

Electronic Supplementary Information

Iron-doped NiCo-MOF hollow nanospheres for enhanced electrocatalytic oxygen evolution

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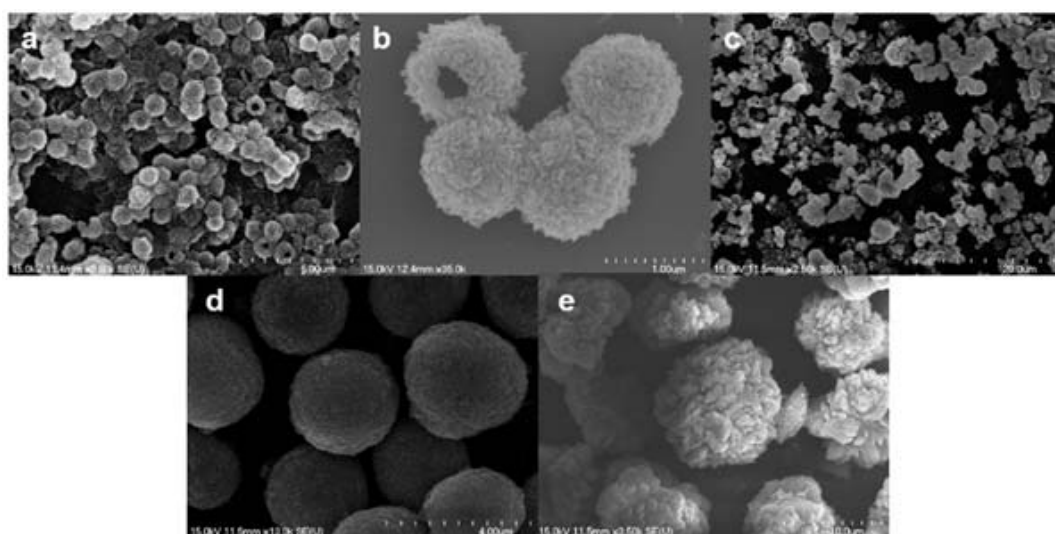


Fig. S1 The SEM images of (a) Ni-MOF, NiCo-MOF with Ni/Co ratio of (b) 2:1, (c) 1:1, (d) 1:2 and (e) Co-MOF.

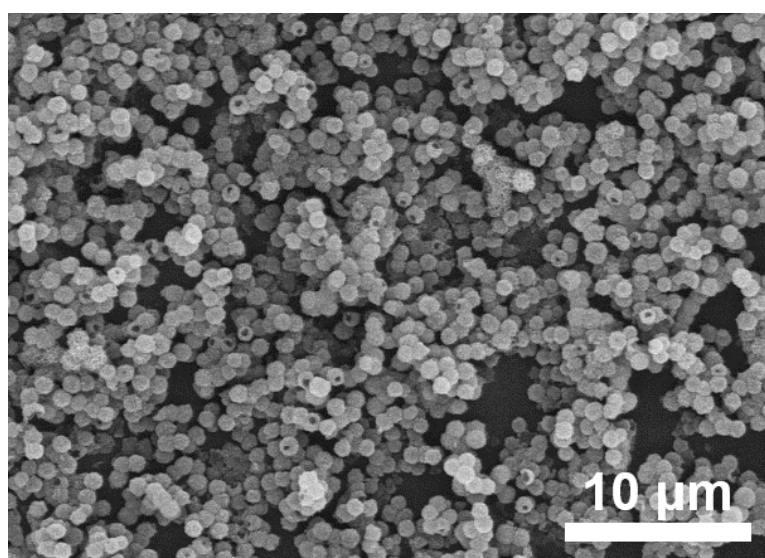


Fig. S2 SEM image of NiCo-MOF HNSs.

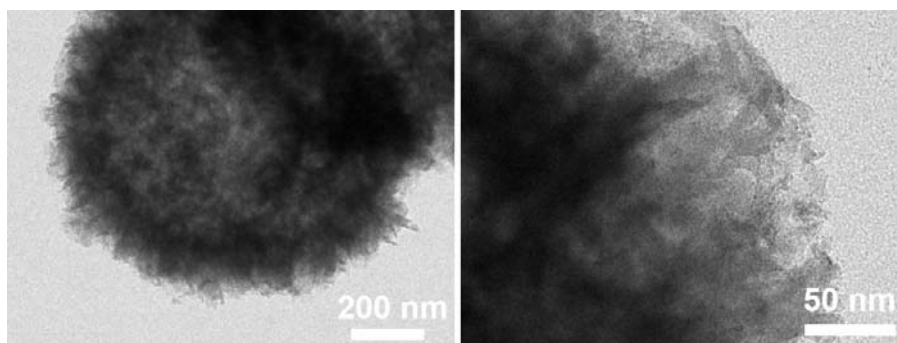


Fig. S3 HRTEM images of Fe@NiCo-MOF HNSs.

