Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supporting materials

Hierarchical $FeCo_2S_4$@CoFe layered double hydroxide on Ni foam as bifunctional electrocatalyst for overall water splitting

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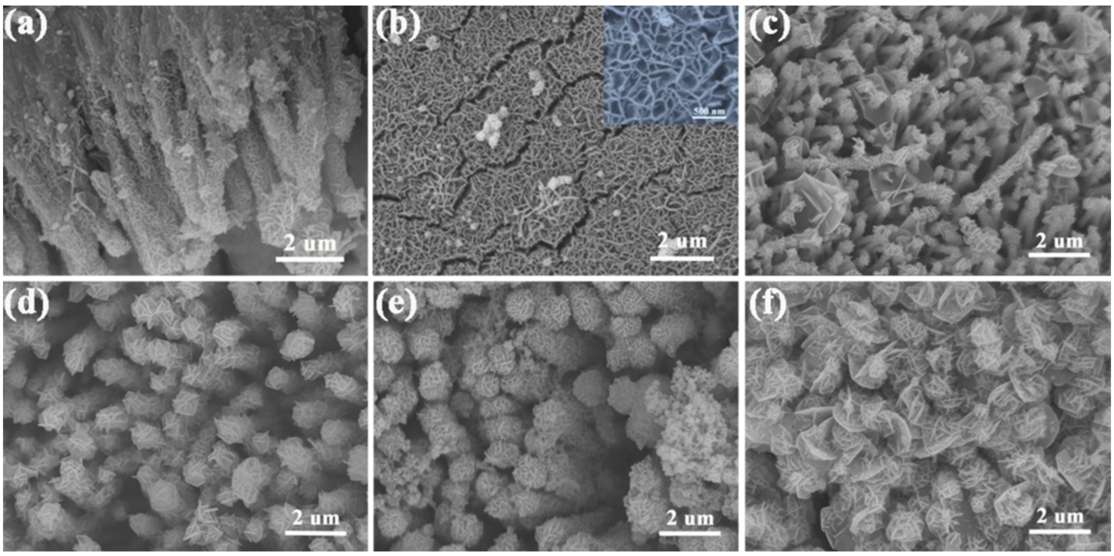

Figure S1. The cross-section SEM image of $FeCo_2S_4$@CoFe LDH. (b) SEM image of CoFe LDH at the electrodeposition time of 60 s. SEM image of $FeCo_2S_4$@CoFe LDH at different electrodeposition time: (c) 30 s, (d) 60 s, (e) 90 s, (f) 200 s.

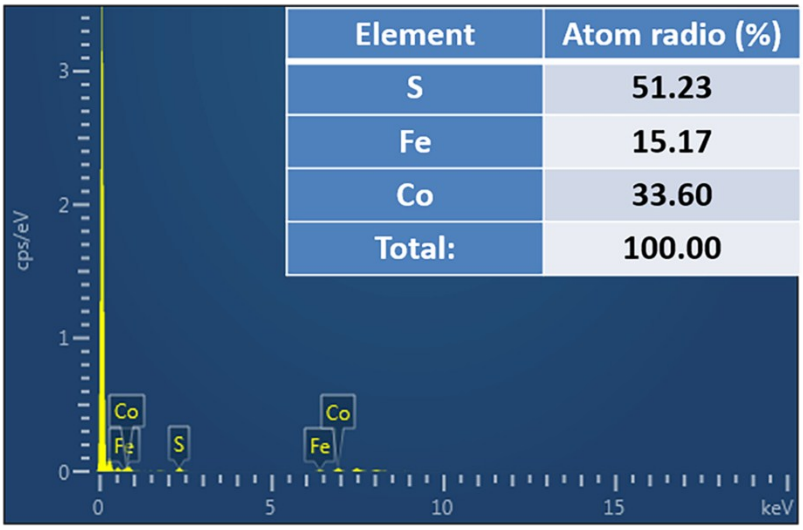

Figure S2. EDX spectra of $FeCo_2S_4$@CoFe LDH.

