Supporting Information

Dual-Electrocatalysis Behavior of Star-like Zinc-Cobalt-Sulfide Decorated with Cobalt-Molybdenum-Phosphide in Hydrogen and Oxygen Evolution Reactions

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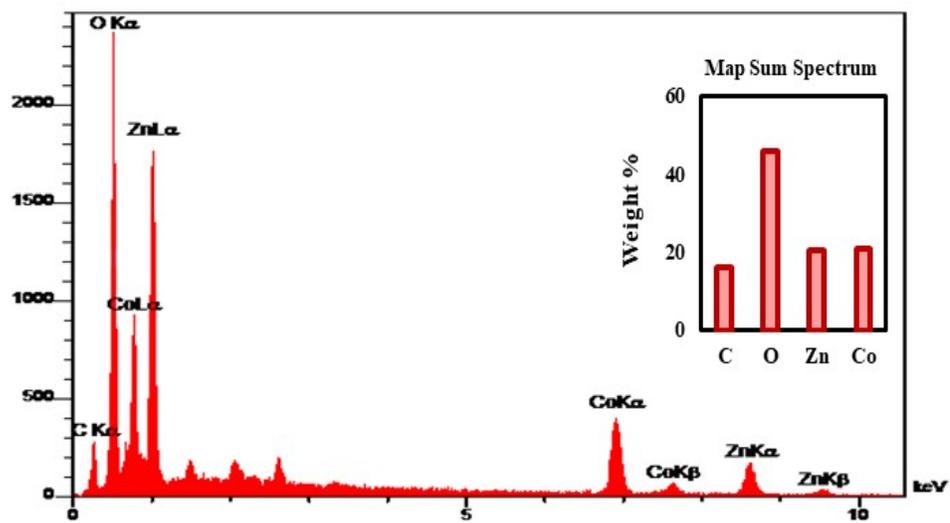
