Supporting information

$CoMoO_4$ modified hematite with oxygen vacancy for high-efficiency solar water splitting

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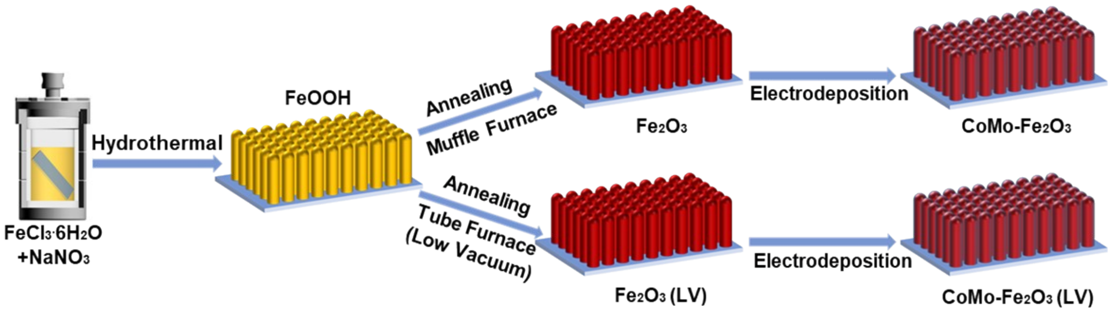

Fig. S1. Schematic illustration of the synthesis processes for Fe_2O_3, Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV) photoanodes.

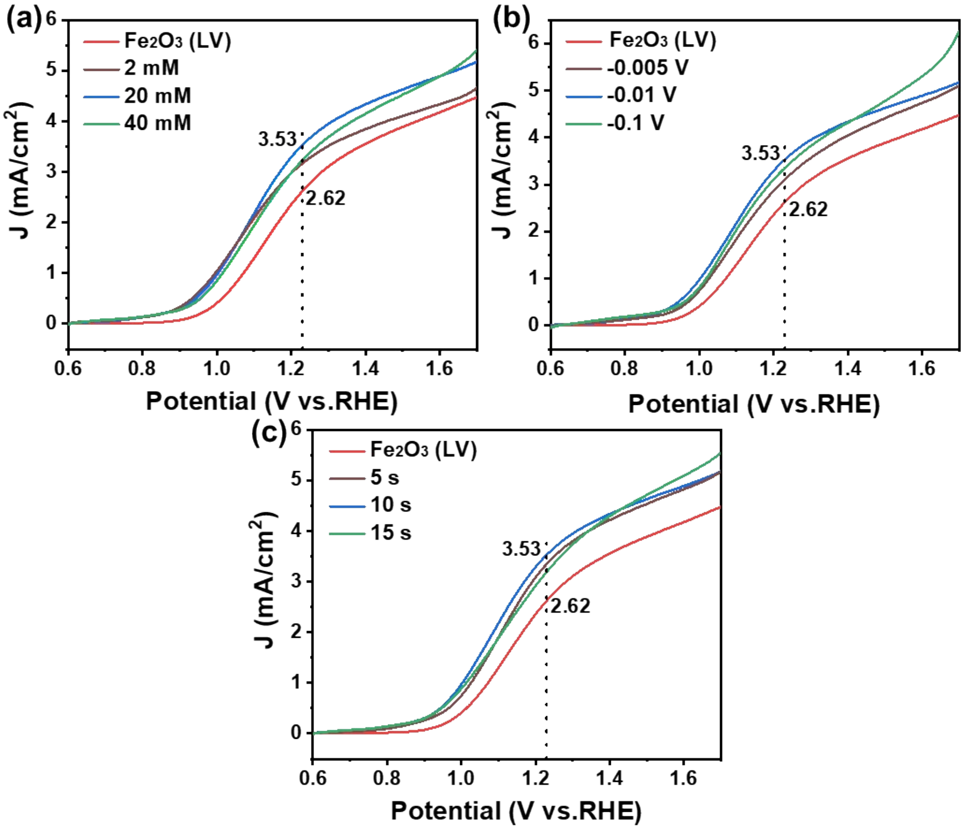

Fig. S2. *J-V* curves of CoMo-Fe_2O_3 (LV) photoanodes treated with (a) different precursor solution concentrations, (b) different deposition voltage and (c) different electrodeposition times.