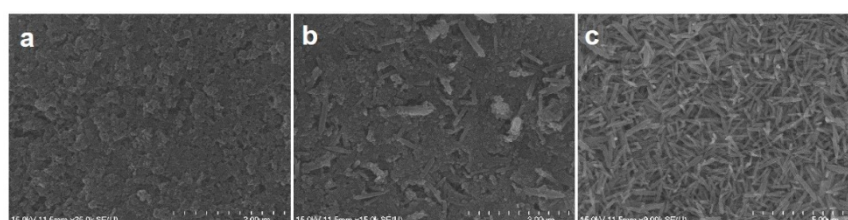


Fig. S4 The SEM images of FeNiCo-MOF prepared by one-pot method with (a) 0.01 mmol Fe^{3+} , (b) 0.03 mmol Fe^{3+} and (c) 0.05 mmol Fe^{3+} .

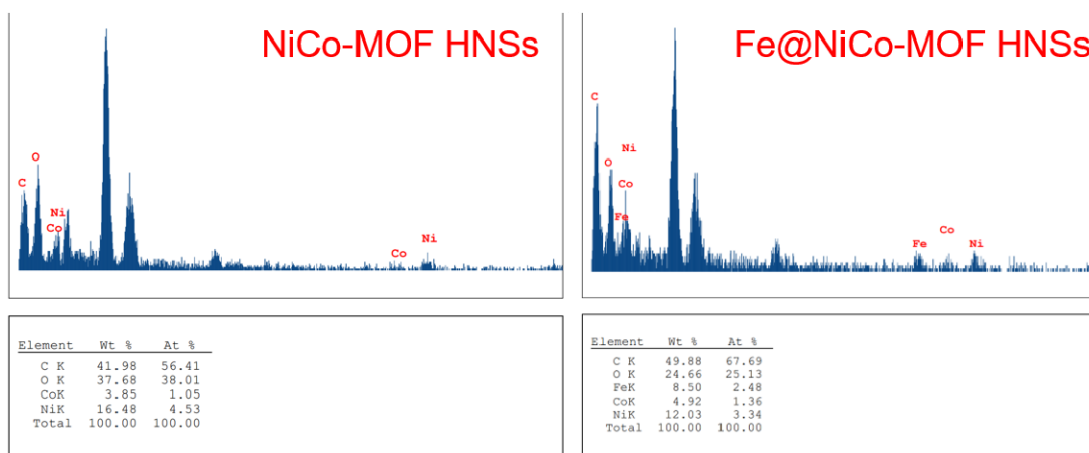


Fig. S5 EDX spectra of a) NiCo-MOF HNSs and b) Fe@NiCo-MOF HNSs.

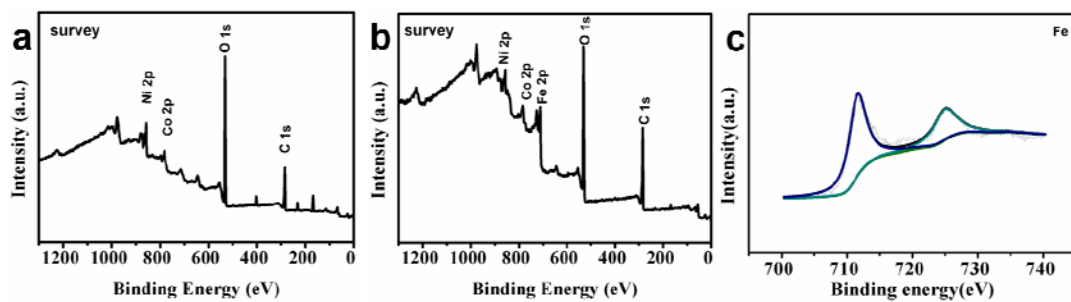


Fig. S6 Full XPS survey spectra of a) NiCo-MOF HNSs, b) Fe@NiCo-MOF HNSs and c) corresponding high-resolution XPS spectra of Fe 2p in Fe@NiCo-MOF HNSs.