Figure S1. Energy-dispersive X-ray of the Zn-Co precursor.
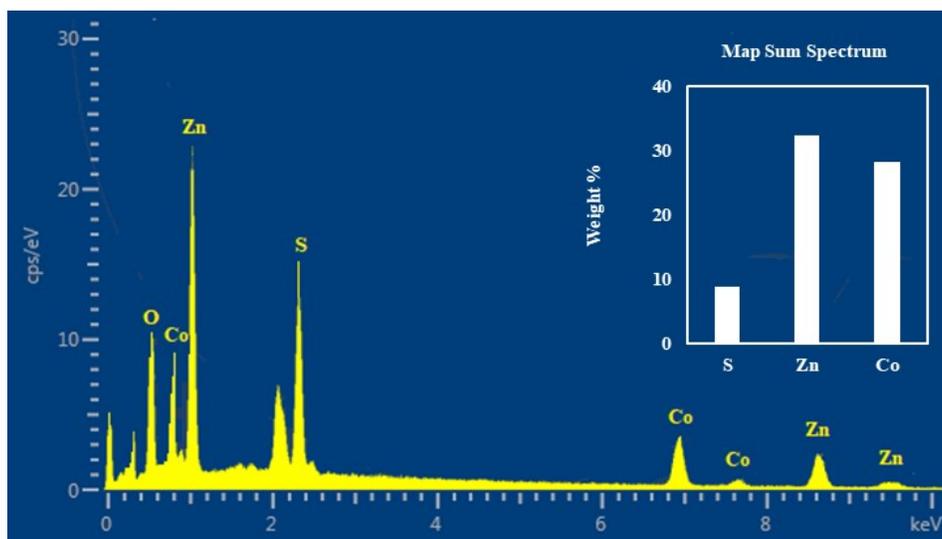
Figure S2. Energy-dispersive X-ray of the Zn-Co-S.
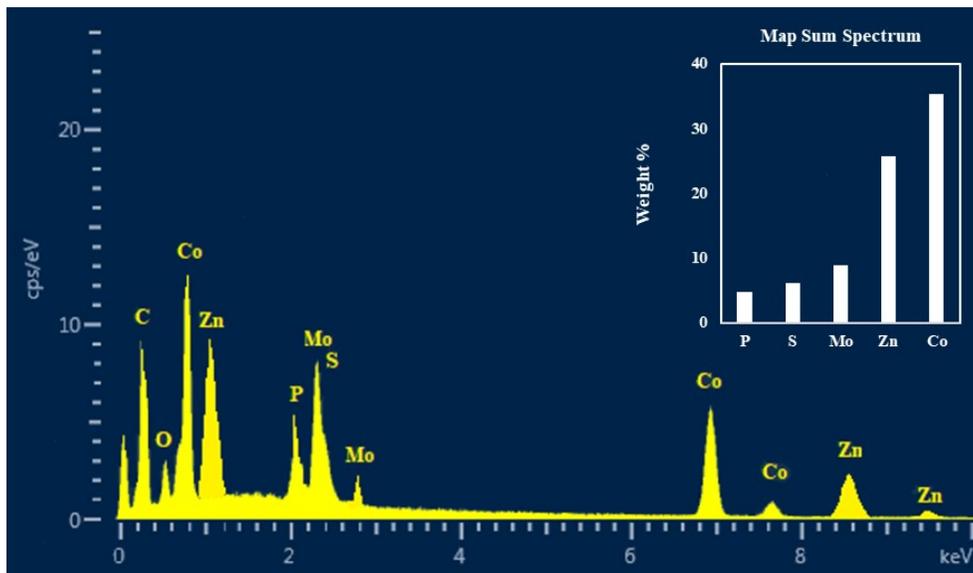
Figure S3. Energy-dispersive X-ray of the Co-Mo-P (3)/Zn-Co-S.