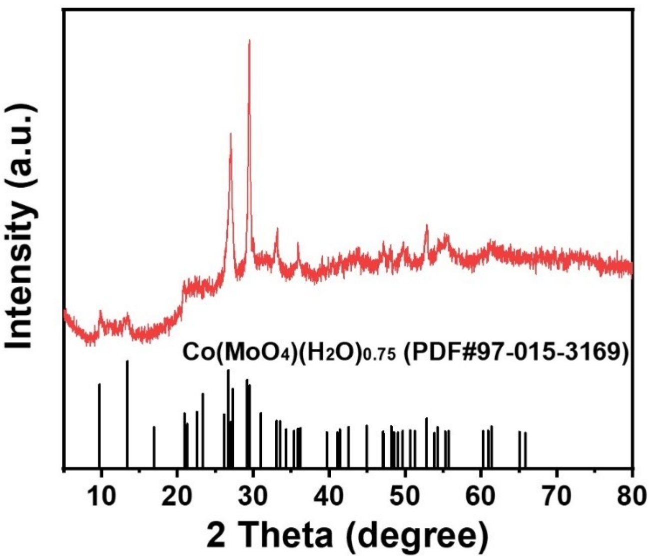

Fig. S3. XRD spectrum of $CoMoO_4$ with a deposition time of 10 hours.

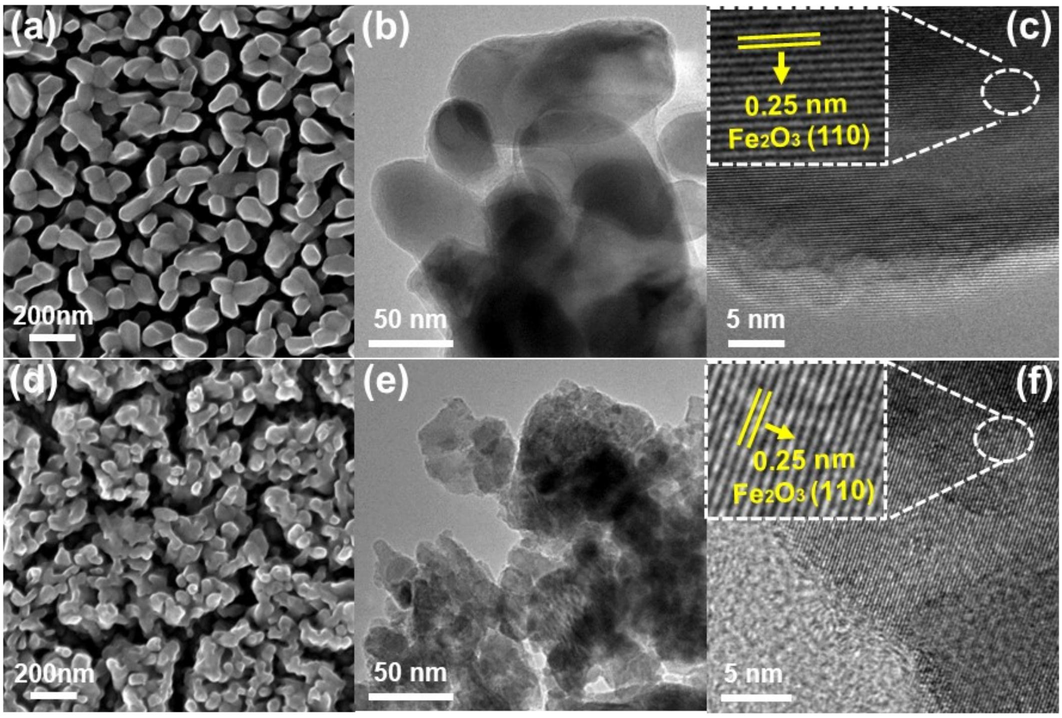

Fig. S4. (a) SEM, (b) TEM and (c) HRTEM images of Fe_2O_3. (d) SEM, (e) TEM and (f) HRTEM images of Fe_2O_3 (LV).

