

Supporting Figures

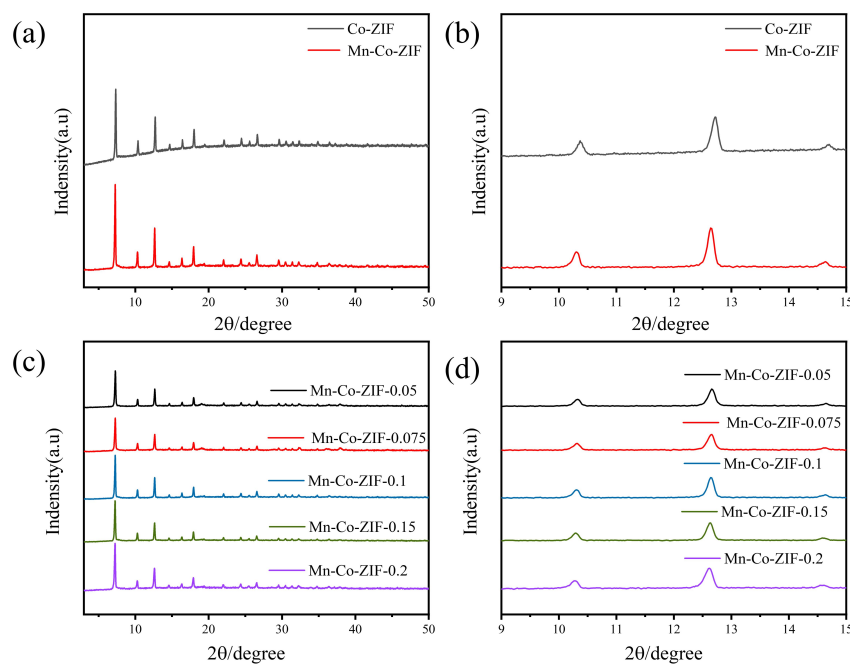


Figure S1 (a-d) XRD patterns of Co-ZIF, Mn-Co-ZIF-0.05, Mn-Co-ZIF-0.075, Mn-Co-ZIF, Mn-Co-ZIF-0.15 and Mn-Co-ZIF-0.2

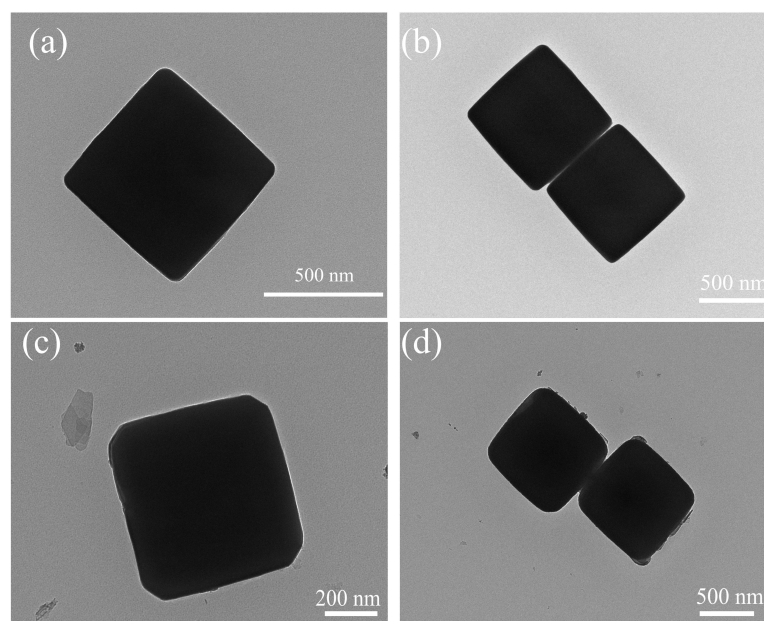


Figure S2 (a, b) TEM images of Co-ZIF precursor; (c, d) TEM images of Mn-Co-ZIF precursor