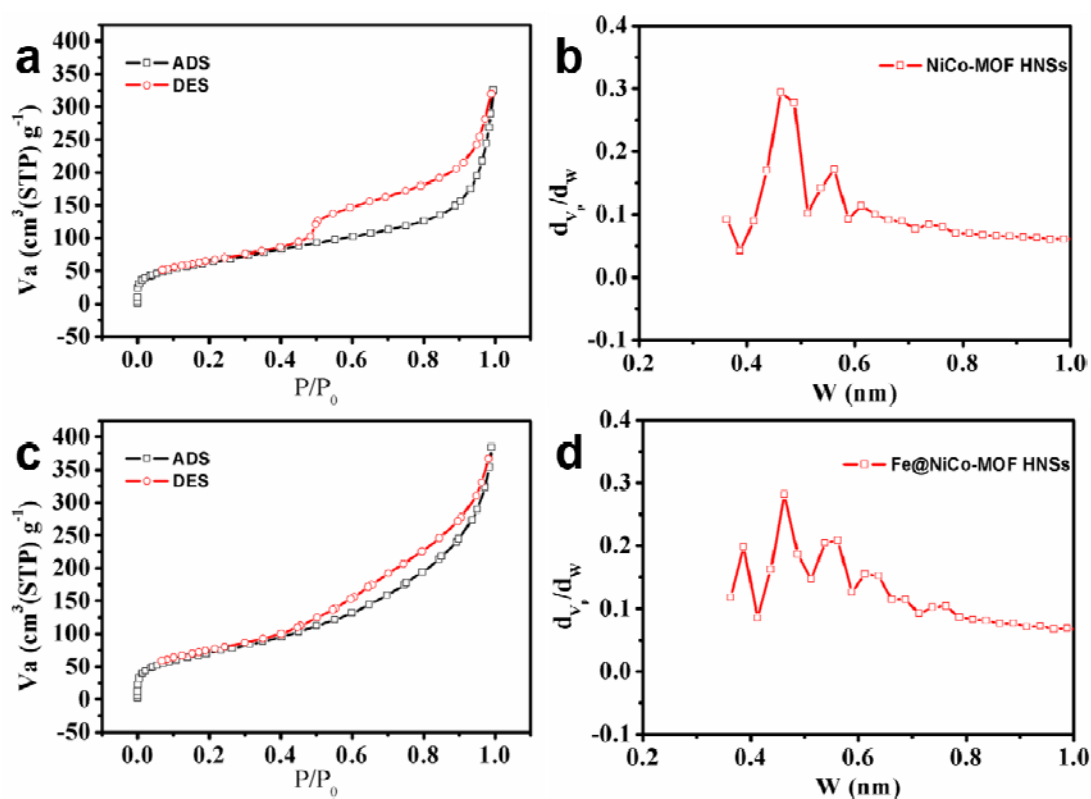


Fig. S7 Nitrogen adsorption-desorption isotherm and the related pore size distribution of a) and b) NiCo-MOF HNSs, c) and d) Fe@NiCo-MOF HNSs.

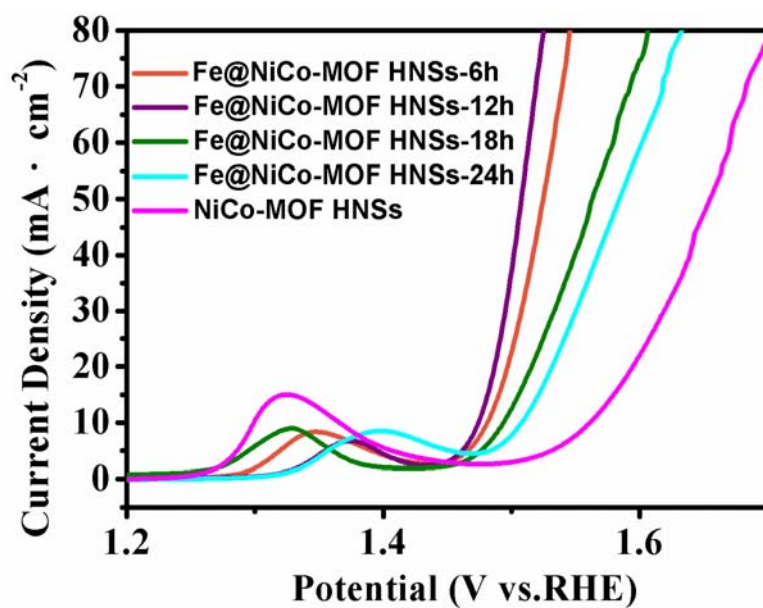


Fig. S8 Linear sweep voltammetry curves toward OER of Fe@NiCo-MOF HNSs with different reaction times.

