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Supporting Information

Improvement of the Water Oxidation Performance of Ti, F Co-modified Hematite by Surface Modification with Co(salen) Molecular Cocatalyst

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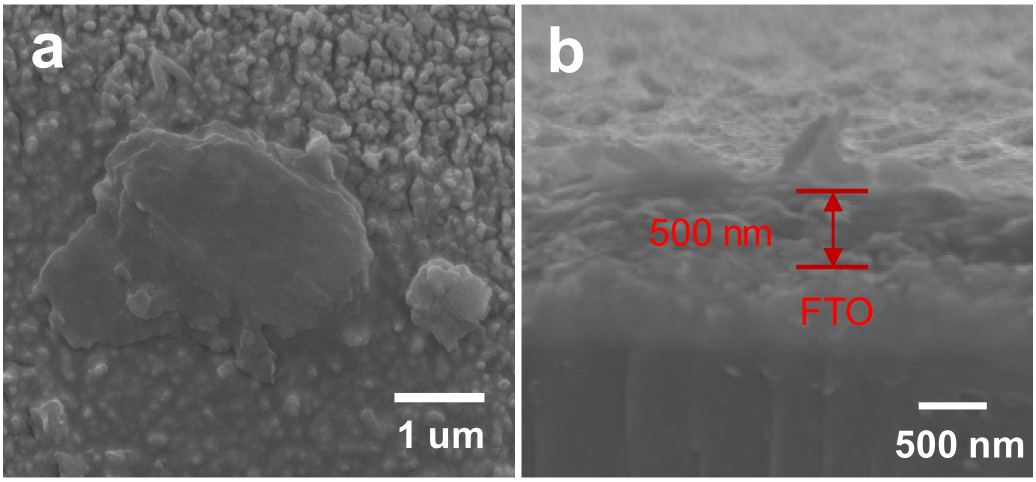

Fig. S1 (a) FE-SEM image of F-Ti-Fe_2O_3/Co(salen); (b) cross-section FE-SEM image of F-Ti-Fe_2O_3/Co(salen).