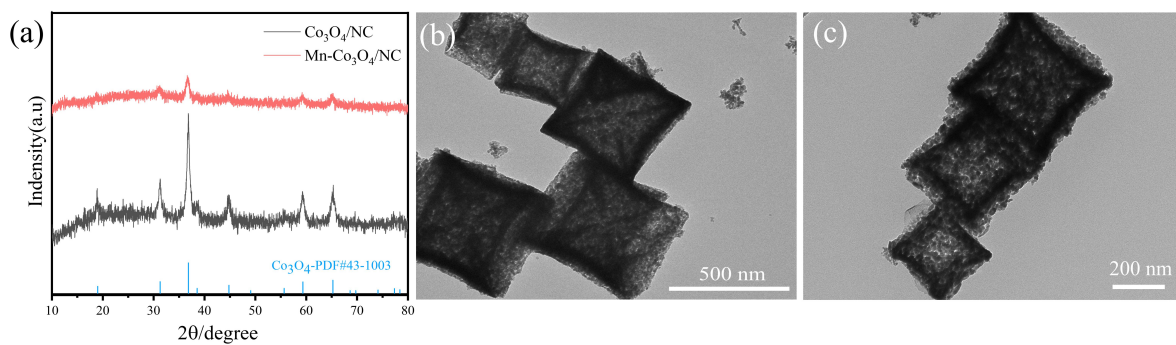


Figure S3 (a) XRD pattern of $\text{Co}_3\text{O}_4/\text{NC}$ and $\text{Mn-Co}_3\text{O}_4/\text{NC}$; (b) TEM image of $\text{Co}_3\text{O}_4/\text{NC}$; (c) TEM image of $\text{Mn-Co}_3\text{O}_4/\text{NC}$