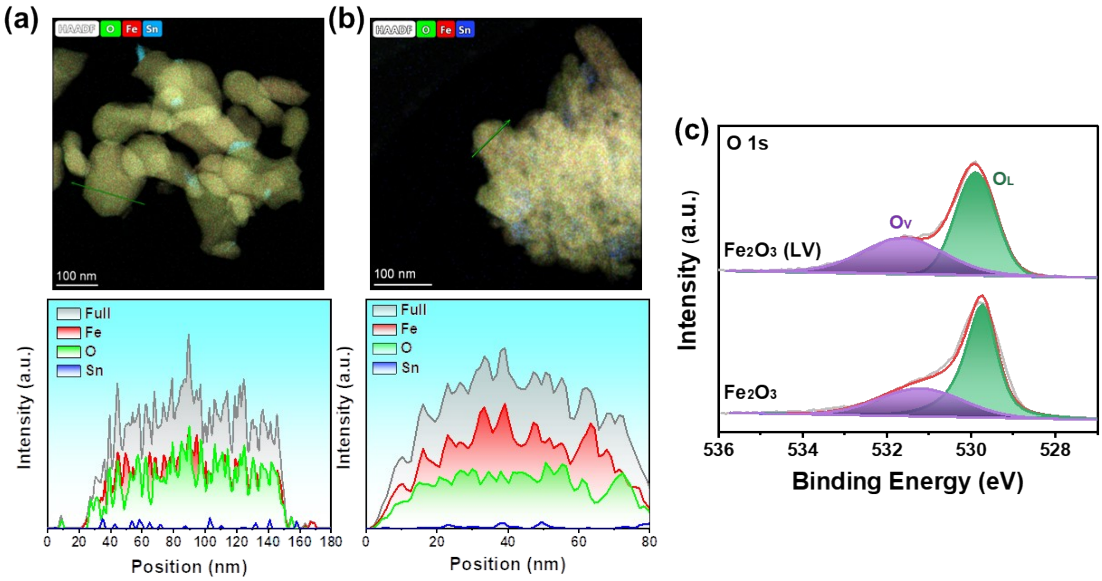

Fig. S5. TEM line scan analysis of (a) Fe_2O_3 and (b) Fe_2O_3 (LV) photoanodes. (c) O 1s high-resolution XPS spectra of Fe_2O_3 and Fe_2O_3 (LV) photoanodes.

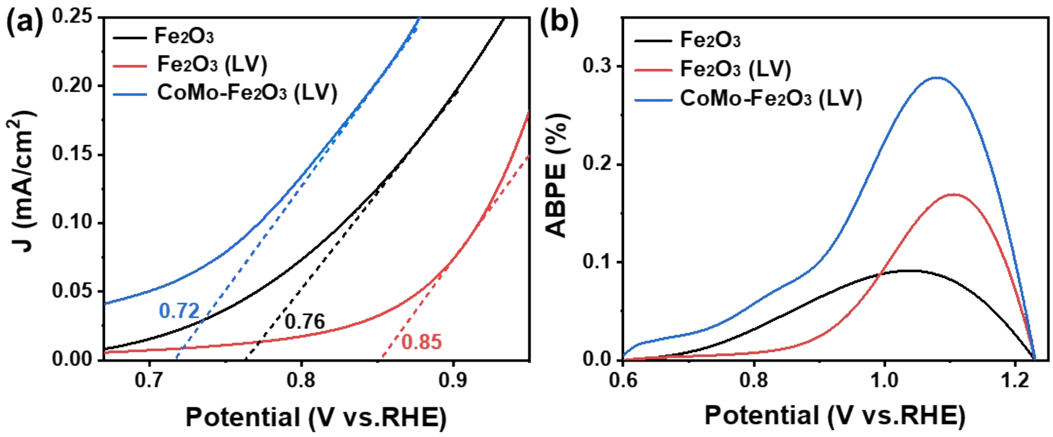

Fig. S6. (a) Magnified onset potential diagrams and (b) the ABPE curves of Fe_2O_3, Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV) photoanodes.

