Supporting Information

Ternary nickel-iron sulfide microflower as a robust electrocatalyst for bifunctional water splitting

Jiahao Yu,[a] Gongzhen Cheng[a] and Wei Luo[a,b*]

[a]College of Chemistry and Molecular Sciences, Wuhan University, Wuhan, Hubei 430072, P. R. China, Tel.: +86-027-68752366

*Corresponding author. E-mail addresses: wluo@whu.edu.cn.

[b]Key laboratory of Advanced Energy Materials Chemistry (Ministry of Education), Nankai University, Tianjin 300071, P. R. China

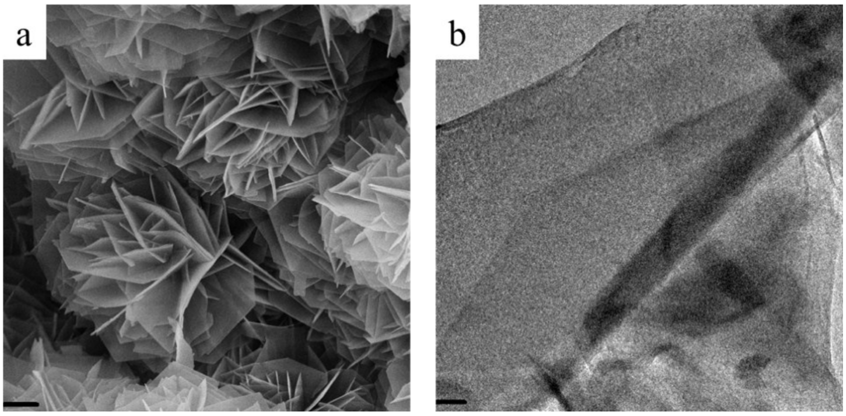

Figure S1. (a) SEM image and (b) TEM image of NiFe LDH. (c) 1 μm; (d) 100 nm.

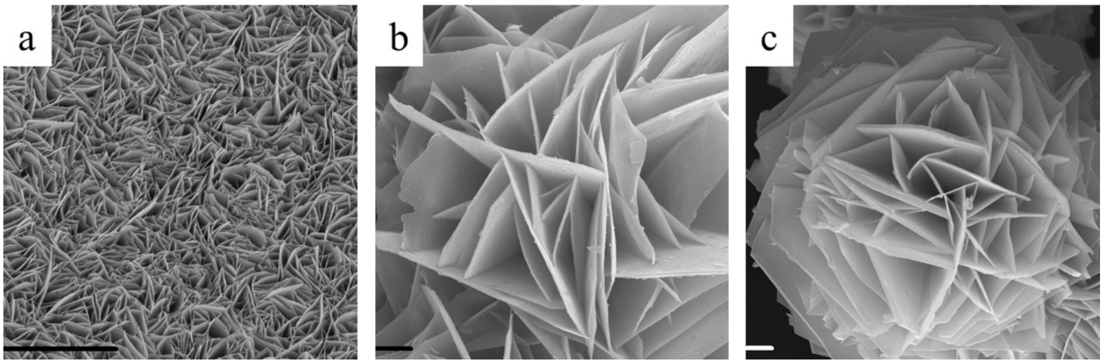

Figure S2. SEM images of (a) NiS_2, (b) $Ni_{0.86}Fe_{0.14}S_2$ and (c) $Ni_{0.58}Fe_{0.42}S_2$. Scale bars: (a) 10 μm; (b) and (c) 1 μm.

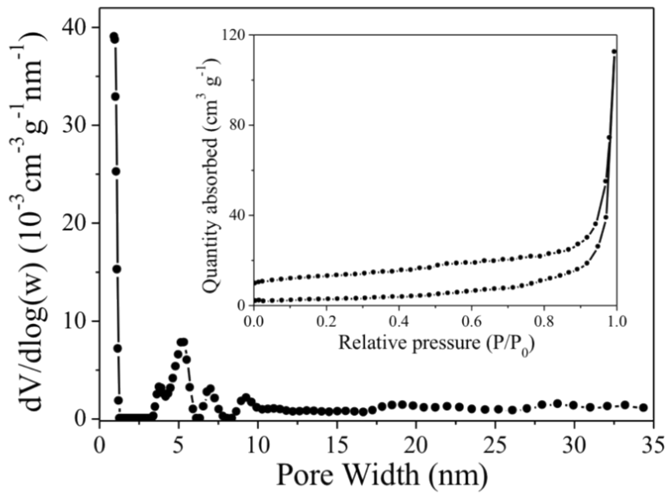

Figure S3. Pore size distribution (DFT model) of $Ni_{0.7}Fe_{0.3}S_2$. Inset shows the N_2 adsorption-desorption isotherm.