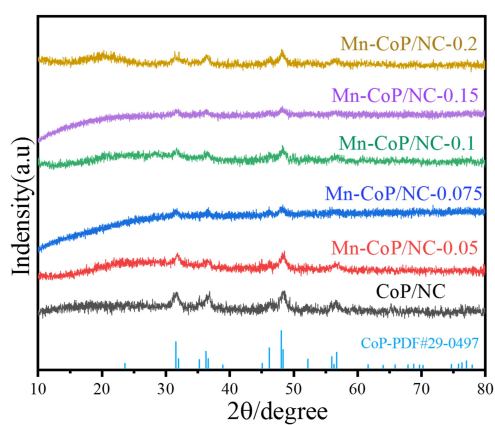


Figure S4 XRD pattern of Mn-CoP/NC with different Mn doping amounts

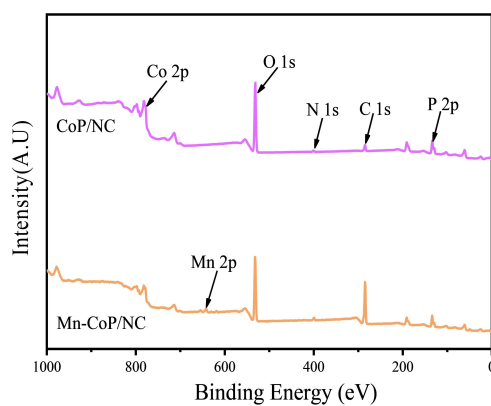


Figure S5 XPS survey spectrum of CoP/NC and Mn-CoP/NC

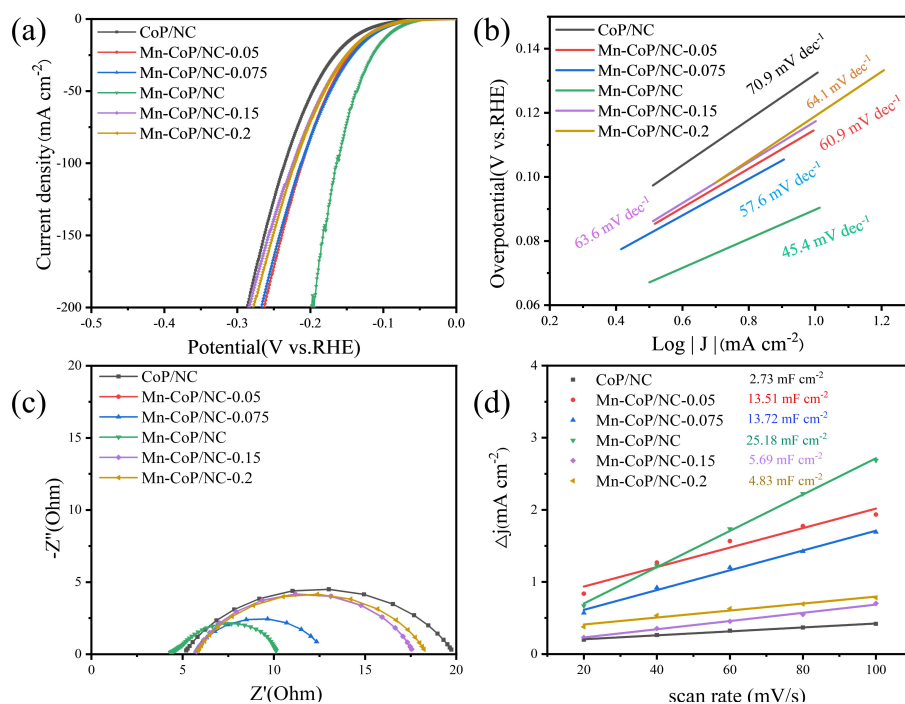


Figure S6 HER performance of Mn-CoP/NC with different Mn doping in 1M KOH. (a) LSV curves; (b) Tafel plots; (c) EIS plots; (d) C_{dl} values observed from CV plots at a scan rate from 20 to 100 mV s⁻¹

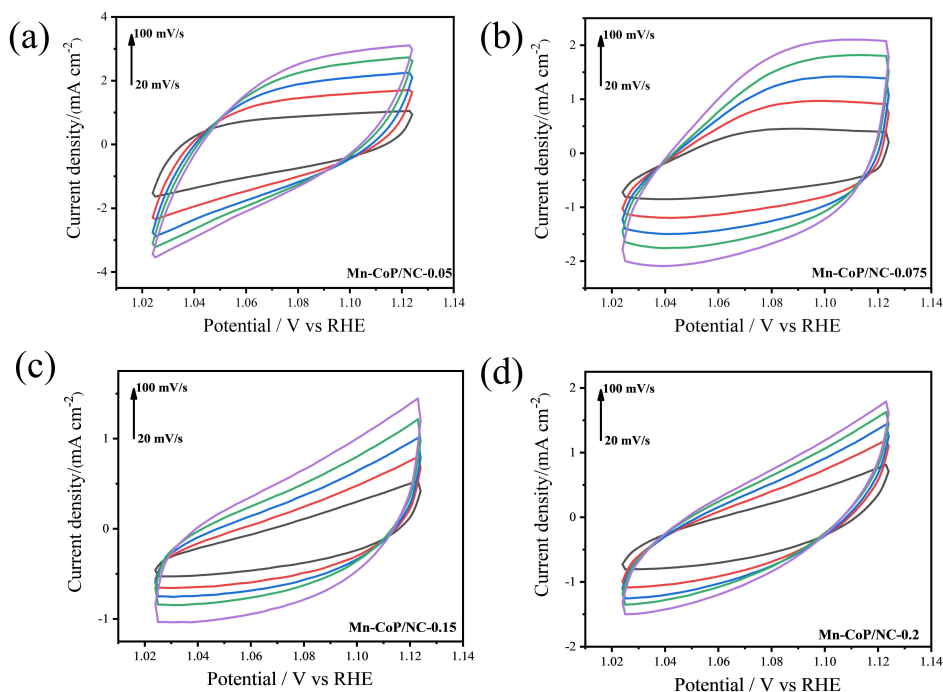


Figure S7 Cyclic voltammetry profiles of (a) Mn-CoP/NC-0.05; (b) Mn-CoP/NC-0.075; (c) Mn-CoP/NC-0.15; (d) Mn-CoP/NC-0.2 the scan rates of 20-100 mV s⁻¹ in 1M KOH

