Supporting Information

Highly active and durable NiMoCuCo catalyst with moderated hydroxide adsorption energy for efficient hydrogen evolution reaction in alkaline media

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Keywords: ternary transition metal, water electrolysis, hydrogen evolution reaction, water dissociation, metal dissolution

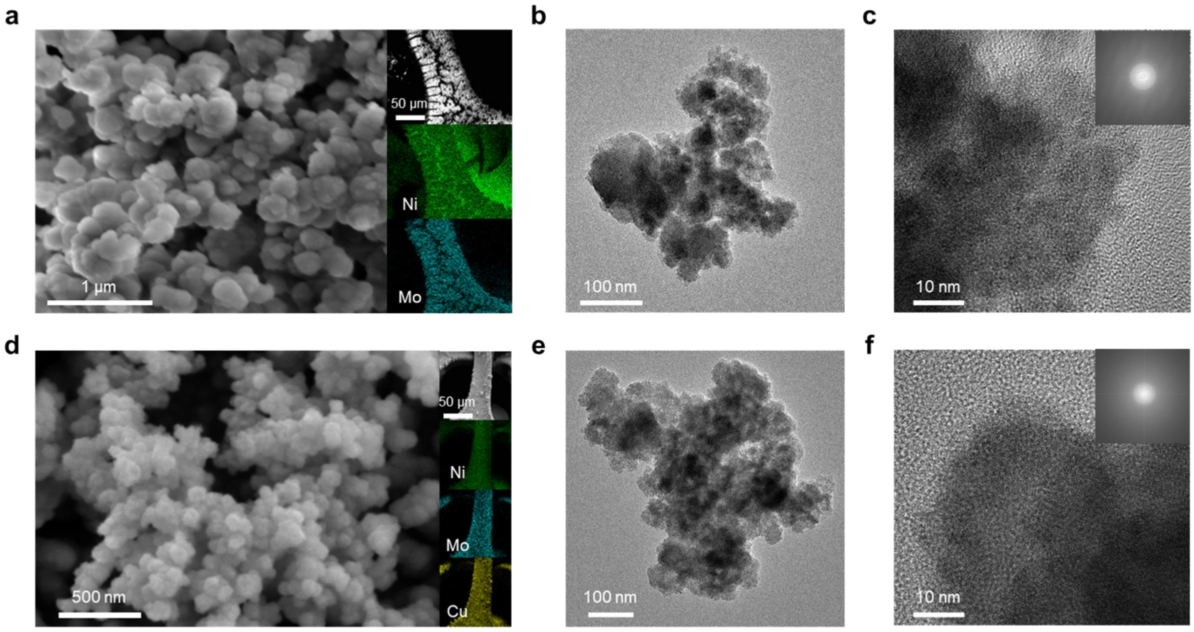

Fig. S1 (a) FE-SEM (left) and EDS (right) images of NiMo. (b) FE-TEM and (c) high-resolution TEM images of NiMo. The inset shows a fast Fourier transform image. (d) FE-SEM (left) and EDS (right) images of NiMoCu. (e) FE-TEM and f) high-resolution TEM images of NiMoCu. The inset shows a fast Fourier transform image.