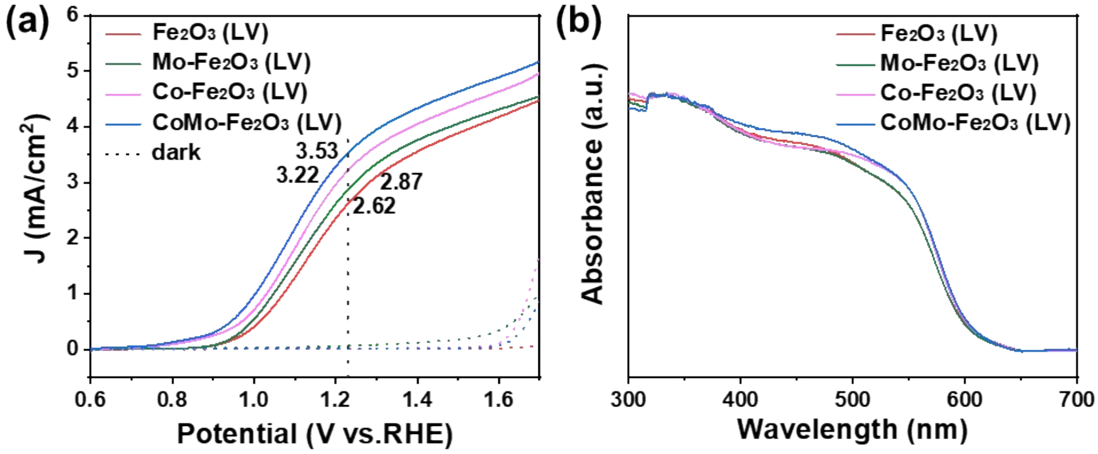

Fig. S7. (a) *J-V* curves and (b) UV-visible absorption spectra of Fe_2O_3 (LV), Mo-Fe_2O_3 (LV), Co-Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV).

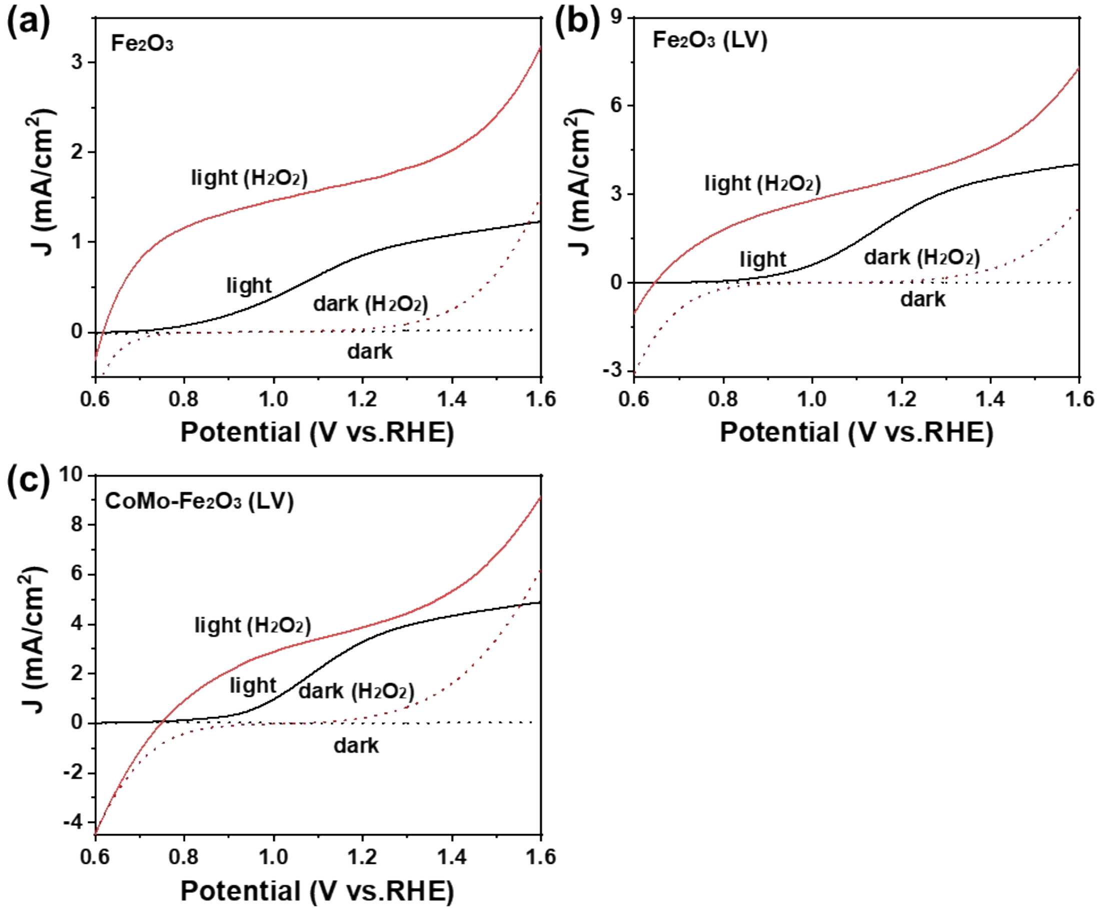

Fig. S8. *J-V* curves with (red) and without (black) H_2O_2 (0.5 M) for Fe_2O_3 (a), Fe_2O_3 (LV) (b) and CoMo-Fe_2O_3 (LV) (c), respectively.