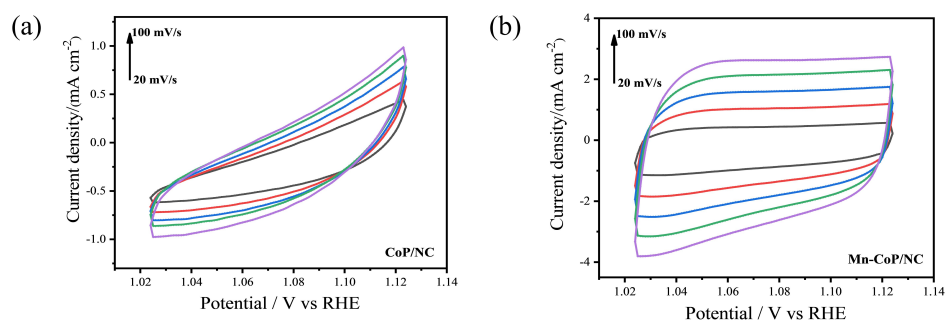


Figure S8 Cyclic voltammetry profiles of (a) CoP/NC; (b) Mn-CoP/NC with the scan rates of 20-100 mV s^{-1} in 1M KOH for HER

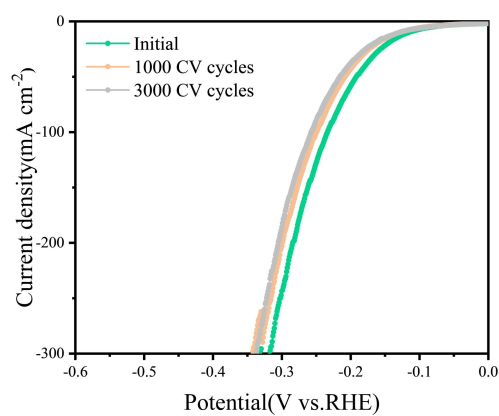


Figure S9 LSV curves test of Mn-CoP/NC after initial, 1000 and 3000 CV cycles under alkaline HER conditions

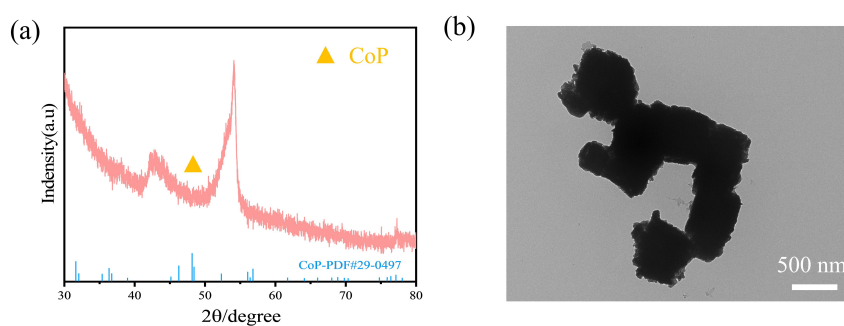


Figure S10 (a) XRD pattern and (b) TEM image of Mn-CoP/NC catalyst after alkaline HER stability test

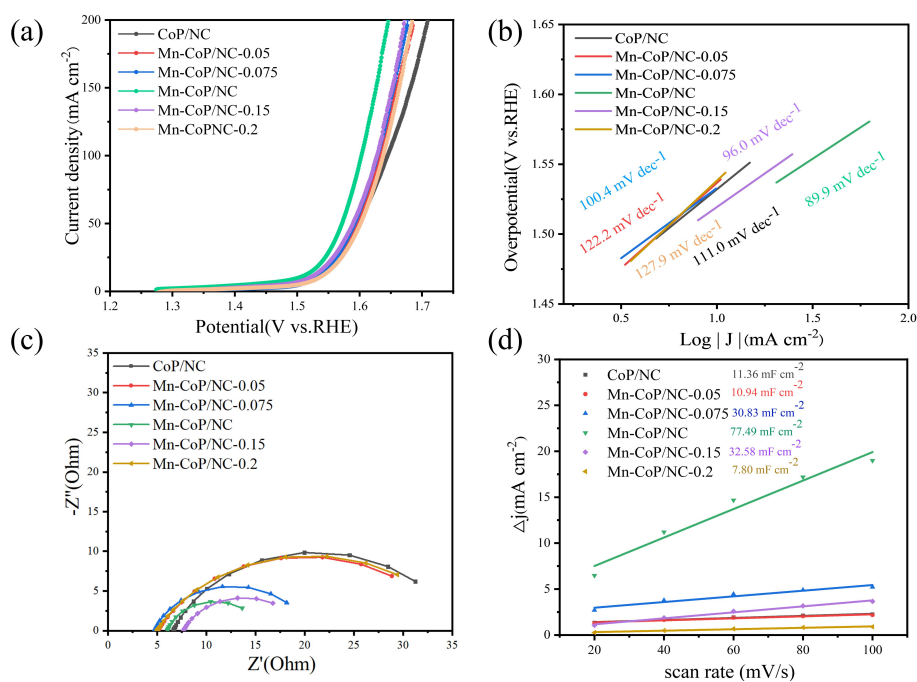


Figure S11 OER performance of Mn-CoP/NC with different Mn doping in 1M KOH. (a) LSV curves; (b) Tafel plots; (c) EIS plots; (d) C_{dl} values observed from CV plots at a scan rate from 20 to 100 mV s^{-1}