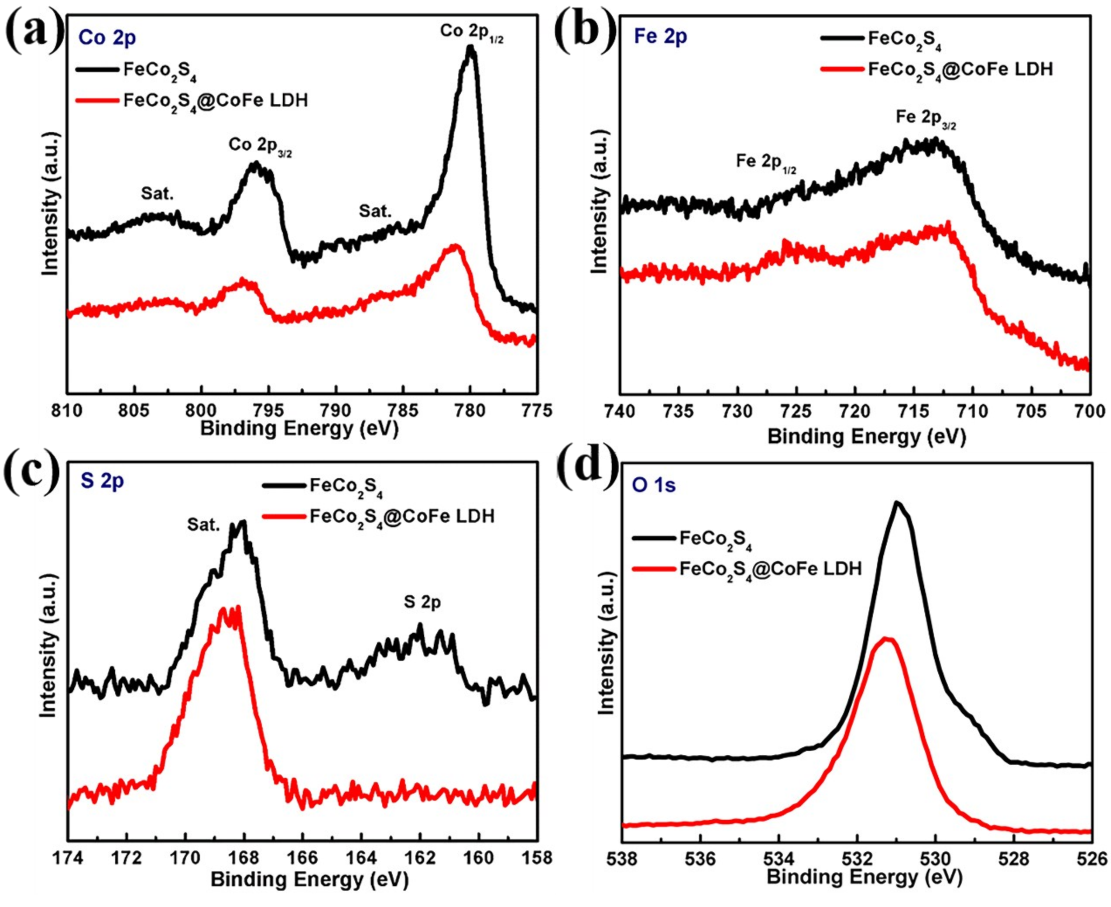

Figure S3. XPS spectra of (a) Co 2p, (b) Fe 2p, (c) S 2p and (d) O 1s from the $FeCo_2S_4$ and $FeCo_2S_4$@CoFe LDH, respectively.

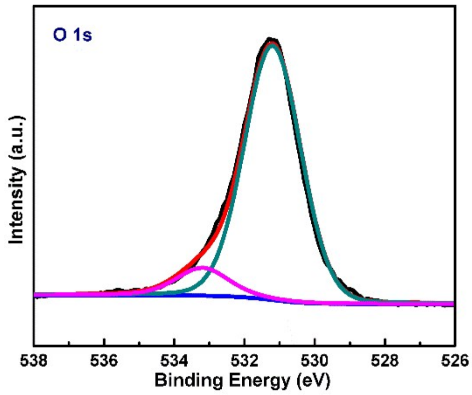

Figure S4. XPS spectra of O 1s from $FeCo_2S_4$@CoFe LDH.

