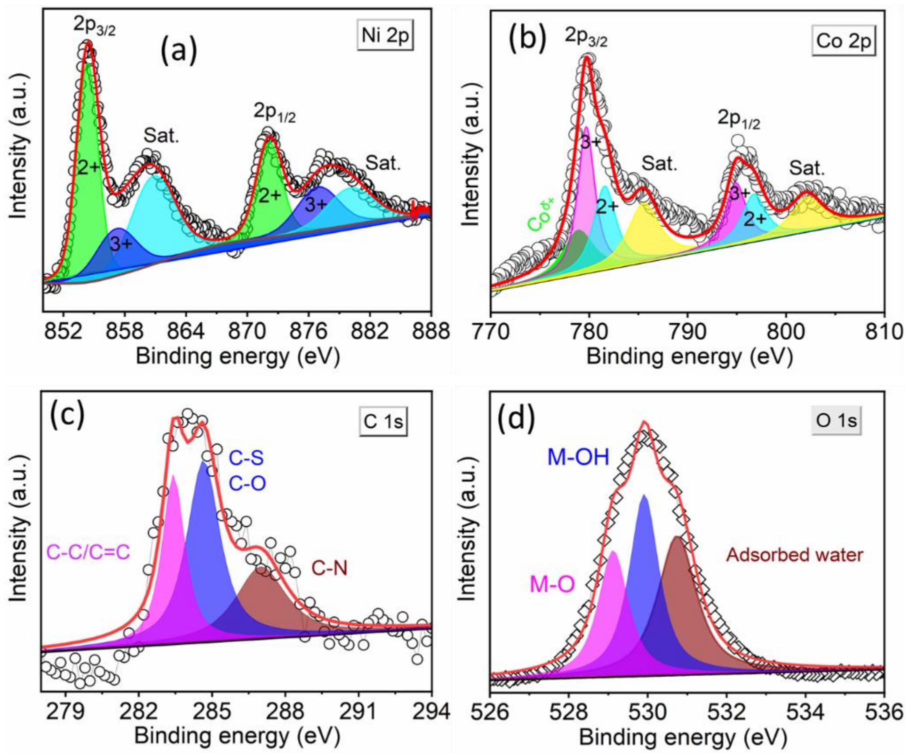

Fig. S9 XPS high-resolution spectra of NF@Co-N-C@$NiCo_2S_4$ for (a) Ni 2p, (b) Co 2p, (c) C 1s, (d) O 1s after HER study.

Table S1 Comparison of OER performance of NF@ZIF-67@$NiCo_2S_4$ and NF@Co-N-C@$NiCo_2S_4$ with other electrocatalysts in 1.0 M KOH.

Catalysts	j (mA cm^{-2})	η (mV vs RHE)	Tafel slope (mV dec^{-1})	Electrolyte	References
CoNi@C on NF	100	355	55.6	1 M KOH	S1
Fe_3C-Co-NC on NF	50	338	59	1 M KOH	S2
NiCoDH/NiCoS	20	303	77.6	1 M KOH	S3
V_s-$NiCo_2S_4$/N,S-rGO	10	340	43.8	0.1 M KOH	S4
Ni_3S_2/VG@NiCo LDHs	100	320	67	1 M KOH	S5
CoS_x/Ni_3S_2@NF	10 50	1.572 1.863	105.4	1 M KOH	S6
Co_3S_4@rGO	10	151	59	0.5 M H_2SO_4	S7
NiCoS-3	10	320	58.8	1.0 M KOH	S8
$NiCo_2S_4$ NW/NF	10	260	40.1	1.0 M KOH	S9
$Ni_{0.7}Fe_{0.3}S_2$	10	198	56	1.0 M KOH	S10
Ni_3S_2/NF	10	260	-	1.0 M KOH	S11
NiFeS-2	10	286	56.3	1.0 M KOH	S12
FeOOH decorated on Ni MOF	20	267	79	1.0 M KOH	S13
NDA/MWCNTs-a	10	285	73	1.0 M KOH	S14
NiFe-Se/CFP	10	281 mV	40.93	1.0 M KOH	S15
Ni–Fe–Se/N-CNTs powder	10	215	97.1	1.0 M KOH	S16
NiFeSe@NiSe|O@CC	10	270	63.2	1.0 M KOH	S17
NiFe-based selenide powder	10	216	36	1.0 M KOH	S18
$NiSe_2$ NPs/	10	324	47.47	1.0 M KOH	S19
(Co.Ni)Se_2@NiFe LDH	10	277	75	1.0 M KOH	S20
Ni–Co–S–P	10	280	78	1.0 M KOH	S21
$(Co_{1-x}Ni_x)(S_{1-y}P_y)_2$/G	10	285	105	1.0 M KOH	S22