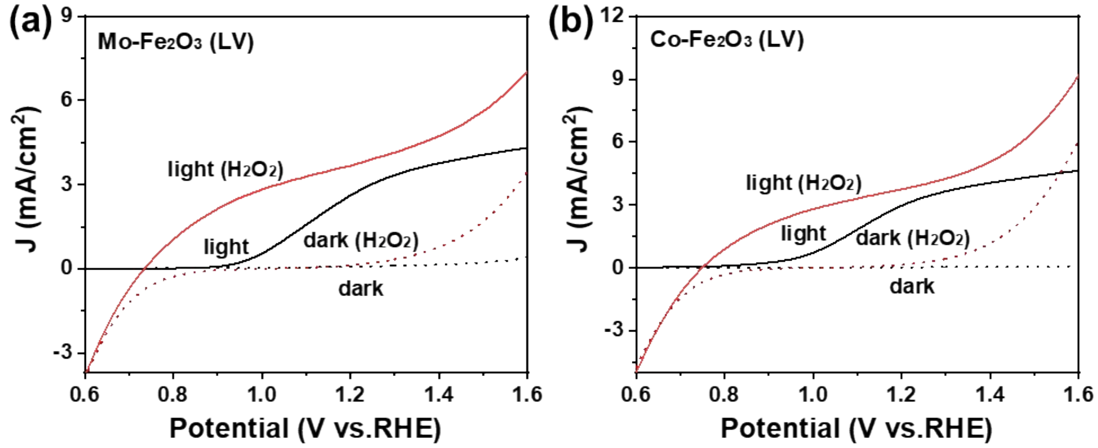

Fig. S9. *J-V* curves with (red) and without (black) H_2O_2 (0.5 M) for Mo-Fe_2O_3 (LV) (a) and Co-Fe_2O_3 (LV) (b), respectively.

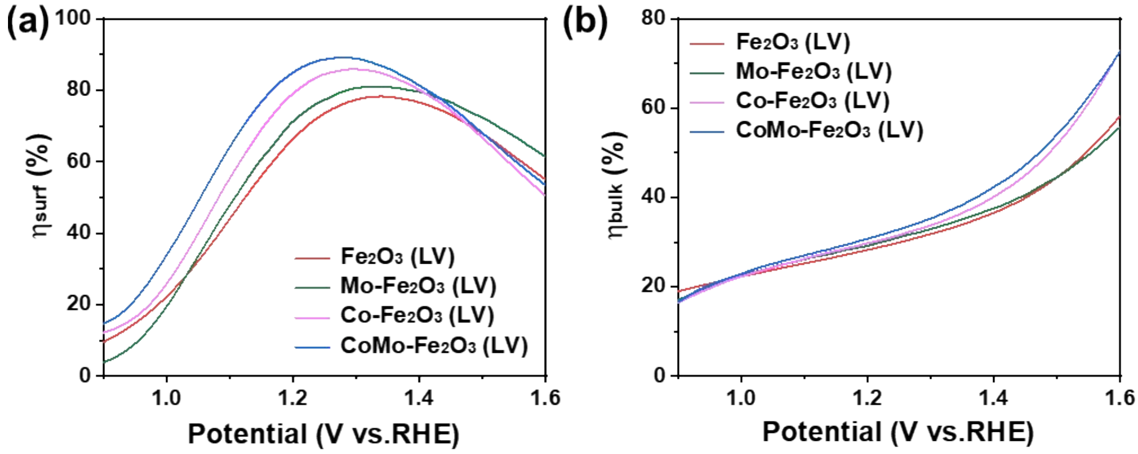

Fig. S10. (a) Surface charge separation efficiencies ($\eta_{surface}$) and (b) bulk charge separation efficiencies (η_{bulk}) of Fe_2O_3 (LV), Mo-Fe_2O_3 (LV), Co-Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV), respectively.