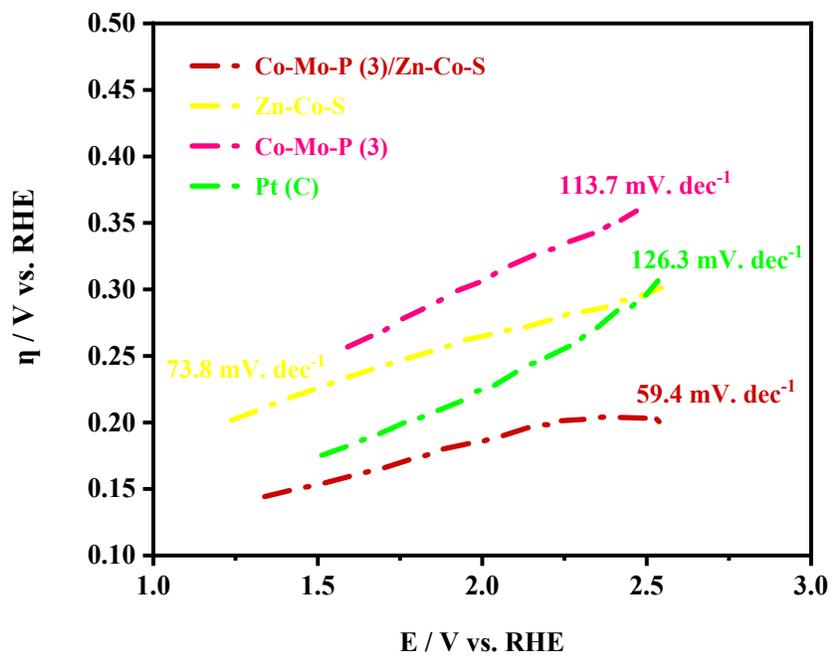
Figure S4. Tafel plots for catalysts at the high overpotentials.
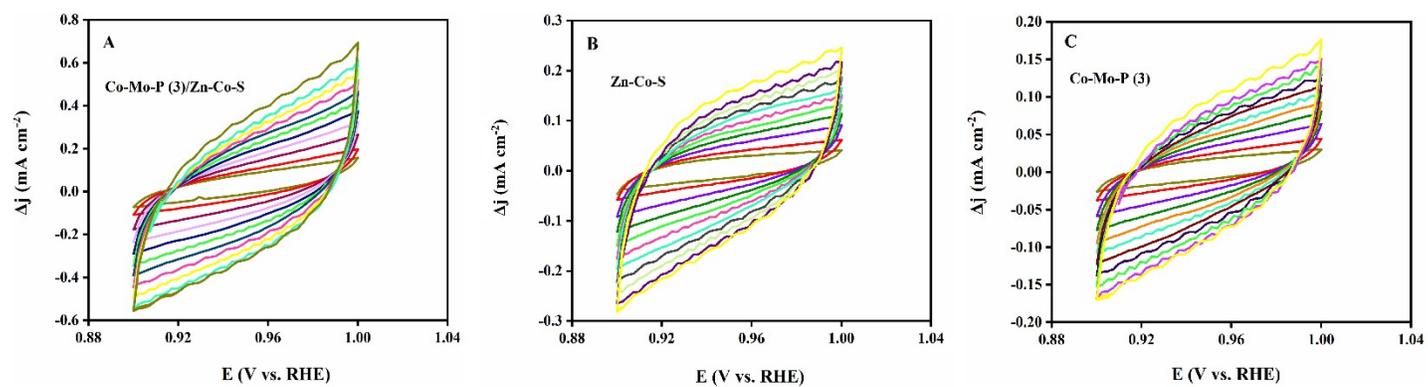
Figure S5. CV curves of catalysts in 1M KOH with different scan rates (5-100 mV s^{-1})