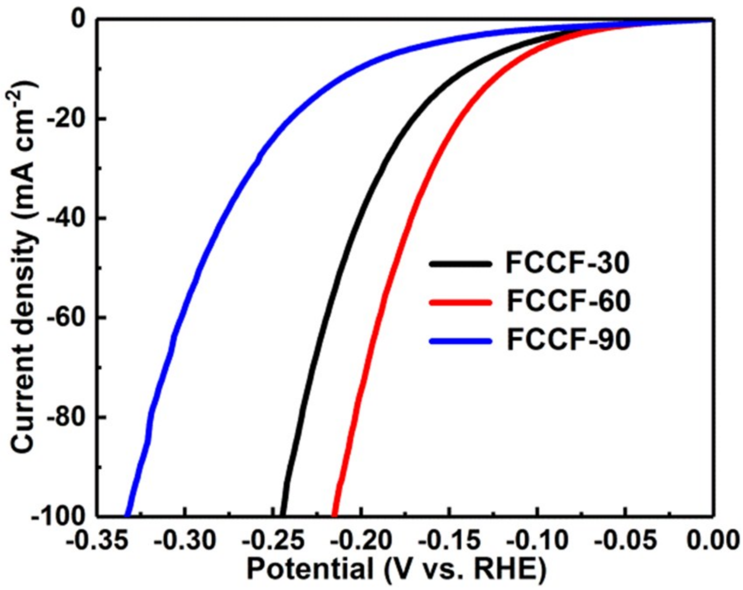

Figure S5. HER polarization curves of FCCF-30, FCCF-60 and FCCF-90.

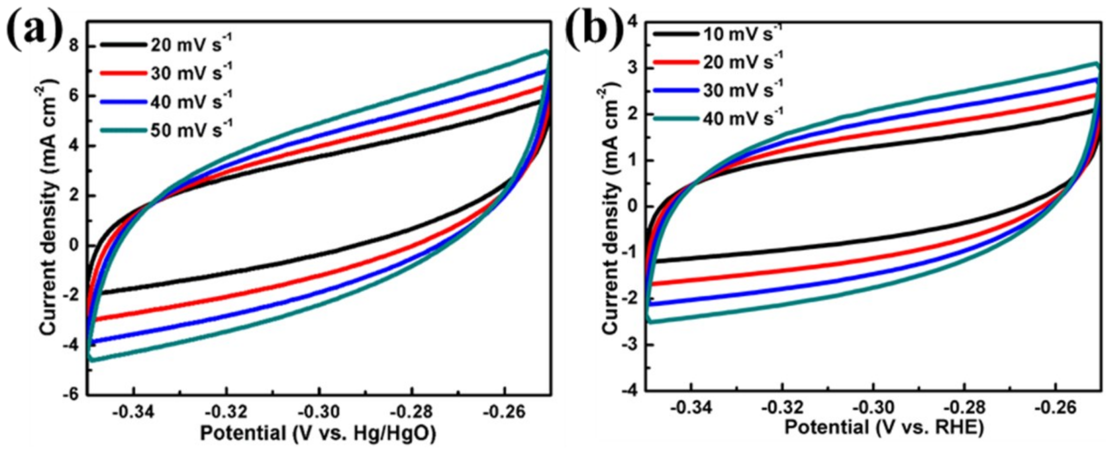

Figure S6. CV curves of (a) $FeCo_2S_4$@CoFe LDH, and (b) $FeCo_2S_4$ at different scan rates, respectively.

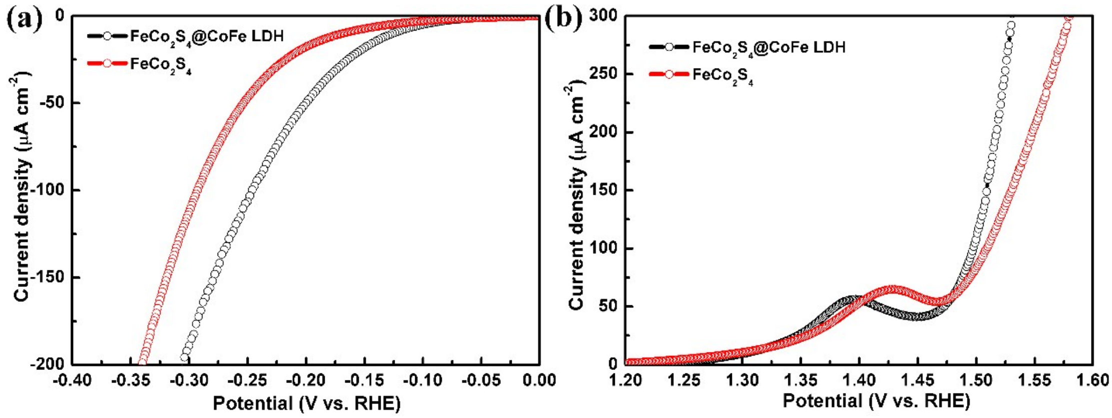

Figure S7. ECSA-normalized polarization curves of $FeCo_2S_4$@CoFe LDH and $FeCo_2S_4$ for (a) HER and (b) OER.