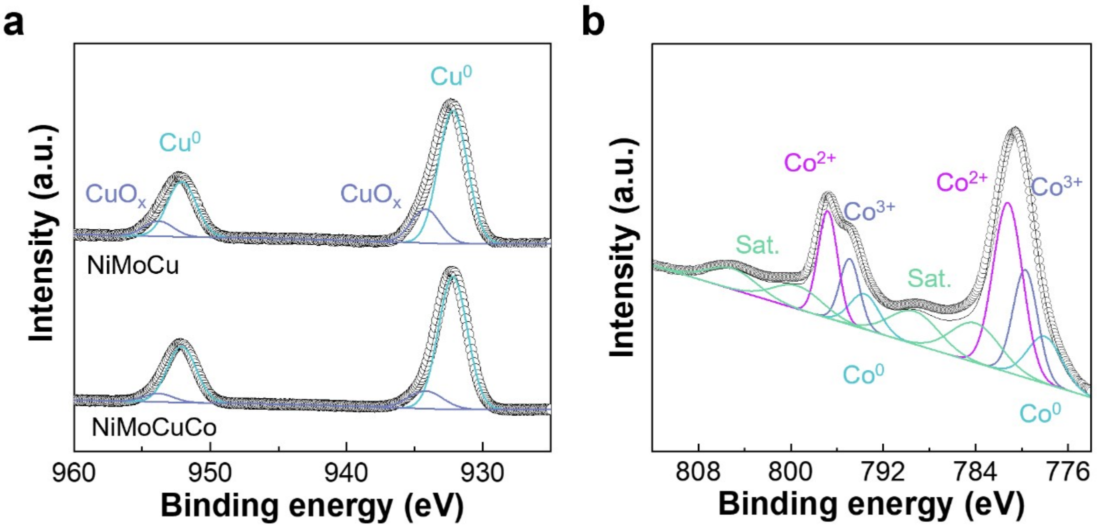

Fig. S2 XPS spectra of the prepared electrocatalysts in (a) Cu 2*p* and (b) Co 2*p* regions.

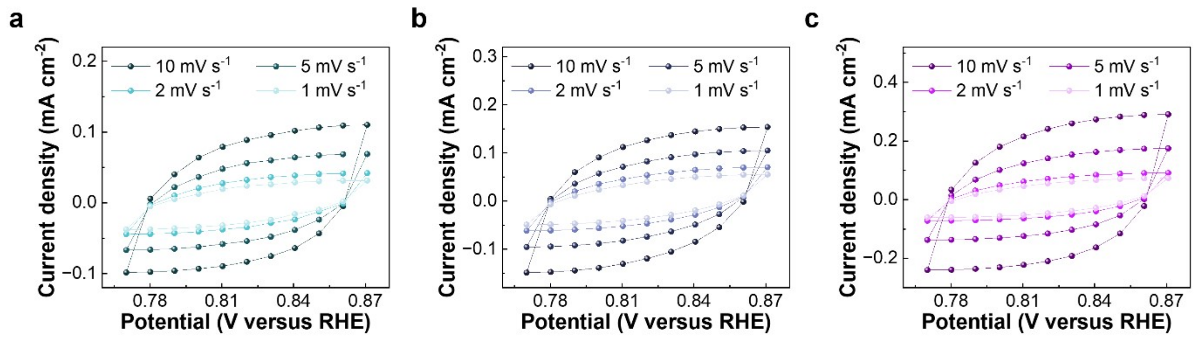

Fig. S3 Cyclic voltammetry curves of (a) NiMo, (b) NiMoCu, and (c) NiMoCuCo.

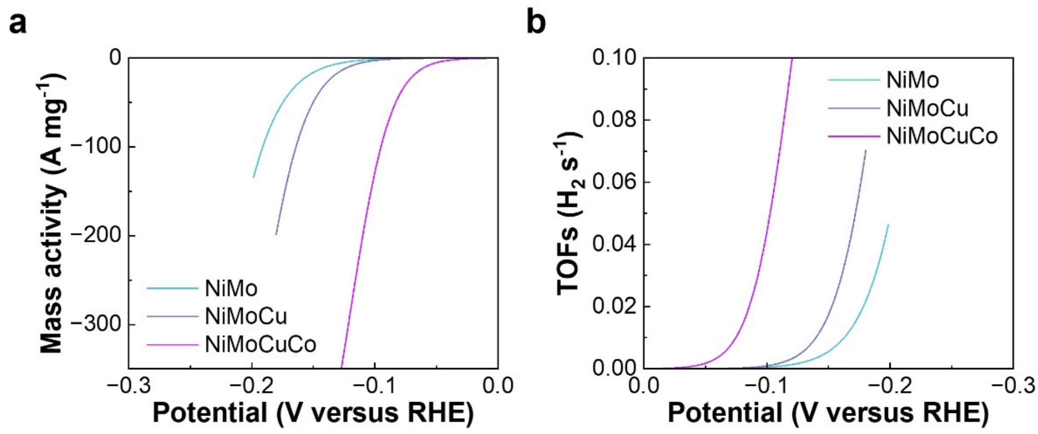

Fig. S4 Polarization curves normalized by (a) loading mass and (b) turnover frequency.