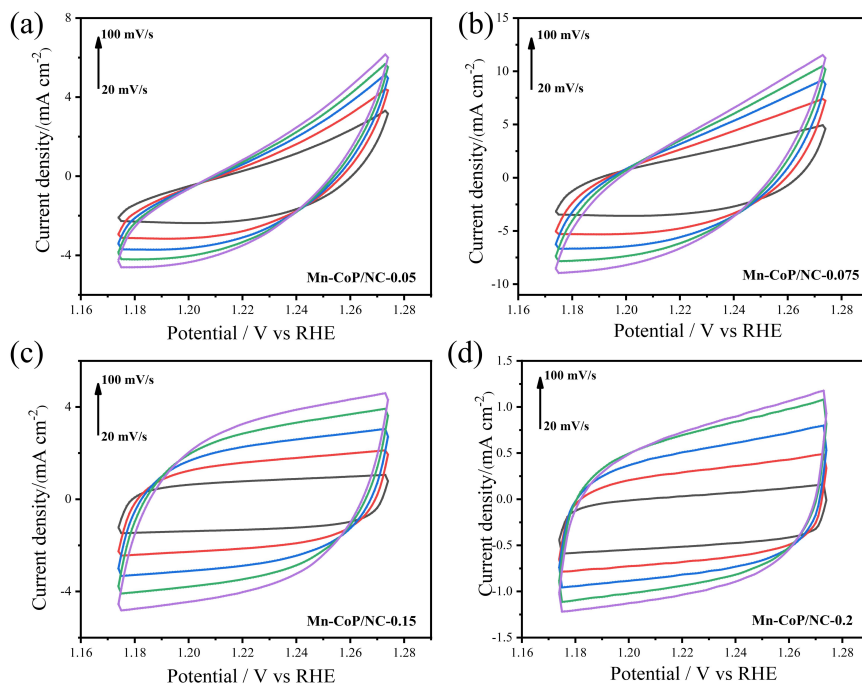


Figure S12 Cyclic voltammetry profiles of (a) Mn-CoP/NC-0.05; (b) Mn-CoP/NC-0.075; (c) Mn-CoP/NC-0.15; (d) Mn-CoP/NC-0.2 with the scan rates of 20-100 mV s^{-1} in 1M KOH for OER

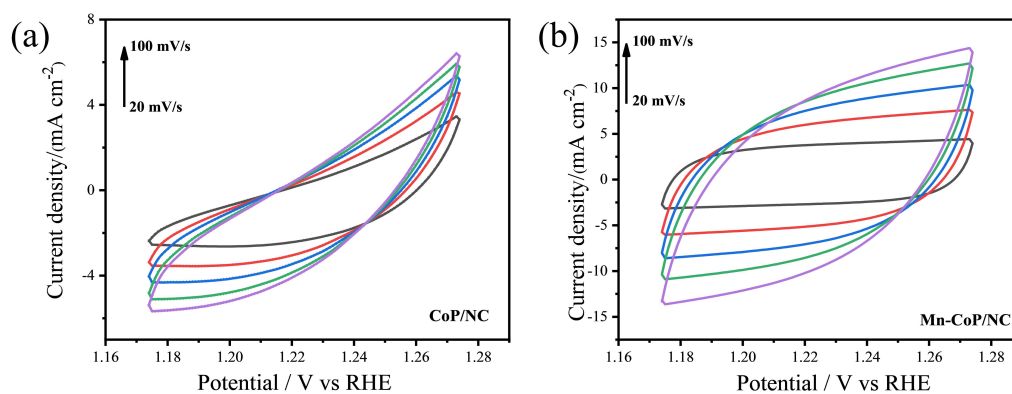


Figure S13 Cyclic voltammetry profiles of (a) CoP/NC; (b) Mn-CoP/NC with the scan rates of 20-100 mV s^{-1} in 1M KOH for OER