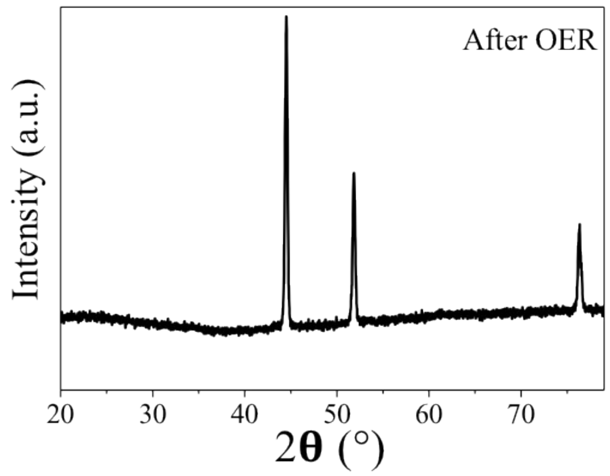

Figure S4. XRD pattern for $Ni_{0.7}Fe_{0.3}S_2$ after OER test.

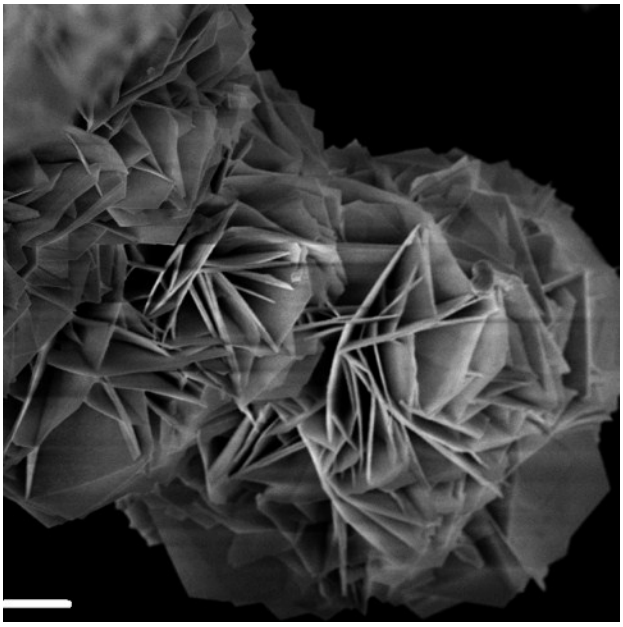

Figure S5. SEM images of $Ni_{0.7}Fe_{0.3}S_2$ after chronopotentiometric measurements of OER. Scale bar: 2 μm.

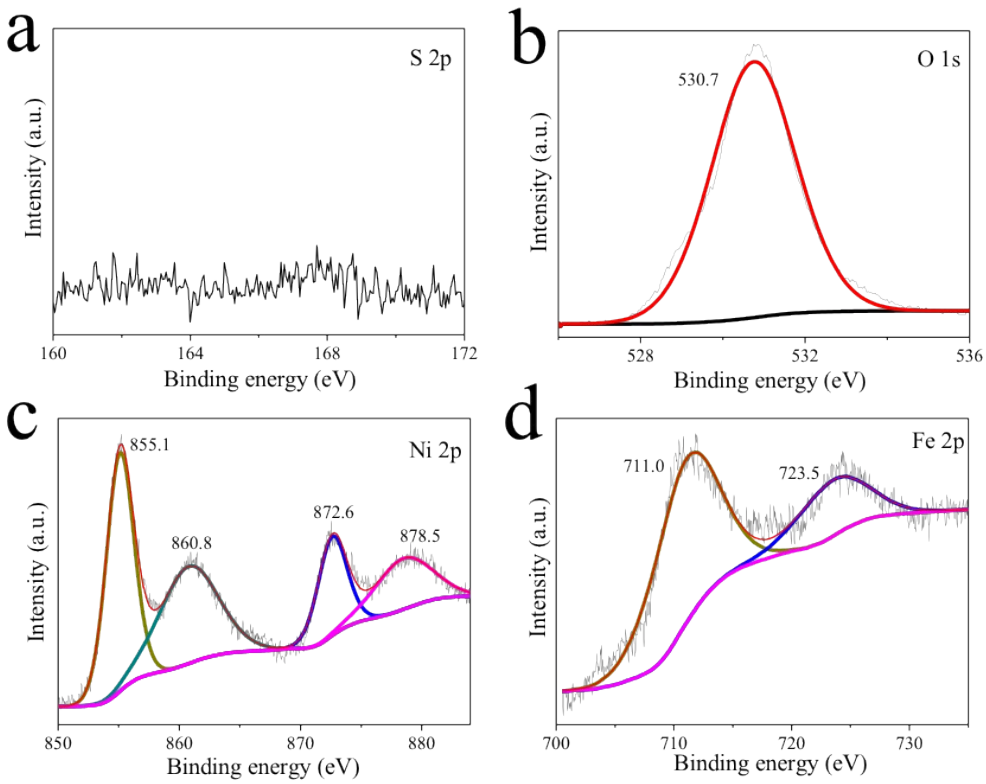

Figure S6. XPS spectra (a) in the S (2p) region, (b) in the O (1s) region, (c) in the Ni (2p) region and (d) in the Fe (2p) region of $Ni_{0.7}Fe_{0.3}S_2$ after OER test.