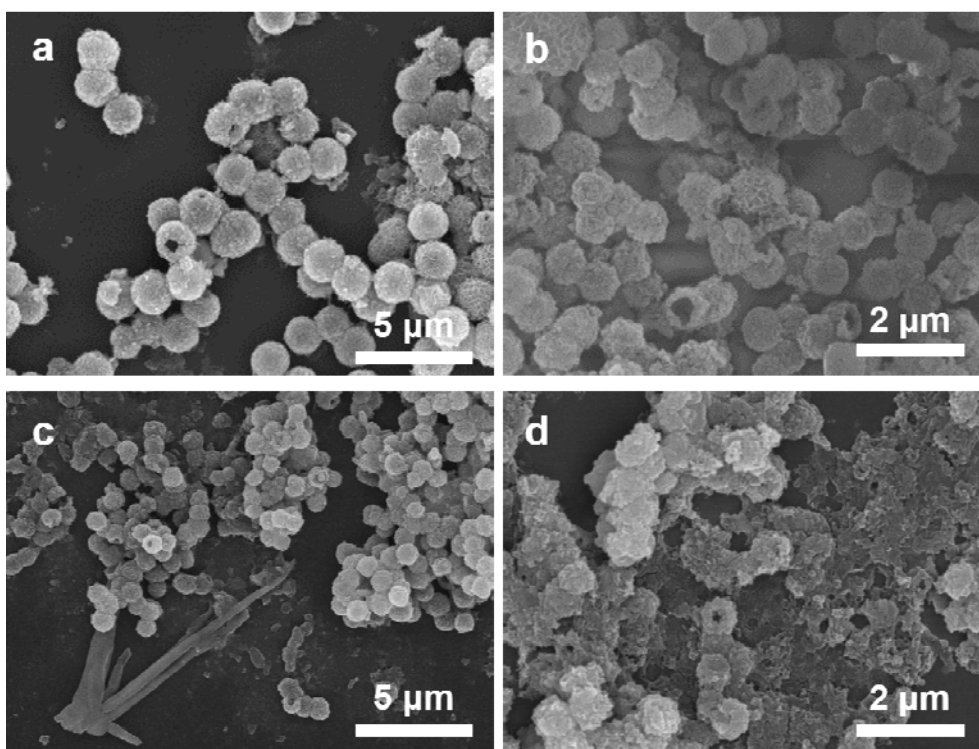


Fig. S9 The SEM images of Fe@NiCo-MOF HNSs with different reaction times: a) 6h, b) 12h, c) 18h, d) 24h.

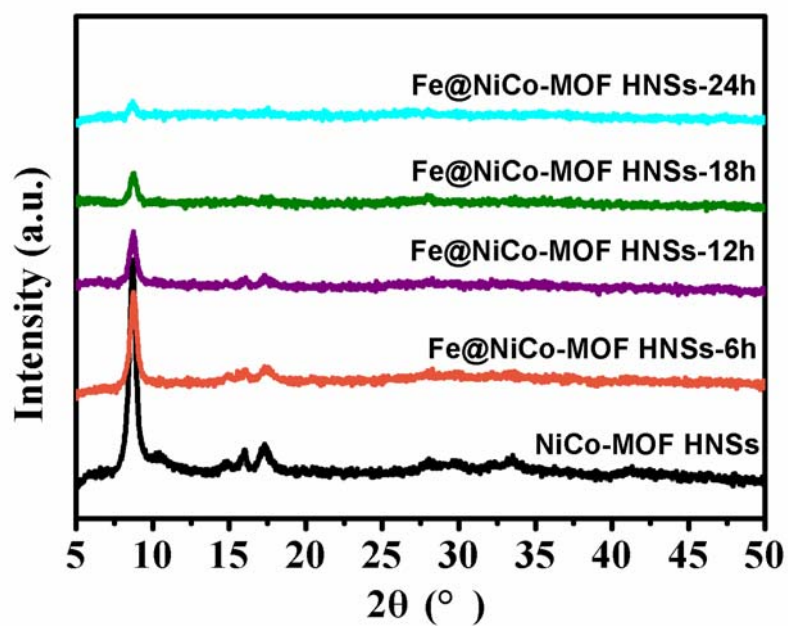


Fig. S10 PXRD patterns of Fe@NiCo-MOF HNSs with different reaction times.

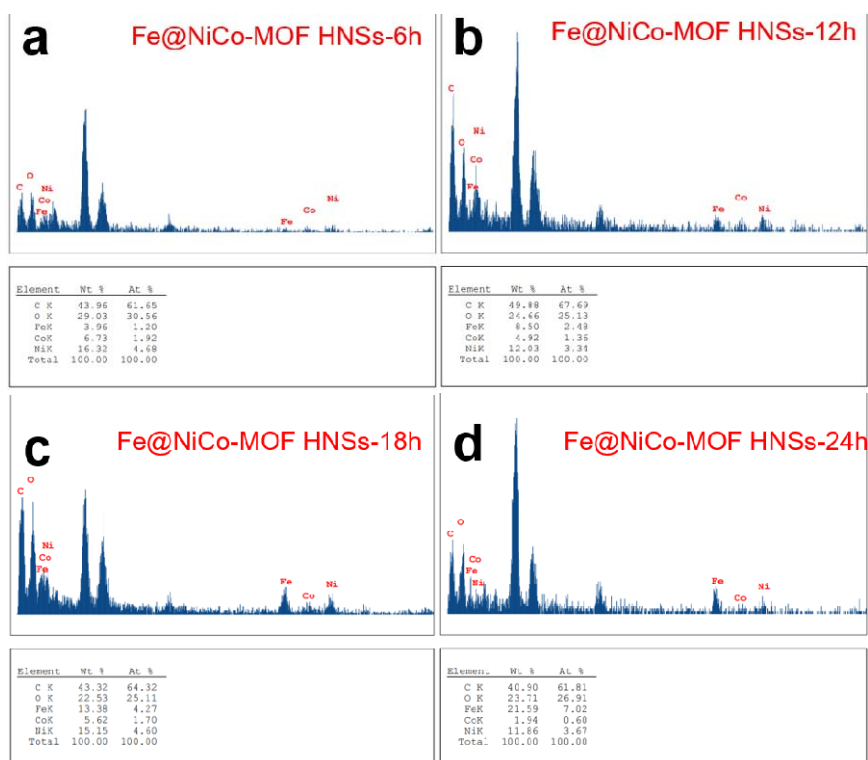


Fig. S11 EDX spectra of Fe@NiCo-MOF HNSs with different reaction times: a) 6h, b) 12h, c) 18h, d) 24h.