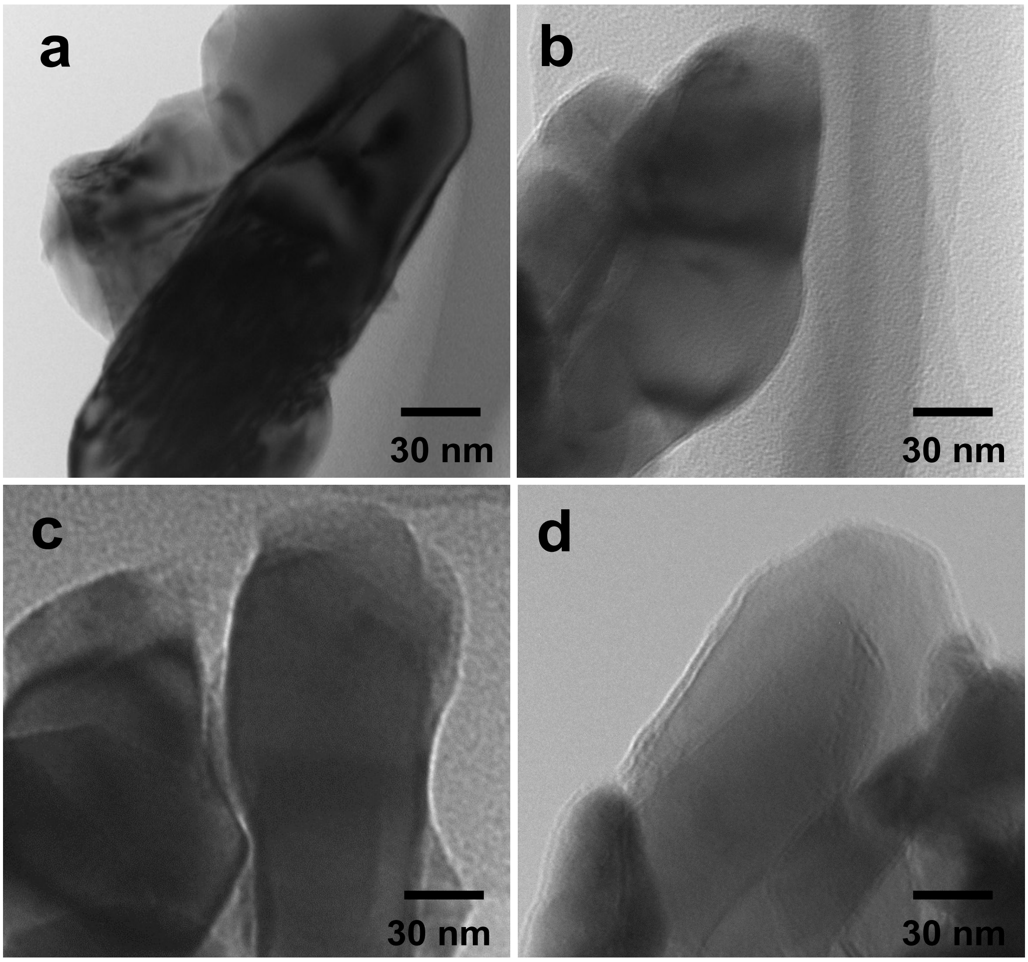

Fig. S2 TEM images of (a) Fe_2O_3, (b) Ti-Fe_2O_3, (c) F-Ti-Fe_2O_3 and (d) F-Ti-Fe_2O_3/Co(salen).

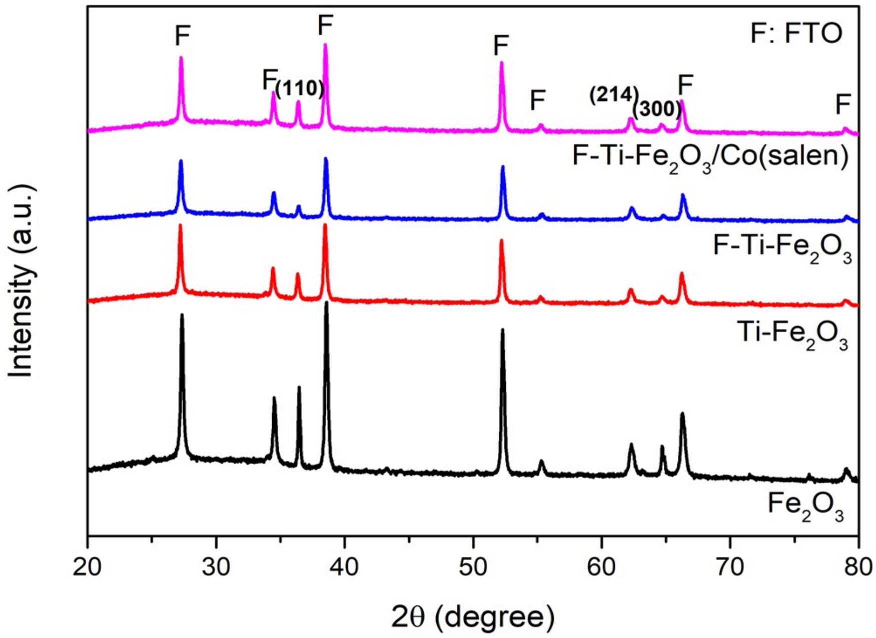

Fig. S3 XRD patterns of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen).

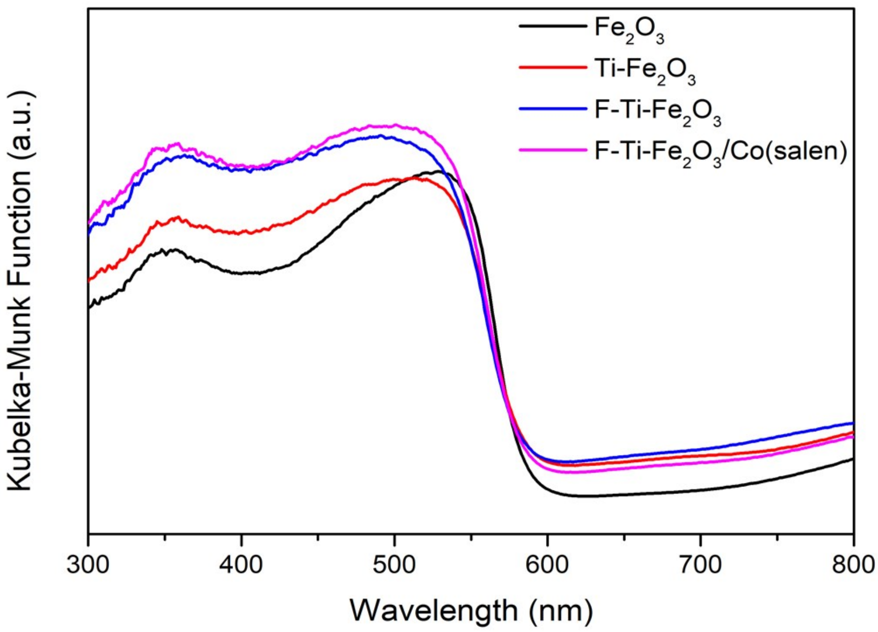

Fig. S4 UV-Vis spectra of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen).