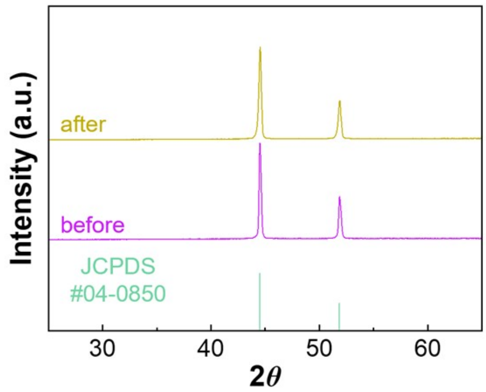

Fig. S5 XRD patterns of NiMoCuCo before and after the long-term stability test.

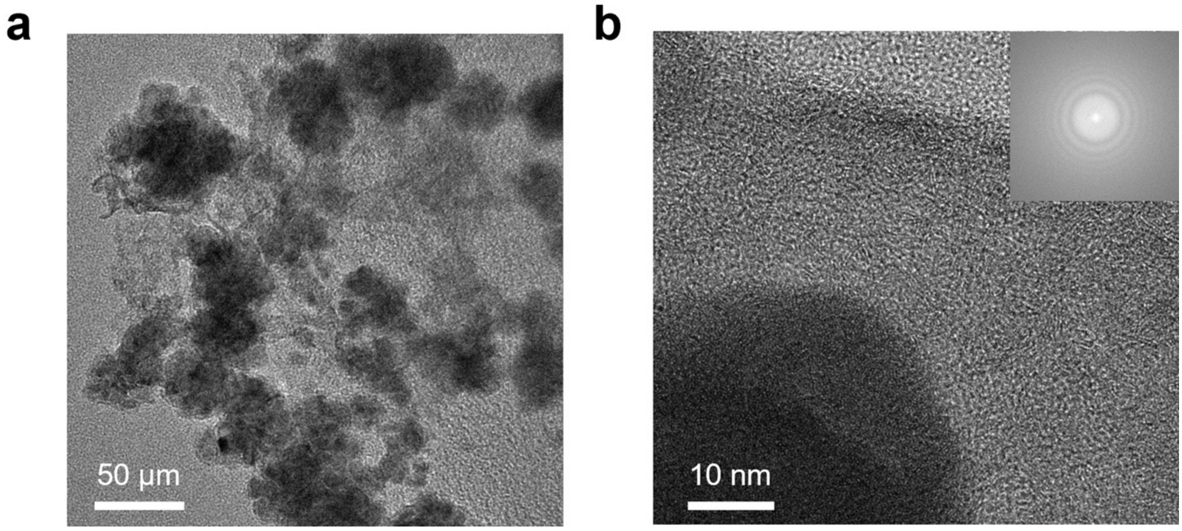

Fig. S6 (a) FE-TEM and (b) high-resolution TEM images of NiMoCuCo after the long-term stability test. The inset shows a fast Fourier transform image.

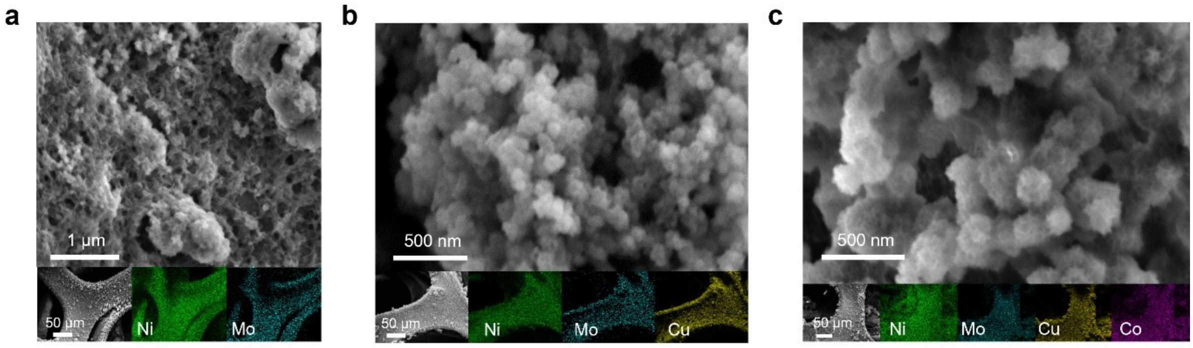

Fig. S7 FE-SEM (top) and EDS (bottom) images of (a) NiMo, (b) NiMoCu, and (c) NiMoCuCo.