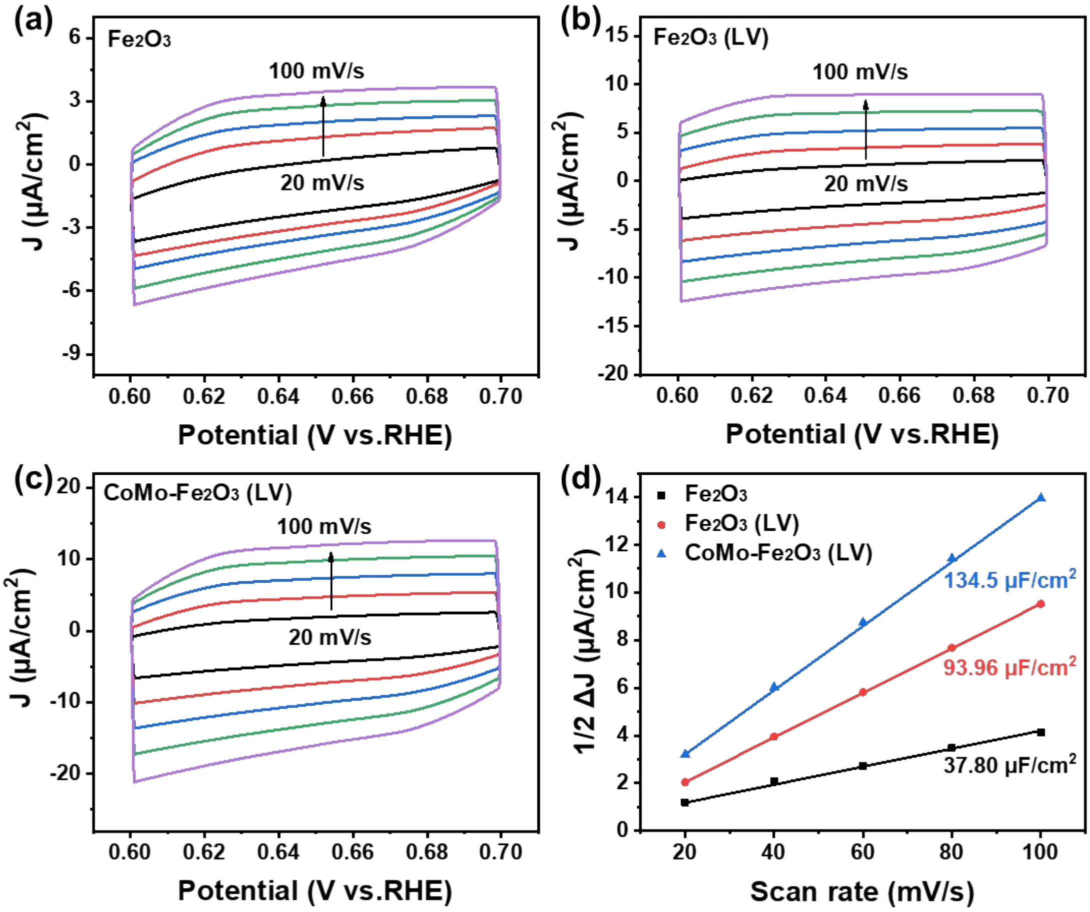

Fig. S11. CV curves recorded at different scan rates (20, 40, 60, 80, and 100 mV/s) for (a) Fe_2O_3, (b) Fe_2O_3 (LV) and (c) CoMo-Fe_2O_3 (LV) electrodes in the dark. (d) The average capacitive current against scan rate for Fe_2O_3, Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV) electrodes.

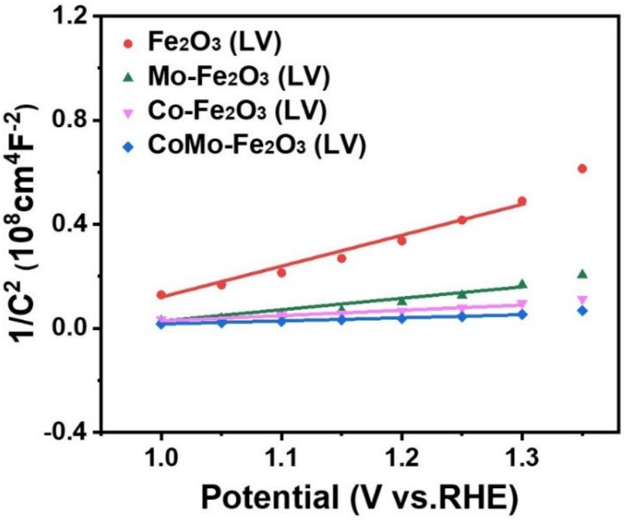

Fig. S12. Mott-Schottky plots of Fe_2O_3 (LV), Mo-Fe_2O_3 (LV), Co-Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV).