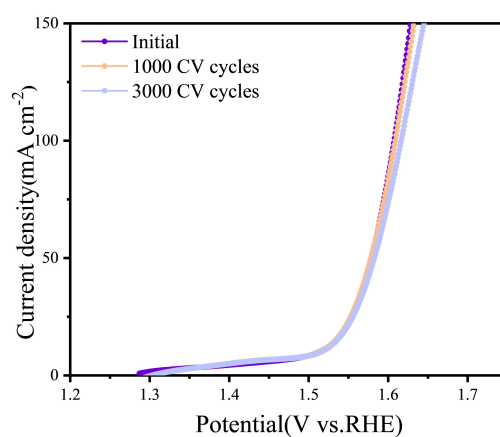


Figure S14 LSV curves test of Mn-CoP/NC after initial, 1000 and 3000 CV cycles under alkaline OER conditions

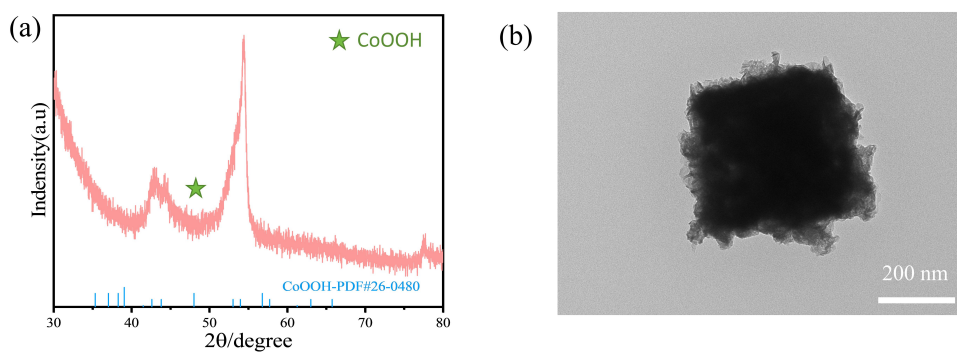


Figure S15 (a) XRD pattern and (b) TEM image of Mn-CoP/NC catalyst after alkaline OER stability test

Table S1 Summary of HER performance of Mn-CoP/NC with different Mn doping in 1M KOH

	Overpotential (η 10) (mV)	Overpotential (η 100) (mV)	Tafel Slope (mV dec ⁻¹)	C _{dl} (mF cm ⁻²)
CoP/NC	132	235	70.9	2.73
Mn-CoP/NC-0.05	115	212	60.9	13.51
Mn-CoP/NC-0.075	113	213	57.6	13.72
Mn-CoP/NC	90	164	45.4	25.18
Mn-CoP/NC-0.15	118	223	63.6	5.69
Mn-CoP/NC-0.2	119	221	64.1	4.83

Table S2 Summary of OER performance of Mn-CoP/NC with different Mn doping in 1M KOH

	Overpotential (η 10) (mV)	Overpotential (η 100) (mV)	Tafel Slope (mV dec ⁻¹)	C _{dl} (mF cm ⁻²)
CoP/NC	303	415	111.0	11.36
Mn-CoP/NC-0.05	302	402	122.2	10.94
Mn-CoP/NC-0.075	301	398	100.4	30.83
Mn-CoP/NC	272	373	89.9	77.49
Mn-CoP/NC-0.15	290	398	96.0	32.58
Mn-CoP/NC-0.2	305	408	127.9	7.80

Table S3 Comparison of the HER performance of Mn-CoP/NC with the reaction performance of other non-precious metal electrocatalysts in 1 M KOH