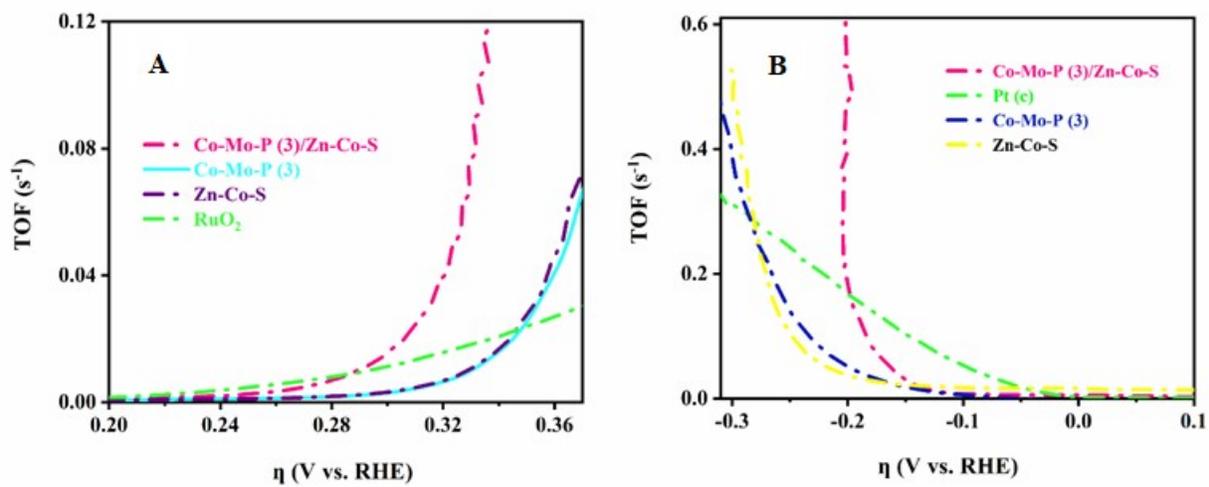
Figure S6. The calculated TOF values for **(A)** OER, and **(B)** HER.
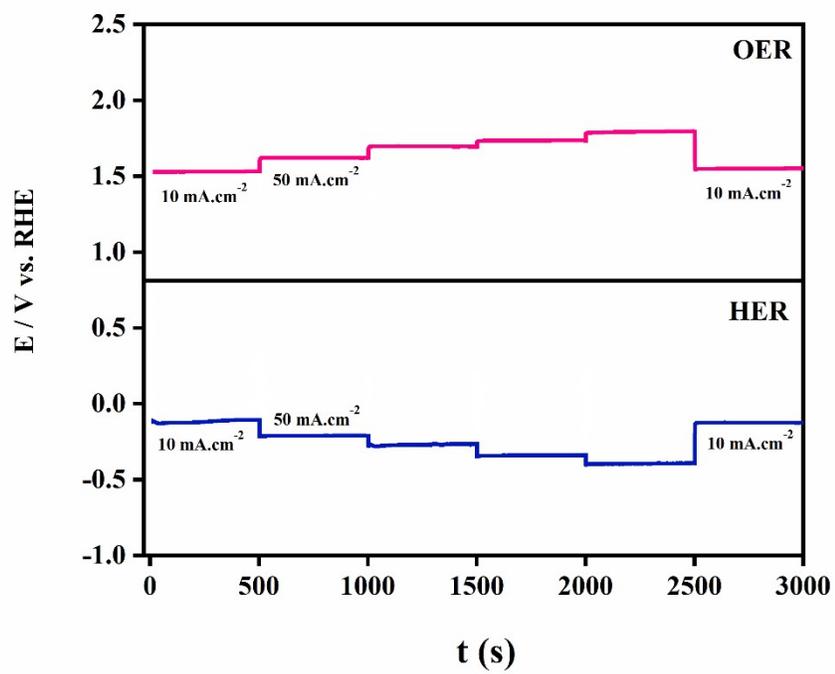
Figure S7. The multi-current step test over Co-Mo-P (3)/Zn-Co-S for OER and HER.