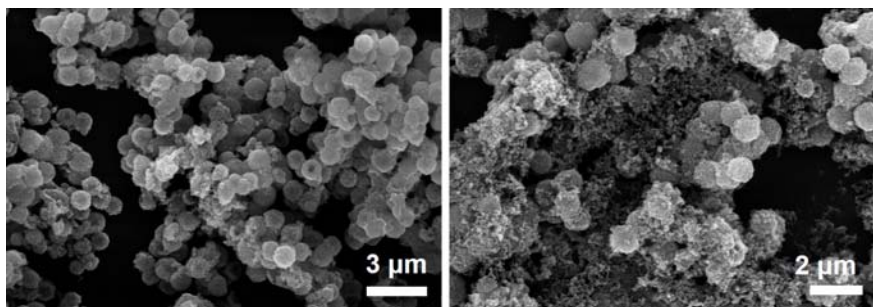


Fig. S12 The SEM images of Fe@NiCo-MOF HNSs after 1000 CVs a) no carbon powder, b) with carbon powder.

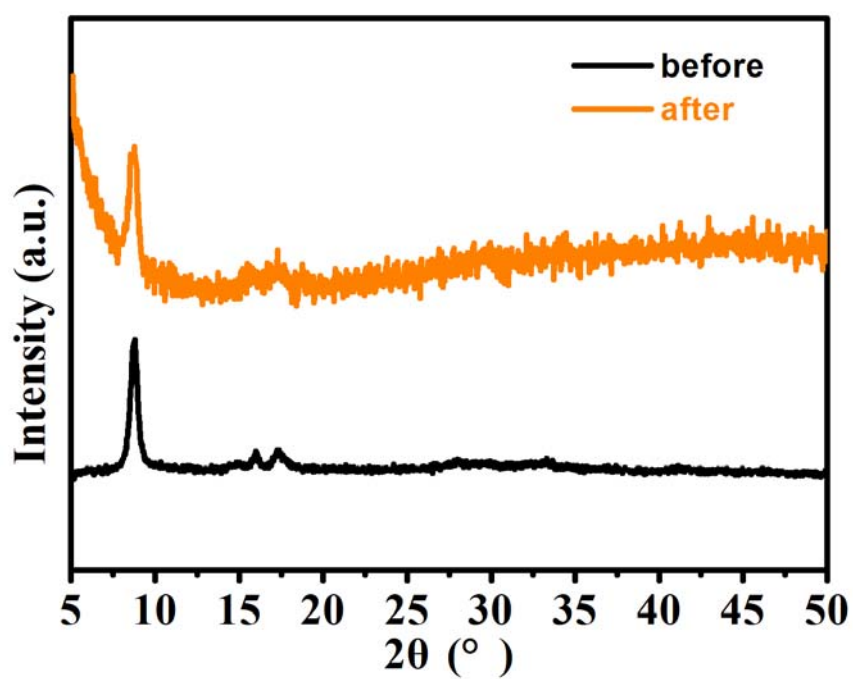


Fig. S13 The PXRD patterns of Fe@NiCo-MOF HNSs before and after 1000 CVs.