The ECSA of the catalyst can be calculated according to the equation: ECAS=C_{dl}/C_s, where the specific capacitance C_s is usually between 20~60 μF cm^{-2}. Here we assume it as 40 μF cm^{-2} in the following calculations of ECSA.[1]

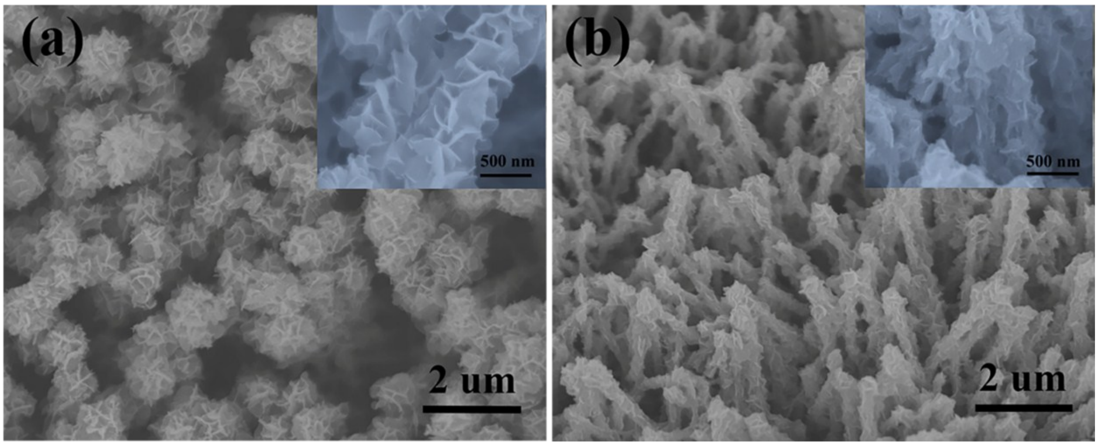

Figure S8. SEM images of $FeCo_2S_4$@CoFe LDH after (a) HER and (b) OER stability test, the inset images are the corresponding SEM images at high resolution.