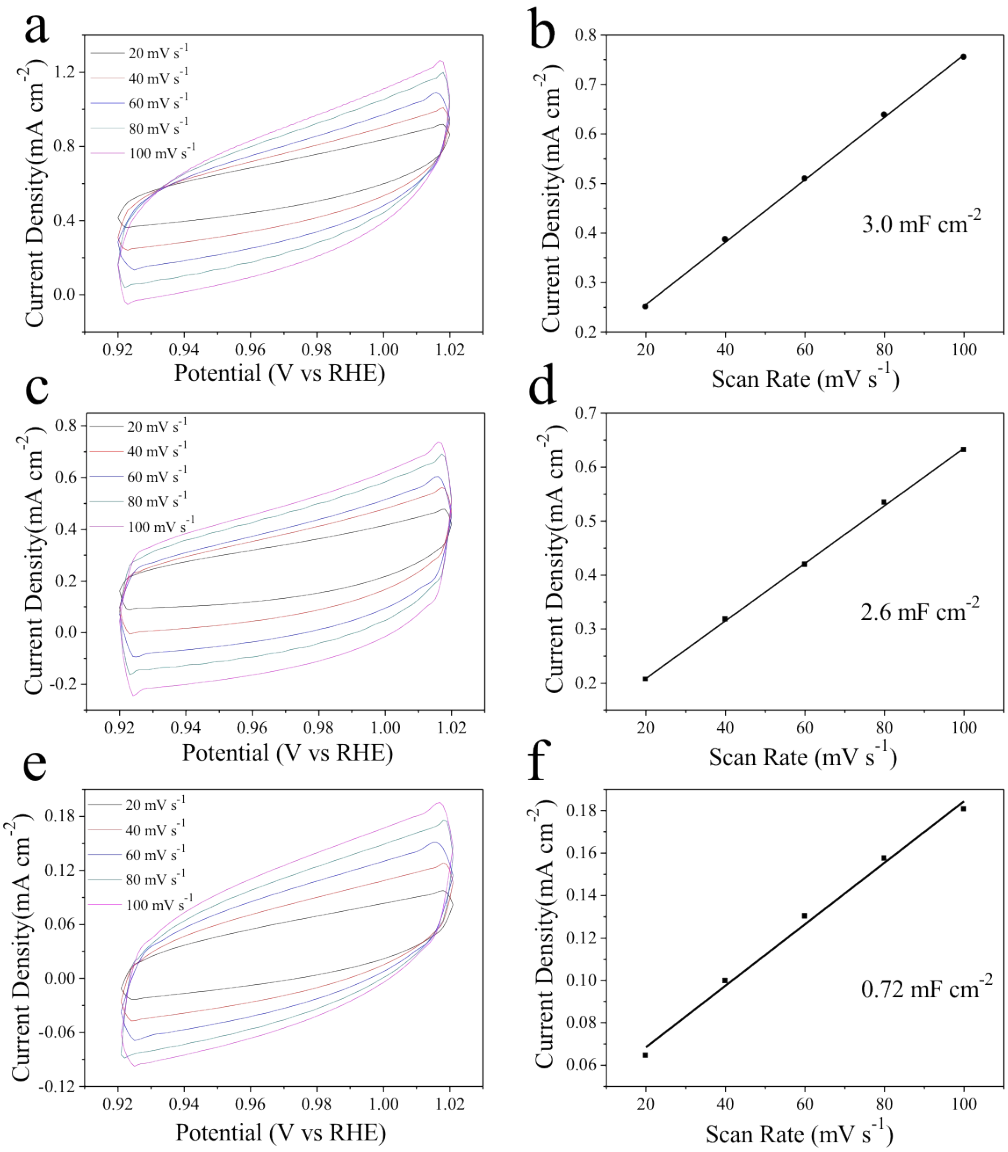

Figure S7. Cyclic voltammetry (CV) curves of (a) $Ni_{0.7}Fe_{0.3}S_2$, (c) NiS_2 and (e) NiFe LDH tested at various scan rates from 20 to 100 mV s^{-1}. Scan rate dependence of the current densities of (b) $Ni_{0.7}Fe_{0.3}S_2$, (d) NiS_2 and (f) NiFe LDH at 0.97 V vs RHE.