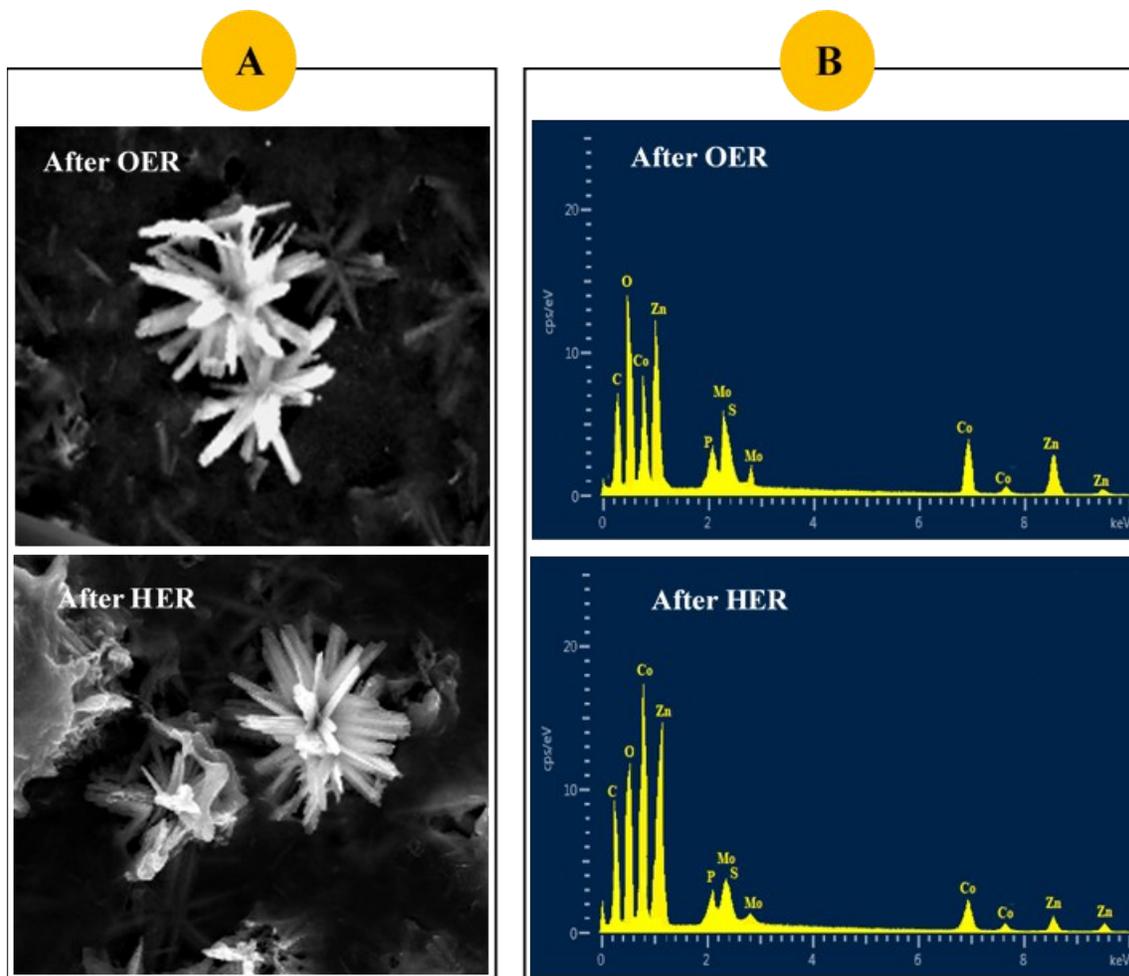
Figure S8. (A) The FE-SEM images, and **(B)** Energy-dispersive X-ray of the Co-Mo-P (3)/Zn-Co-S after OER and HER tests.
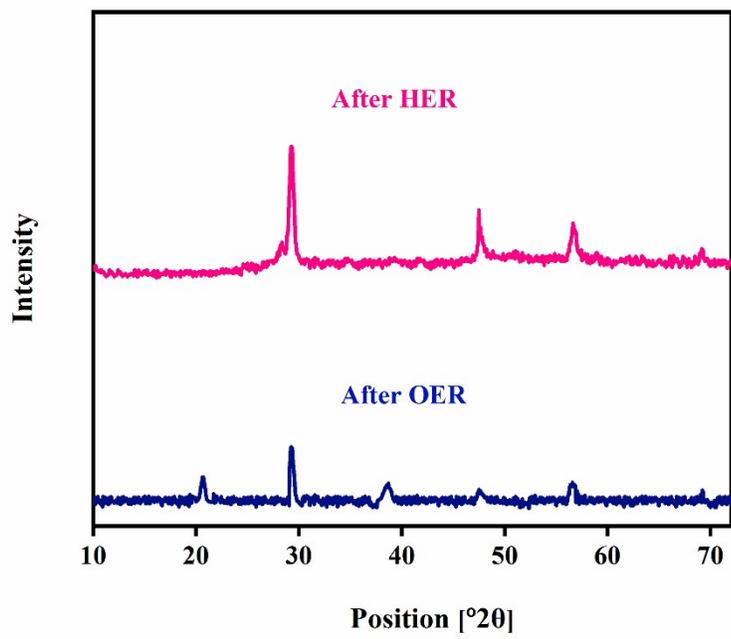
Figure S9. The XRD patterns of the Co-Mo-P (3)/Zn-Co-S after OER and HER.