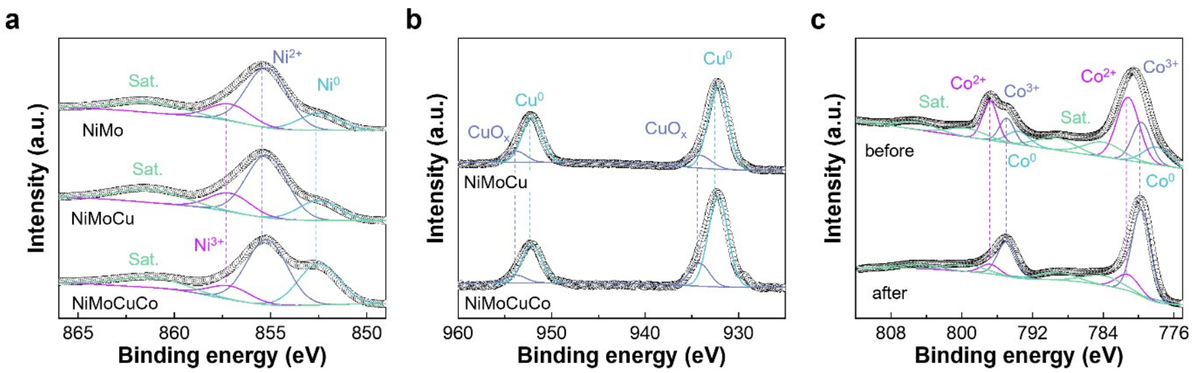

Fig. S8 XPS spectra of the long-term stability tested electrocatalysts in (a) Ni 2*p*, (b) Cu 2*p*, and (c) Co 2*p* regions.

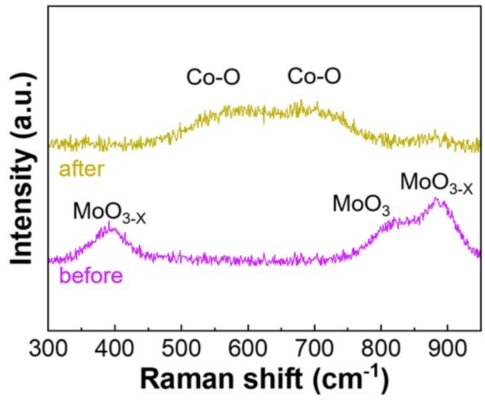

Fig. S9 Raman spectra of NiMoCuCo before and after the long-term stability test.

Table S1 Comparative analysis of the recently studied alkaline HER electrocatalysts with respect to the catalytic performance at a current density of 10 mA cm^{-2}.

Catalysts	Electrode	Overpotential (mV)	Tafel slope (mV dec^{-}	Stability Condition	Stability time (h)	Ref.
NiMoCuCo	Ni foam	53	34.2	100 mA cm^{-2}	100	This work
VNMS	Graphite rod	122	57	−0.17 V versus RHE	10	1
Pt/NiRu-LDH	Ni foam	38	39	−0.075 V versus RHE	30	2
Se-MoS_2/$CoSe_2$	Ni foam	30	44	100 mA cm^{-2}	40	3
$RhSe_2$	Glassy carbon	81.6	96	10,000 cycle	-	4
O-NiCu	Iron foam	23	34.1	10 mA cm^{-2}	100	5
FeCoNiCuPd	Carbon cloth	29.7	47.2	100 mA cm^{-2}	36	6
Mo-NiS/Ni_3S_2-0.08S	Ni foam	73	115.7	1,000 cycle	-	7
MoS_2-MoP/NC	Carbon cloth	35	30	10,000 cycle	-	8
6B-Fe_7S_8/FeS_2/CC	Carbon cloth	113	57.4	1,000 cycle	-	9
NiP_2-650 (c/m)	Carbon cloth	134	67	50 mA cm^{-2}	14	10
CeO_2/CoS_2/Ti	Ti plate	36	38	40 mA cm^{-2}	1,000	11
1‰Pt-NiCoP@Mxene	Carbon cloth	26.5	38.6	500 mA cm^{-2}	3,000	12
RRu-Ru_2P	Glassy carbon	95	31.99	1,000 mA cm^{-2}	1,000	13
NiVB@rGO	Glassy	196	88	Not	12	14

	carbon			mentioned		
Ni_2Cr_1-LDH	Nickel foam	138	61.5	-0.07 V versus RHE	30	15

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