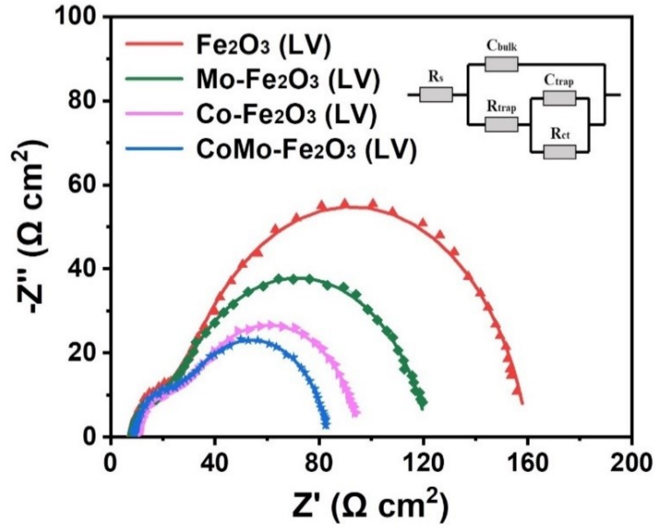

Fig. S13. EIS spectra of Fe_2O_3 (LV), Mo-Fe_2O_3 (LV), Co-Fe_2O_3 (LV) and CoMo-Fe_2O_3 (LV).

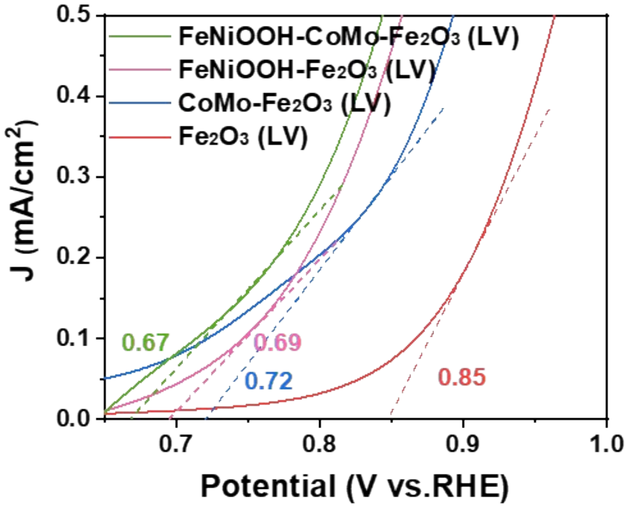

Fig. S14. Magnified onset potential diagrams of Fe_2O_3 (LV), CoMo-Fe_2O_3 (LV), FeNiOOH-Fe_2O_3 (LV) and FeNiOOH-CoMo-Fe_2O_3 (LV) photoanodes.

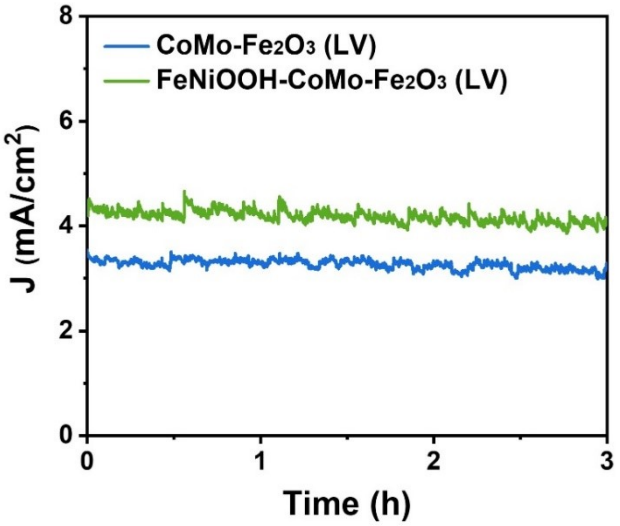

Fig. S15. Photochemical stability curves of CoMo-Fe_2O_3 (LV) and FeNiOOH-CoMo-Fe_2O_3 (LV) measured at 1.23 V_{RHE}.

Table S1. Parameters of the equivalent circuit elements.