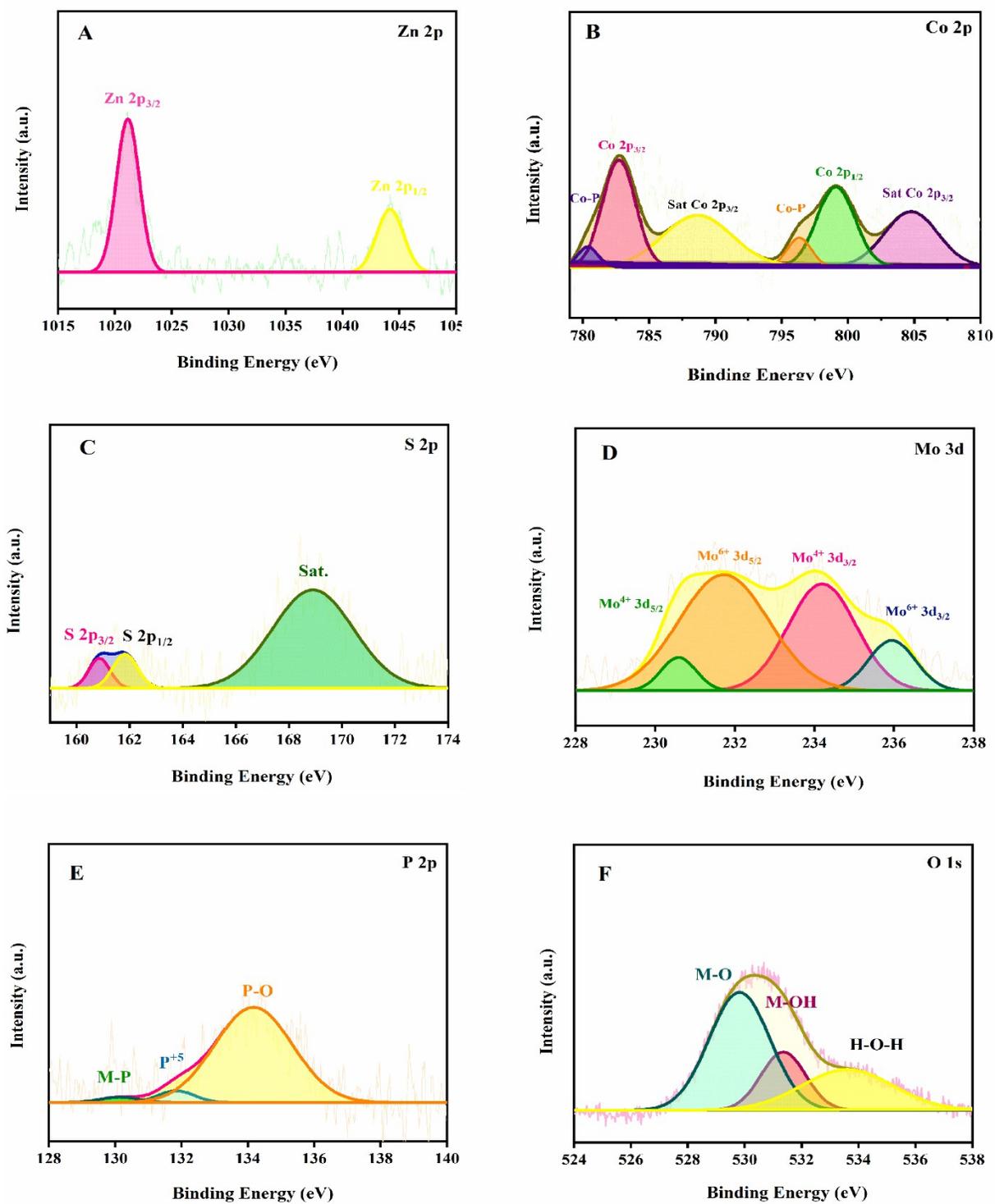
Figure S9. The XPS of the Co-Mo-P (3)/Zn-Co-S after OER test.
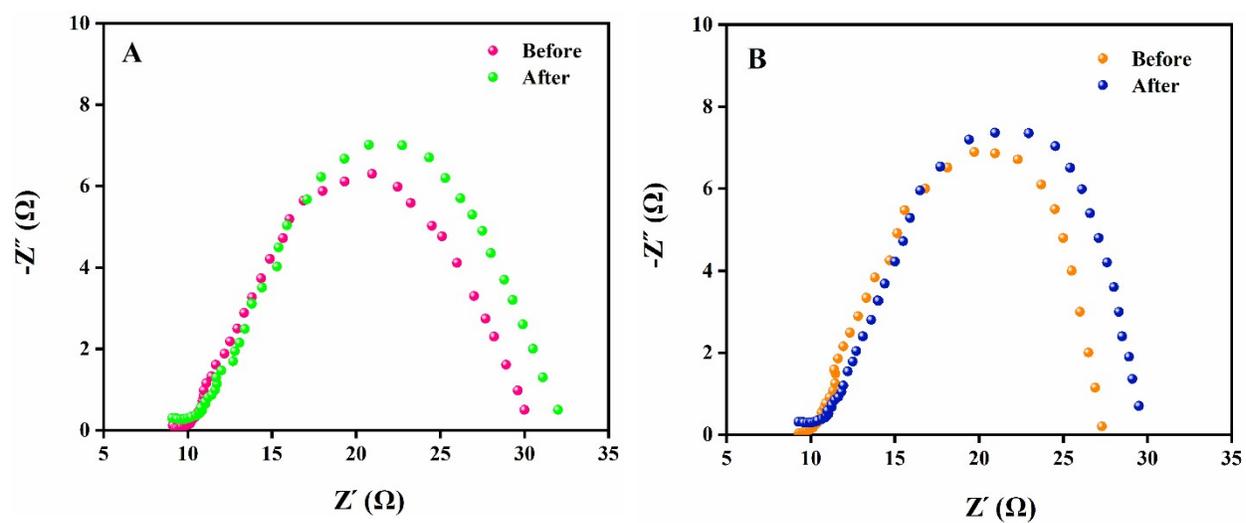
Figure S11. EIS Nyquist plots recorded for Co-Mo-P (3)/Zn-Co-S catalyst after **(A)** OER, and