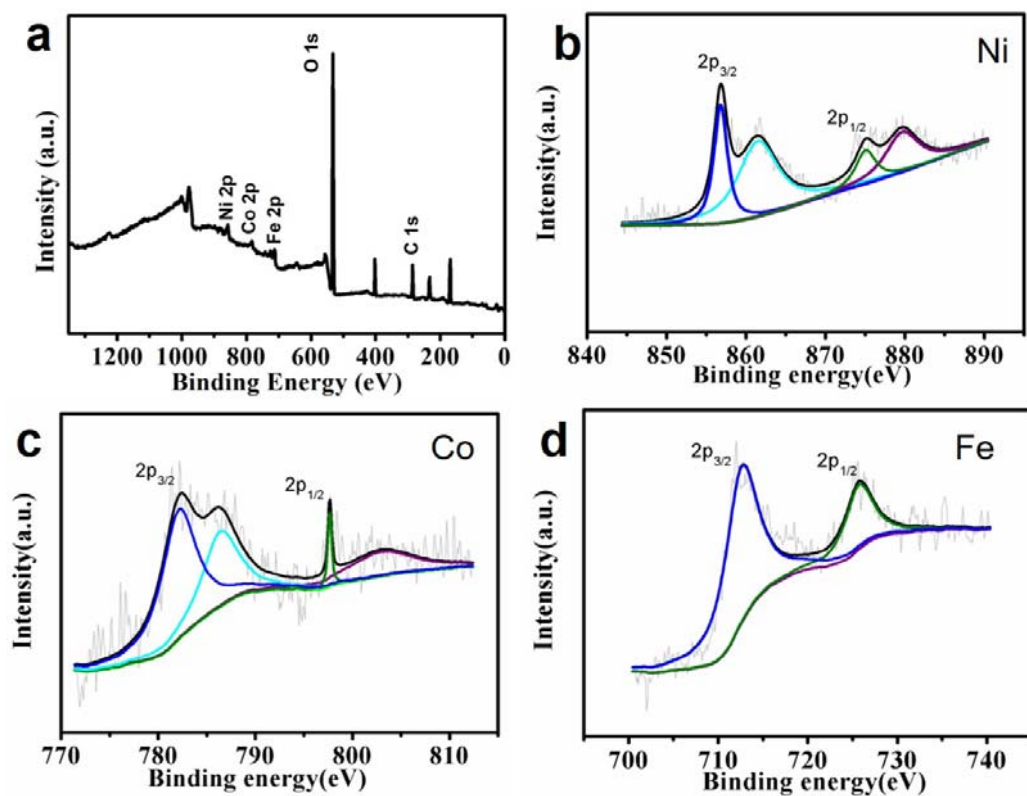


Fig. S14 The XPS spectra: a) XPS survey spectra, b) Ni 2p, c) Co 2p and d) Fe 2p of Fe@NiCo-MOF HNSs after 1000 CVs.

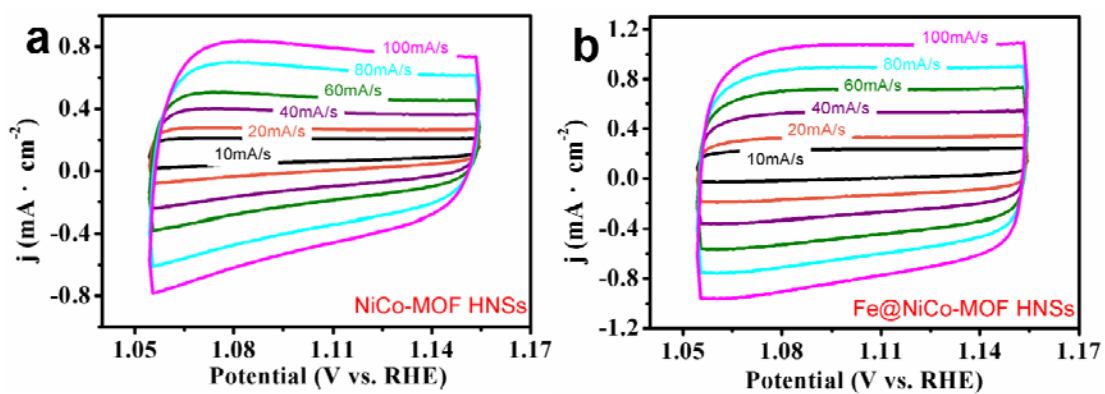


Fig. S15 CV curves in potential range of 1.05–1.15 V vs RHE of a) NiCo-MOF HNSs, b) Fe@NiCo-MOF HNSs.

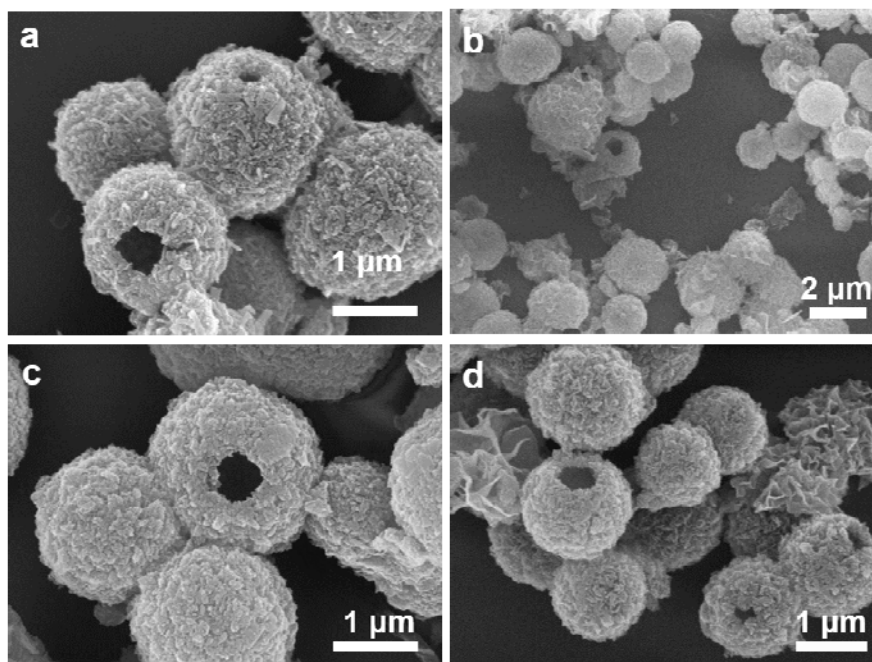


Fig. S16 The SEM images of a) Cu@NiCo-MOF HNSs, b) Zn@NiCo-MOF HNSs, c) Mn@NiCo-MOF HNSs, d) Cr@NiCo-MOF HNSs.