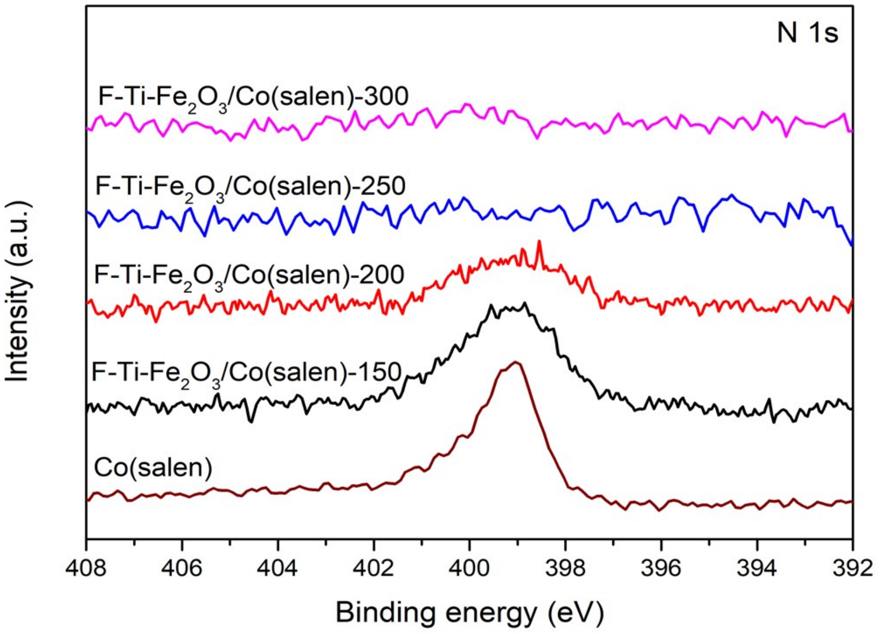

Fig. S5 N 1s XPS spectra of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen).

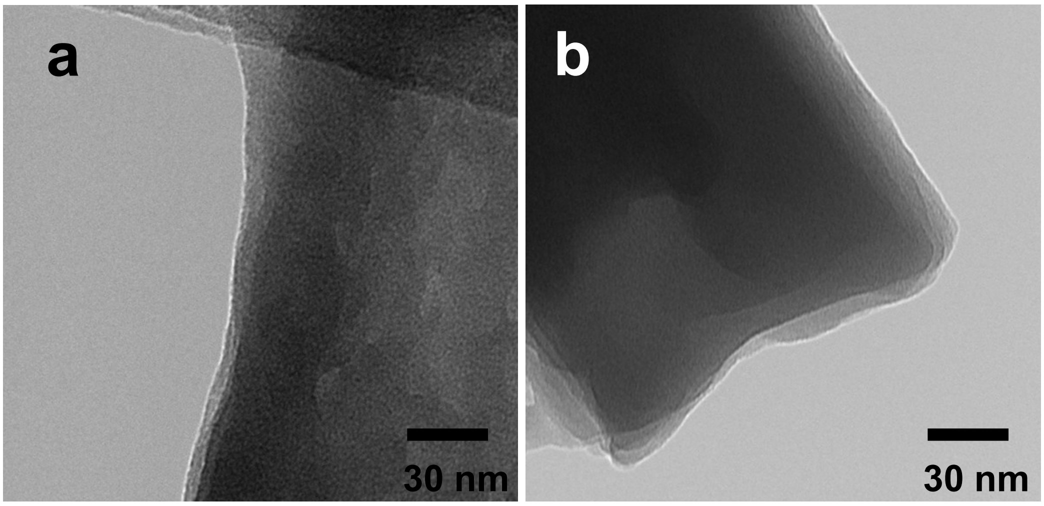

Fig. S6 TEM images of (a) F-Ti-Fe_2O_3/Co(salen)-250 and (b) F-Ti-Fe_2O_3/Co(salen)-300.