(B) HER tests.

Table S1. Electrochemical parameters of the Zn-Co precursor, Zn-Co-A, Zn-Co-O, and Zn-Co-S catalysts toward OER in 1 M KOH solution.

Catalysts	η at $j = 10$ mA cm^{-2} (mV)	η at $j = 50$ mA cm^{-2} (mV)	j at $\eta = 0.34$ V (mA cm^{-2})
Zn-Co precursor	377	-	3.95
Zn-Co-O	394	450	1.04
Zn-Co-A	372	413	2.9
Zn-Co-S	321	355	22.79

Table S2. Electrochemical parameters of the Zn-Co precursor, Zn-Co-A, Zn-Co-O, and Zn-Co-S catalysts toward HER in 1 M KOH solution.

Catalysts	η at j = 10 mA cm^{-2} (mV)	η at j = 50 mA cm^{-2} (mV)	j at η = 0.2 V (mA cm^{-2})
Zn-Co precursor	478	550	2.29
Zn-Co-O	414	467	1.12
Zn-Co-A	303	383	2.56
Zn-Co-S	176	242	17.32

Table S3. Electrochemical parameters of the Co-P, Co-Mo-P (1), Co-Mo-P (2), Co-Mo-P (3), and

Co-Mo-P (4) catalysts toward OER in 1 M KOH solution.

Catalysts	η at j = 10 mA cm^{-2} (mV)	η at j = 50 mA cm^{-2} (mV)	j at η = 0.34 V (mA cm^{-2})
Co-P	380	416	1.73
Co-Mo-P (1)	378	411	1.85
Co-Mo-P (2)	357	398	5.05
Co-Mo-P (3)	348	381	6.82
Co-Mo-P (4)	367	402	3.01

Table S4. Electrochemical parameters of the Co-P, Co-Mo-P (1), Co-Mo-P (2), Co-Mo-P (3), and

Co-Mo-P (4) catalysts toward HER in 1 M KOH solution.

Catalysts	η at j = 10	η at j = 50	j at η = 0.2
	mA cm^{-2} (mV)	mA cm^{-2} (mV)	V (mA cm^{-2})
Co-P	334	425	2.57
Co-Mo-P (1)	309	362	2.70
Co-Mo-P (2)	288	336	3.10
Co-Mo-P (3)	171	268	14.85
Co-Mo-P (4)	250	312	5.75

Table S5A. Comparison of OER activity data with some representative non-noble catalysts.

Catalyst	Electrolyte	J (mA cm^{-2})	η (mV)	Tafel slope (mV dec^{-1})	Ref.
Co$_9$S$_8$/Zn-Co-S	1 M KOH	10	292	52	1
CoP(MoP)-CoMoO$_3$@CN	1 M KOH	10	296	105	2
Co$_5$Mo$_x$P NSs@NF	1 M KOH	10	270	54.4	3
CoMoPx	1 M KOH	10	305	50	4
Co-Mo-P (3)/Zn-Co-S	1 M KOH	10	273	41	This work

Table S5B. Comparison of HER activity data with some representative non-noble catalysts.

Catalyst	Electrolyte	J (mA cm^{-2})	η (mV)	Tafel slope (mV dec^{-1})	Ref.
CoP(MoP)-CoMoO$_3$@CN	1 M KOH	10	198	72	2
Co$_5$Mo$_x$P NSs@NF	1 M KOH	10	173	218.6	3
CoP3/CoMoP	1 M KOH	10	125	61.1	5
ZnCo/NC@MoS$_2$	1 M KOH	10	130	60.2	6
Co-Mo-P (3)/Zn-Co-S	1 M KOH	10	120	61.7	This work

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