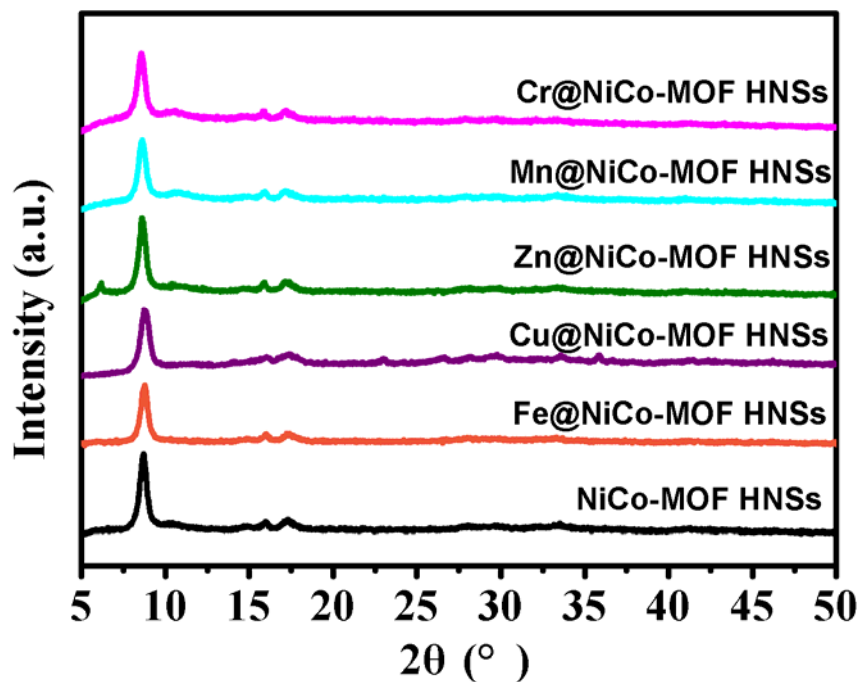


Fig. S17 PXRD patterns of M@NiCo-MOF HNSs (M = Fe, Cu, Zn, Mn, Cr).

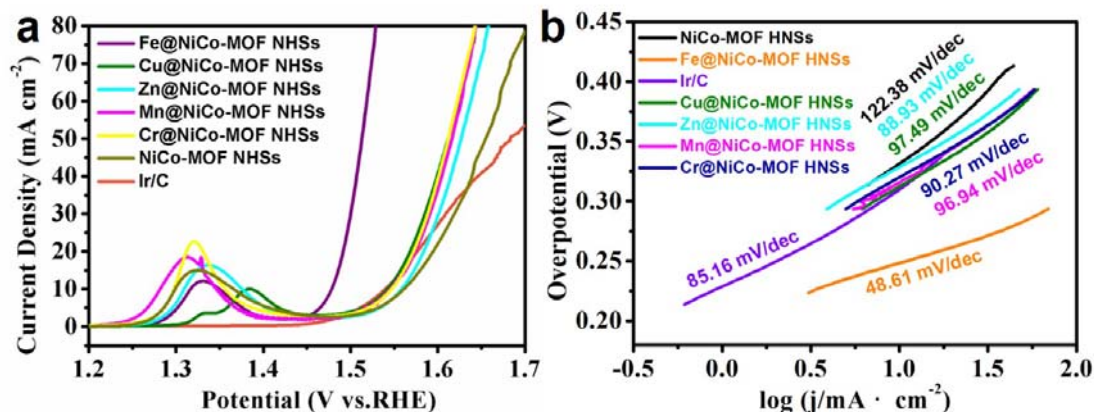


Fig. S18 a) Linear sweep voltammetry curves toward OER and b) Tafel plots of M@NiCo-MOF HNSs (M = Fe, Cu, Zn, Mn, Cr).

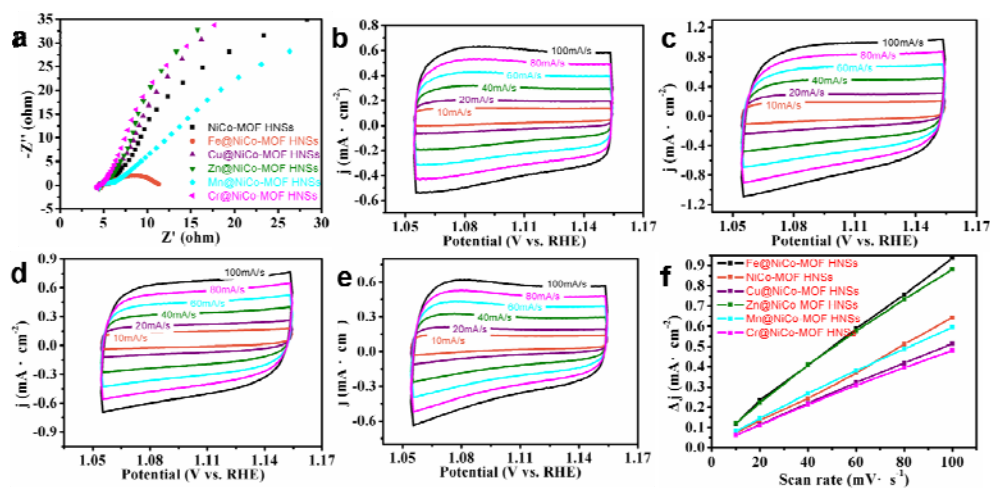


Fig. S19 a) Nyquist plots of M@NiCo-MOF HNSs (M = Fe, Cu, Zn, Mn, Cr), CV curves of b) Cu@NiCo-MOF HNSs, c) Zn@NiCo-MOF HNSs, d) Mn@NiCo-MOF HNSs, e) Cr@NiCo-MOF HNSs and f) Capacitive current plotted against the scan rate.