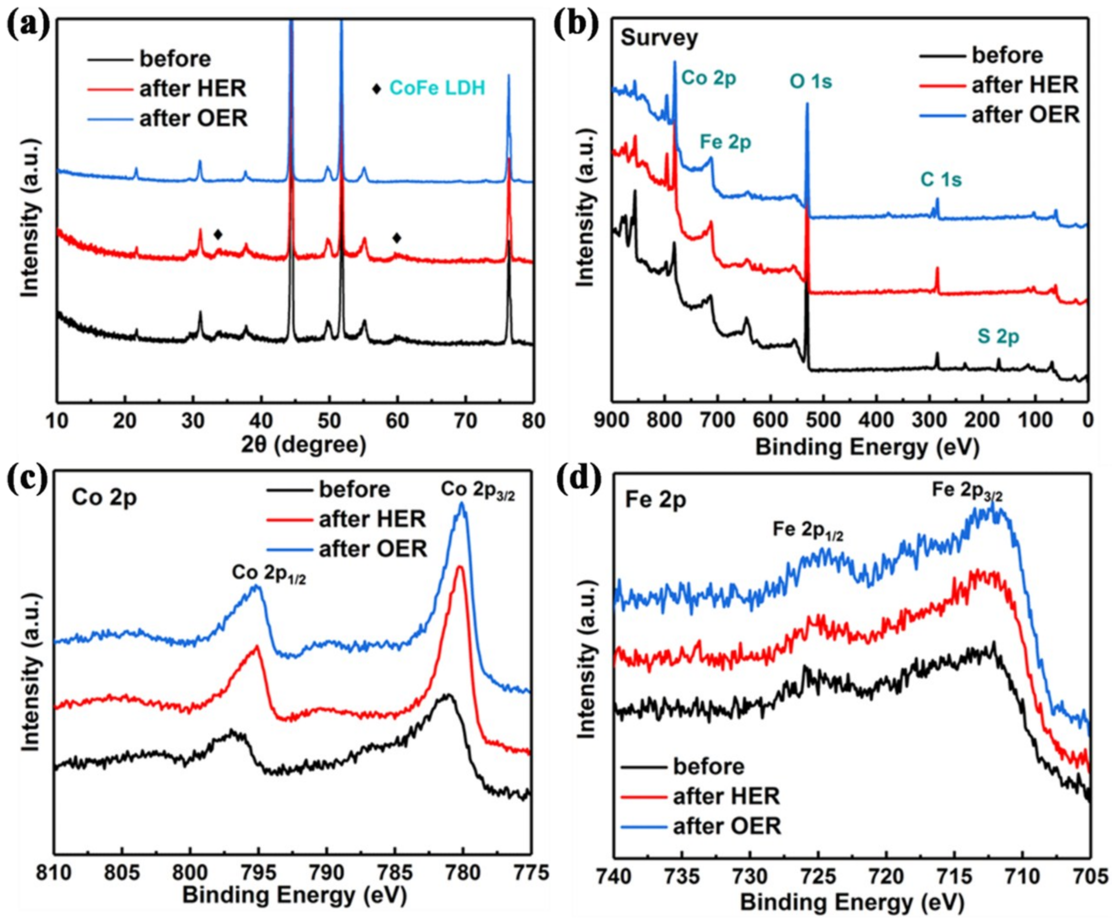

Figure S9. (a) XRD patterns and (b) XPS surveys of $FeCo_2S_4$@CoFe LDH before test, after HER and OER stability test. XPS spectra of (c) Co 2p and (d) Fe 2p characteristic peaks from $FeCo_2S_4$@CoFe LDH before test, after HER and OER stability test.

Table S1. Comparison of HER activity data with other reported non-noble catalysts.

Catalyst	Electrolyte	η(mV)@j(mA cm^{-2})	Tafel slope (mV dec^{-1})	Time
$FeCo_2S_4$@CoFe LDH/NF	1 M KOH	115@10	72.8	24 h (this work)
CoP/CC[2]	1 M KOH	209@10	129	*
Ni_9S_8/NF[3]	1 M KOH	230@10	123.3	24 h
$NiCo_2O_4$@NiFe LDH/NF[4]	1 M KOH	192@10	59	10 h
$FeNiP_x$/NF[5]	1 M KOH	153@10	80	90 h
$NiFe_2O_4$/NiFe LDH/NF[6]	1 M KOH	101@10	67.1	
NiFeS[7]	1 M KOH	180@10	53	200 h
$NiCo_2S_4$ NA/CC[8]	1 M KOH	228@20	141	12 h

Table S2. Comparison of OER activity with other reported non-noble catalysts.

Catalyst	Electrolyte	η(mV)@j(mA cm^{-2})	Tafel slope (mV dec^{-1})	Time
$FeCo_2S_4$@CoFe LDH/NF	1 M KOH	259@100	68.9	24 h (this work)
CoFe[9]	1 M KOH	286@10	48	5 h
CoFe-LDH/TEG[10]	1 M KOH	301@10	52	5 h
$Co_{0.75}Ni_{0.25}Se$/NF[11]	1 M KOH	269@50	74	40 h
FeOOH/NiFe LDH	1 M KOH	208@10	42.5	5 h
CoFe-LDH NS[12]	1 M KOH	280@10	33.4	8 h
$CoFe_2O_4$/CFP[13]	1 M KOH	378@10	73	40 h
$Cu(OH)_2$@CoNiCH NTs/CF[14]	1 M KOH	288@30	74	12 h

Table S3. Comparison of the electrocatalytic performance for $FeCo_2S_4$@CoFe LDH catalyst with other reported catalysts in 1 M KOH electrolyte.

Catalyst	HER		OER		Cell voltage@10 mA cm^{-2}
	η(mV)@j (mA cm^{-2})	Tafel slope (mV dec^{-1})	η(mV)@j (mA cm^{-2})	Tafel slope (mV dec^{-1})	
$FeCo_2S_4$@CoFe LDH/NF	118@10	81.5	259@100	68.9	1.6 (this work)
CoFe@NiFe-200/NF[15]	240	84.69	190@10	45.71	1.59
NiFe LDH-NiSe/NF[16]	276@100	70	240@100	65.6	1.53
Cu@CoFe LDH/CF[17]	171@10	36.4	240@10	44.4	1.68
$NiCo_2S_4$ NW /NF[18]	210@10	58.9	260@10	40.1	1.63
EG/$Co_{0.85}$Se/NiFe-LDH[19]	260@10	160	270@150	57	1.67
NiFe-NCs/CFP[20]	197@10	130	271@10	48	1.67
$NiFe_2O_4$/NiFe LDH/NF[6]	101@10	67.1	213@100	28.2	1.535
NiFe/$NiCo_2O_4$/NF[21]	105@10	88	240@10	38.8	1.67
$NiCo_2O_4$@$Ni_{0.796}$Co LDH/NF[22]	115@10	56.42	193@10	37.59	1.6
NiCoFe LTHs/CFC[23]	200@10	70	239@10	32	1.55
$NiCo_2S_4$@NiFe LDH/NF[24]	200@10	46.3	201@60	101.1	1.6
$NiCo_2O_4$@NiO@Ni/NF[25]	124@10	58	240@10	43	1.6
Co_3S_4@MoS_2[26]	136@10	74	280@10	43	1.58
NiS/NF[27]	158@20	83	335@50	89	1.64

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