	R_s (Ω)	C_{bulk} (μF)	R_{trap} (Ω)	C_{trap} (mF)	R_{ct} (Ω)
Fe_2O_3 (LV)	8.11±0.06	65.14±6.81	24.02±0.80	0.57±0.02	128.00±1.50
Mo-Fe_2O_3 (LV)	8.34±0.04	101.60±9.63	19.96±0.65	0.90±0.02	93.65±1.00
Co-Fe_2O_3 (LV)	10.11±0.05	105.80±9.54	23.17±0.70	1.08±0.03	62.74±0.99
CoMo-Fe_2O_3 (LV)	8.99±0.04	121.10±9.82	25.56±0.77	0.99±0.04	48.89±0.92

Table S2. Comparison of the photocurrents on hematite-based photoanodes (at 1.23 V $_{RHE}$).

Electrodes	Solutions	J (mA/cm²)	Reference
FeNiOOH-CoMo-Fe_2O_3 (LV)	**1 M NaOH (pH 13.6)**	**4.18**	**This work**
FH/TH/Co	1 M NaOH (pH 13.6)	6.0	*(1)*
$NiFeO_x$@Ge-PH	1 M NaOH (pH 13.6)	4.60	*(2)*
$NiFeO_x$/Si:Ti-Fe_2O_3	1 M NaOH (pH 13.6)	4.30	*(3)*
Ti:Fe_2O_3/SiO_x/Ti–FeOOH	1 M NaOH (pH 13.6)	4.06	*(4)*
$NiFeO_x$/Ti:Si-Fe_2O_3 (Dual photoanode)	1 M NaOH (pH 13.6)	4.00	*(5)*
Fe_2O_3-MA-18 min	1 M NaOH (pH 13.6)	3.90	*(6)*
Co-Pi/Sn-Fe_2O_3	1 M NaOH (pH 13.6)	3.90	*(7)*
IrO_2/Fe_2O_3	1 M NaOH (pH 13.6)	3.75	*(8)*
F/Sn: Fe_2O_3	1 M NaOH (pH 13.6)	3.64	*(9)*
$NiFeO_x$/P,Ti-Fe_2O_3	1 M NaOH (pH 13.6)	3.54	*(10)*
Co-Pi/Mn-Fe_2O_3	1 M NaOH (pH 13.6)	3.50	*(11)*
Ti-Fe_2O_3 MC/Co-Pi	1 M NaOH (pH 13.6)	3.50	*(12)*
InO_2 layer / Fe_2O_3	1 M NaOH (pH 13.6)	3.40	*(13)*
CoPi-Ti/Au/ Fe_2O_3	1 M NaOH (pH 13.6)	3.39	*(14)*
Sn:Fe_2O_3 with V_O	1 M NaOH (pH 13.6)	3.30	*(15)*
$NiFe(OH)_x$/Ta:Fe_2O_3@Fe_2O_3	1 M NaOH (pH 13.6)	3.22	*(16)*
Fe_2O_3/FeOOH/Au	1 M KOH (pH 13.6)	3.20	*(17)*
Ti:Fe_2O_3/SiO_x/Co–Pi	1 M NaOH (pH 13.6)	3.19	*(18)*
Co-Pi/(3D) Ti-Fe_2O_3/NTO	1 M NaOH (pH 13.6)	3.16	*(19)*
Fe_2O_3/TiO_2/FeOOH	1 M KOH (pH 13.6)	3.15	*(20)*
Fe_2O_3/SiMWs	1 M NaOH (pH 13.6)	3.12	*(21)*
P:Fe_2O_3 /Co–Pi	1 M NaOH (pH 13.6)	3.10	*(22)*
TiO_2/Ti: Fe_2O_3 BNR/FeOOH	1 M KOH (pH 13.6)	3.10	*(23)*
Sb_2Se_3–Fe_2O_3	1 M NaOH (pH 13.6)	3.07	*(24)*
CoPi-Ti :Fe_2O_3	1 M NaOH (pH 13.6)	3.05	*(25)*
Co-Pi/CQDs/Fe_2O_3/TiO_2	1 M NaOH (pH 13.6)	3.00	*(26)*
Ni_2P/Ta:α-Fe_2O_3	1 M KOH (pH 13.6)	2.98	(27)
A:Ce-Fe_2O_3@Fe_2O_3	1 M KOH (pH 13.6)	2.50	(28)
Cu@α-Fe_2O_3-Vo-pn	1 M KOH (pH 13.6)	2.49	(29)

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