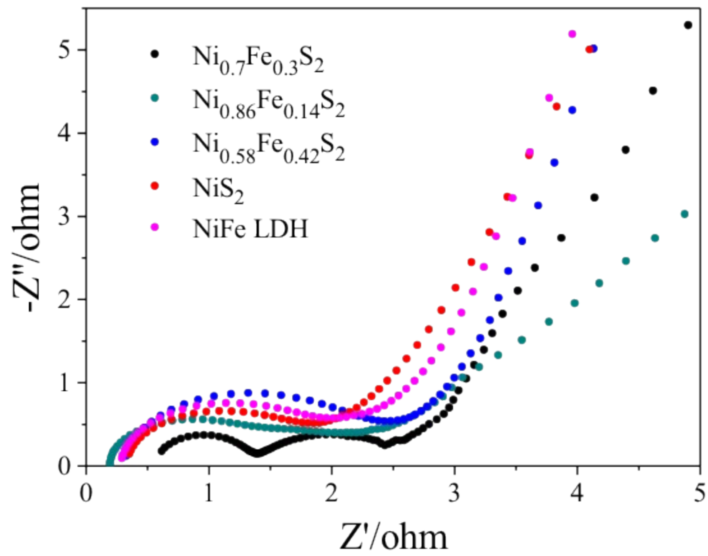

Figure S8. EIS spectra of $Ni_xFe_{1-x}S_2$, NiS_2 and NiFe LDH.

Table S1 The actual Ni/Fe atomic ratios of different added $Ni(NO_3)_2 \cdot 6H_2O/FeSO_4 \cdot 7H_2O$ ratios determined by ICP-AES.

Feed ratios	**Ni (Atomic%)**	**Fe (Atomic%)**
x=0.25	27.9	27.2
x=0.5	38.9	22.2
x=0.75	54.7	11.6

Table S2 Comparison of OER catalytic performance with other sulfides and non-noble metal based catalysts.

Materials	Current Density (mA cm^{-2})	Overpotential (mV)	Reference
$Ni_{0.7}Fe_{0.3}S_2$	10	198	This work
	20	212	
	50	245	
	100	287	
	200	360	
$Ni_{2.3\%}$-CoS_2/CC	100	370	[1]
$Co_{0.5}Fe_{0.5}S$@N-MC	10	410	[2]
NiS/Ni foam	50	335	[3]
Ni-Fe disulfide@oxyhydroxide	10	230	[4]
Fe-Ni_3S_2/FeNi	10	282	[5]
$NiCo_2S_4$ NA/CC	100	340	[6]
Ni-Co-S/CF	100	363	[7]
MoO_x/Ni_3S_2 composite	200	373	[8]
CoNi-P-NS /NF	10	209	[9]
(Ni, Co)$_{0.85}$Se@NiCo-LDH	10	216	[10]
$Co_{0.13}Ni_{0.87}Se_2$/Ti	100	320	[11]
NiCoP	50	308	[12]
Sandwiched NiFe/C arrays	20	220	[13]
NiFe/RGO	10	245	[14]
FeNi-O	10	213	[15]
NiFe LDH	10	240	[16]

Table S3 Comparison of HER catalytic performance with other sulfides and non-noble metal based catalysts.

Materials	**Current Density ($mA\ cm^{-2}$)**	**Overpotential (mV)**	**Reference**
$Ni_{0.7}Fe_{0.3}S_2$	10	155	This work
$NiCo_2S_4$ NA/CC	10	~190	[6]
$Fe_{0.1}$-NiS_2 NA/Ti	10	~250	[17]
Ni_2P/NiO_x	10	220	[18]
EG/$Co_{0.85}$Se/NiFe-LDH	10	260	[19]
Co_9S_8-Ni_xS_y/Ni foam	10	163	[20]
Ni_3S_2/AT-Ni	10	200	[21]
CoP	10	209	[22]
NiFe LDH/NF	10	210	[16]
NiCoP/rGO	10	209	[23]
$Co_{0.5}Fe_{0.5}$S@N-MC	10	410	[2]

Table S4 Comparison of catalytic performance for water splitting with other sulfides and non-noble metal based catalysts.

Materials	**Current Density ($mA\ cm^{-2}$)**	**Cell voltage (V)**	**Reference**
$Ni_{0.7}Fe_{0.3}S_2$	10 50	1.625 1.751	This work
Ni-Co-S/CF	10	1.67	[7]
NiS/Ni foam	10	1.64	[3]
NiSe/Ni foam	10	1.63	[24]
Co-P/Cu foil	10	1.65	[25]
$NiCo_2S_4$ NA/CC	10	1.68	[6]
NiCoP	50	1.77	[12]
Ni_2P/NiO_x	10	1.63	[18]
NiCoP	10	1.64	[26]
EG/$Co_{0.85}$Se/NiFe-LDH	10	1.67	[19]
$NiCo_2O_4$	10	1.65	[27]

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