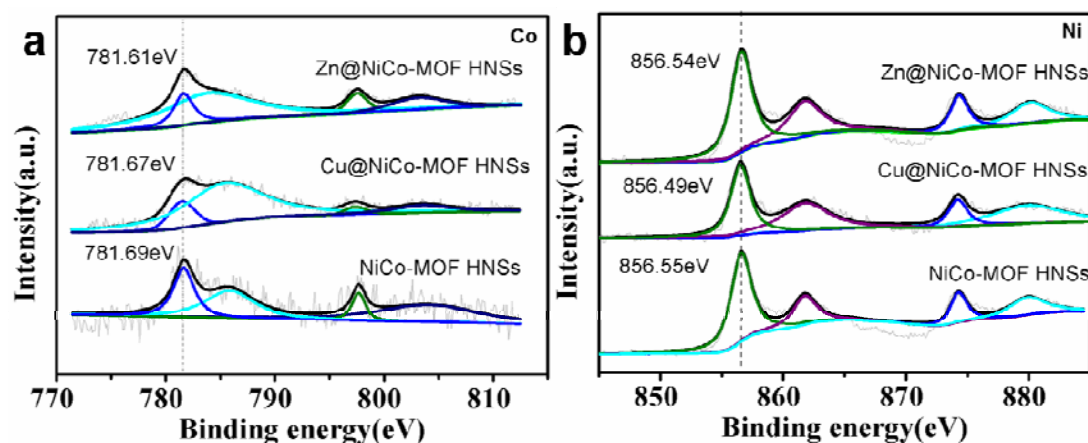


Fig. S20 XPS spectra in a) Ni 2p region and b) Co 2p region of NiCo-MOF HNSs, Cu@NiCo-MOF HNSs and Zn@NiCo-MOF HNSs.

Table S1 Comparison on the OER performances of various transition metal-based electrocatalysts.

Catalysts	Overpotential (mV) at 10 mA cm ⁻²	Tafel slope (mV·dec ⁻¹)	References
Fe@NiCo-MOF HNSs	244	48.61	This work
NiO_x/NiCo₂O₄/Co₃O₄	315	79	<i>Electrochim. Acta.</i> 2019 , 322, 134753
Fe-MOFs@Ni-MOFs	275	56.7	<i>Small.</i> 2019 , 15, 1903410
NiCoFe-MOF-74	270	89	<i>J. Am. Chem. Soc.</i>

			2018 , 140, 15336
Ni-Co-Fe (NCF)-MOF	320	49	<i>Adv. Funct. Mater.</i> 2018 , 28, 1802129
NiCoFeP/C	270	65	<i>Chem. Commun.</i> 2019 , 55, 10896
(Ni₂Co)_{0.925}Fe_{0.075}-M OF-NF	257	41.3	<i>Adv. Mater.</i> 2019 , 1901139

Table S2 The ICP data for the Co, Ni and Fe contents in NiCo-MOF HNSs and Fe@NiCo-MOF HNSs.

Sample	Co (wt%)	Ni (wt%)	Fe (wt%)
NiCo-MOF HNSs	4.66	19.85	--
Fe@NiCo-MOF HNSs	4.76	15.36	11.70

Table S3 TOF values of the catalysts at overpotentials of 240, 260, 300 and 360 mV.

TOF s⁻¹ Samples	$\eta=240\text{mV}$	$\eta=260\text{mV}$	$\eta=300\text{mV}$	$\eta=360\text{mV}$
NiCo-MOF HNSs	6.36×10^{-3}	6.60×10^{-3}	1.19×10^{-2}	4.48×10^{-2}
Fe@NiCo-MOF HNSs	1.47×10^{-2}	4.40×10^{-2}	1.65×10^{-1}	3.56×10^{-1}
Cu@NiCo-MOF HNSs	5.96×10^{-3}	6.84×10^{-3}	1.43×10^{-2}	6.58×10^{-2}
Zn@NiCo-MOF HNSs	4.34×10^{-3}	4.54×10^{-3}	8.38×10^{-3}	4.29×10^{-2}
Mn@NiCo-MOF HNSs	5.12×10^{-3}	7.08×10^{-3}	1.45×10^{-2}	7.12×10^{-2}
Cr@NiCo-MOF HNSs	7.16×10^{-3}	7.94×10^{-3}	1.65×10^{-2}	8.16×10^{-2}