Catalysts	Overpotential (mV)	Reference
Mn-CoP/NC	η 10 (90)	This work
CeO ₂ -LDH/Ni ₃ S ₂ /MoS ₂	η 10 (116)	<i>Materials.</i> , 2024, (17) , 4876.
CdS-V ₂ O ₅ /g-C ₃ N ₄	η 10 (202)	<i>Fuel.</i> , 2025, (385) , 134100.
FeP/Fe ₃ C@NPC	η 10 (97)	<i>ACS Omega.</i> , 2022, (7) , 13687–13696.
BiO ₅ :NiO	η 10 (171)	<i>ACS Appl Mater Inter.</i> , 2025, (17) , 11946–11955.
Co ₂ C-NiTe	η 10 (227)	<i>Fuel.</i> , 2024, (375) , 132445.
Co ₃ O ₄ @NiFe-LDH-120/NF	η 10 (79)	<i>J Alloy Compd.</i> , 2022, (919) , 165877.
Ni/Mo _x C/NC-100	η 10 (162)	<i>ACS Appl Mater Inter.</i> , 2018, (10) , 35025–35038.
Mo-CoSe ₂ /CC	η 10 (85)	<i>Chinese Chemical Letters.</i> , 2023, (34) , 107364.
Fe _{0.2} -NiMo	η 10 (85)	<i>Fuel.</i> , 2025, (381) , 133302.
FeMo@CoNi-OH/Ni ₃ S ₂	η 10 (89)	<i>Chem Eng J.</i> , 2023, (468) , 143605.

Table S4 Comparison of the OER performance of Mn-CoP/NC with the reaction performance of other non-precious metal electrocatalysts in 1 M KOH

Catalysts	Overpotential (mV)	Reference
Mn-CoP/NC	η 10 (272)	This work
Fe-Co ₃ O ₄ /NF	η 10 (290)	<i>Molecules.</i> , 2025, (30) , 1046.
Ni ₃ N-NiMoN-5	η 10 (277)	<i>Nano Energy.</i> , 2018, (44) , 353-363.
Co ₃ Fe ₇ /Mo ₂ C	η 10 (257)	<i>Colloid Surfaces A.</i> , 2022, (645) , 128953.
Co ₂ FeO ₄ @PdO	η 10 (259)	<i>Int J hydrogen energy.</i> , 2023, (48) , 19494e19508.
C@NiCo12	η 10 (320)	<i>J Alloys Compd.</i> , 2021, (889) , 161528.
ZrTe-Mn ₂ O ₃	η 10 (244)	<i>Fuel.</i> , 2025, (381) , 133197.
FeCoP/C	η 10 (282)	<i>Colloid Surfaces A.</i> , 2022, (635) , 128118.
Ni@NCS-800	η 10 (330)	<i>Appl Surf Sci.</i> , 2023, (616) , 156499.
Ni _{1.5} Co _{1.5} P/MFs	η 10 (314)	<i>Inte J hydrogen energy.</i> , 2021, (46) , 29889e29895.
Fe-Co-O/Co@NC-mNS/NF	η 10 (257)	<i>Small.</i> , 2021, (17) , 2101312.

Table S5 Comparison of this work with other reported overall hydrolysis performance of catalysts in 1 M KOH

Catalysts	E ₁₀ (V) 10 mA cm ⁻²	Reference
Mn-CoP/NC	1.66	This work
Cr-Cu ₂ S@CF	1.75	<i>Int J Hydrogen Energy.</i> , 2024, (49) , 1113-1122.
Co-N/GF-900	1.68	<i>ACS Catal.</i> , 2018, (8) , 4637-4644.
E-Co-Mo-CNTs/rGO-CF	1.52	<i>Nano technology.</i> , 2022, (33) , 065704.
Co-Fe(1/1)-Se/CC	1.68	<i>Materials Chemistry and Physics.</i> , 2022, (275) , 125201.
Fe-Ni ₃ S ₂ /MoO _x -0.5	1.50	<i>ACB.</i> , 2024, (353) , 124100.
Co ₂ P/Fe ₂ P	1.56	<i>ACS Appl Mater Inter.</i> , 2024, (16) , 13795-13805.
Co ₃ S ₄ /MoS ₂	1.66	<i>Inorg Chem Front.</i> , 2022, (9) , 2139-2149.
FeCoNbS	1.61	<i>J Colloid Interf Sci.</i> , 2023, (638) , 893-900.
Co-Ni-S/NF	1.59	<i>J Alloy Compd.</i> , 2023, (965) , 171124.
Co@N-CNTF	1.71	<i>J Mater Chem A.</i> , 2019, (7) , 3664-3672.