$FeCoNiP_{0.5}S_{0.5}$	100	285	69	1.0 M KOH	S23
Ru@NiCo-MOF HPNs	10	284	78.8	1.0 M KOH	S24
NF@ZIF-67@$NiCo_2S_4$	50	248	68	1.0 M KOH	
	100	361	68	1.0 M KOH	This work
NF@Co-N-C@$NiCo_2S_4$	50	239	66	1.0 M KOH	
	100	300	66	1.0 M KOH	This work

Table S2 Comparison of HER performance of NF@ZIF-67@$NiCo_2S_4$ and NF@Co-N-C@$NiCo_2S_4$ with other electrocatalysts in 1.0 M KOH.

Catalysts	**j (mA cm^{-2})**	**η (mV vs RHE)**	**Tafel slope (mV dec^{-1})**	**Electrolyte**	**Reference**
Ni-MOF/NC-800	10	369	127.1	1.0 M KOH	S25
Fe-Co-CN/rGO-700	10	215	-	1.0 M KOH	S26
$NiCo_2S_4$ NW/NF	10	260	67	1.0 M KOH	S9
Ni_3S_2-CNFs/CC	20	300	-	1.0 M KOH	S30
NF@ZIF-67@$NiCo_2S_4$	20	230	139	1.0 M KOH	This work
NF@Co-N-C@$NiCo_2S_4$	20	229	131	1.0 M KOH	This work

Table S3 Comparison of Overall water splitting performance of NF@ZIF-67@$NiCo_2S_4$ and NF@Co-N-C@$NiCo_2S_4$ with other electrocatalysts in 1.0 M KOH.

Catalysts	**j (mA cm^{-2})**	**η (mV vs RHE)**	**Reference**
Co-NCNTFs//NF	10	1.62	S27
FeCoNi@FeNC	10	1.63	S28
$Co(S_xSe_{1-x})_2$	10	1.63	S36
NiS/Ni_2P/CC	10	1.67	S37

Ni–Co–S–P	10	1.61	S21
$(Co_{1-x}Ni_x)(S_{1-y}P_y)_2/G$	10	285	S38
$Ni_{0.33}Co_{0.67}S_2$	5	1.65	S29
$NiCo_2S_4$ NW/NF	10	1.63	S9
$NiCo(OH)_2$/NF	10	1.65	S29
N, O and S tridoped carbon-encapsulated	10	1.6	S31
Ni_3S_4/NF	10	1.61	S32
$Ni_{0.7}Fe_{0.3}S_2$	10	1.625	S33
Ni Co-LDH/NF	10	1.66	S34
$NiCo_2S_4$/N-rGO	10	1.63	S35
Ni_3S_2/VG@NiCo LDHs	10	1.66	S5
NF@ZIF67@$NiCo_2S_4$‖NF@ZIF-67@$NiCo_2S_4$	10	1.62	This work
NF@Co-N-C@$NiCo_2S_4$(+)‖NF@Co-N-C@$NiCo_2S_4$(-)	10	1.59	This work

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