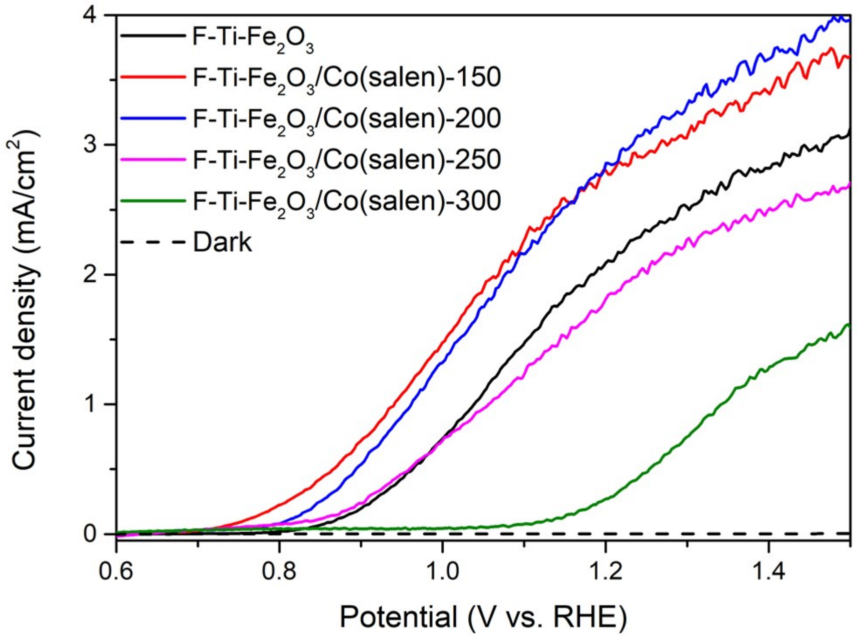

Fig. S7 LSV curves of F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) at different temperatures photoanodes under illumination.

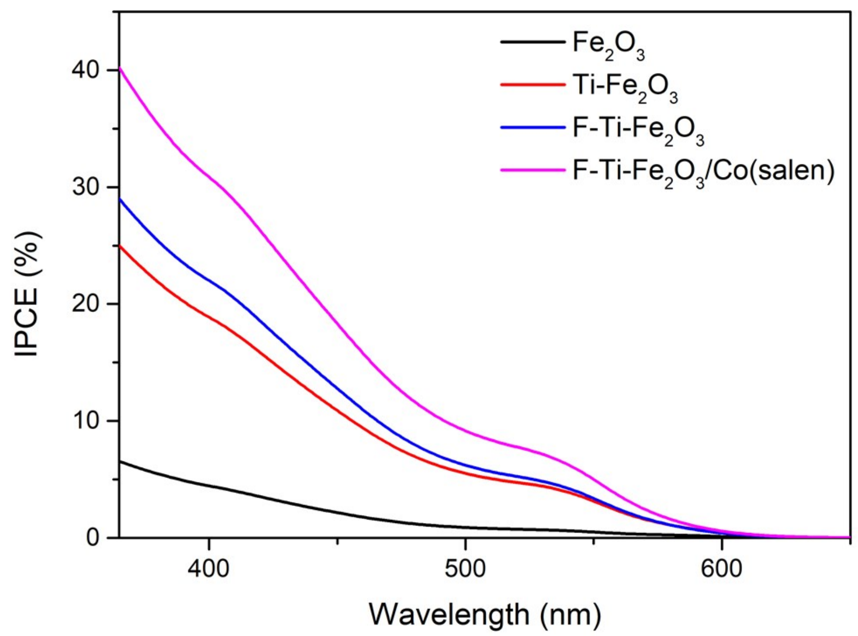

Fig. S8 IPCE curves of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes at 1.23 V vs. RHE under illumination.

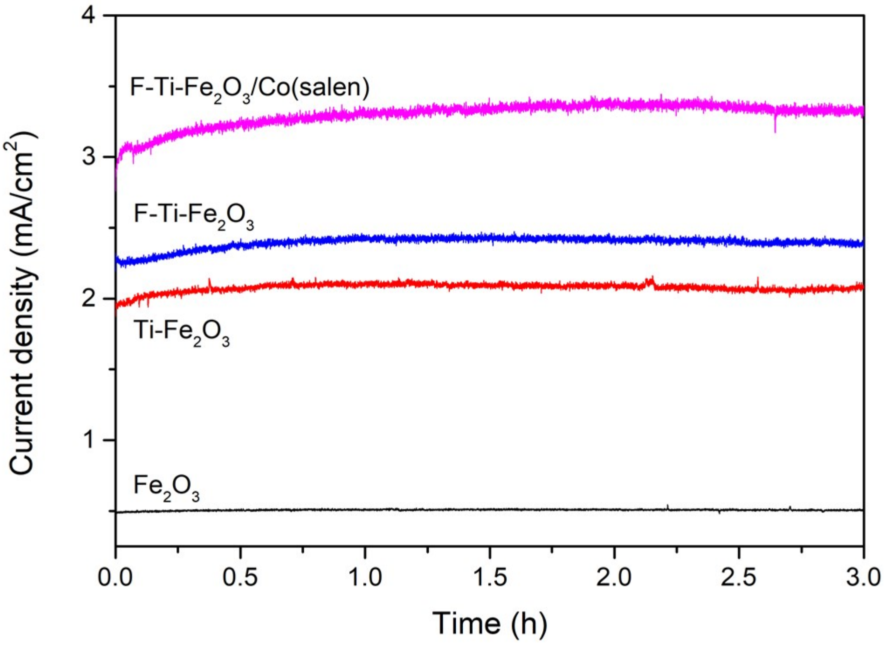

Fig. S9 Amperometric I-t curves of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes.

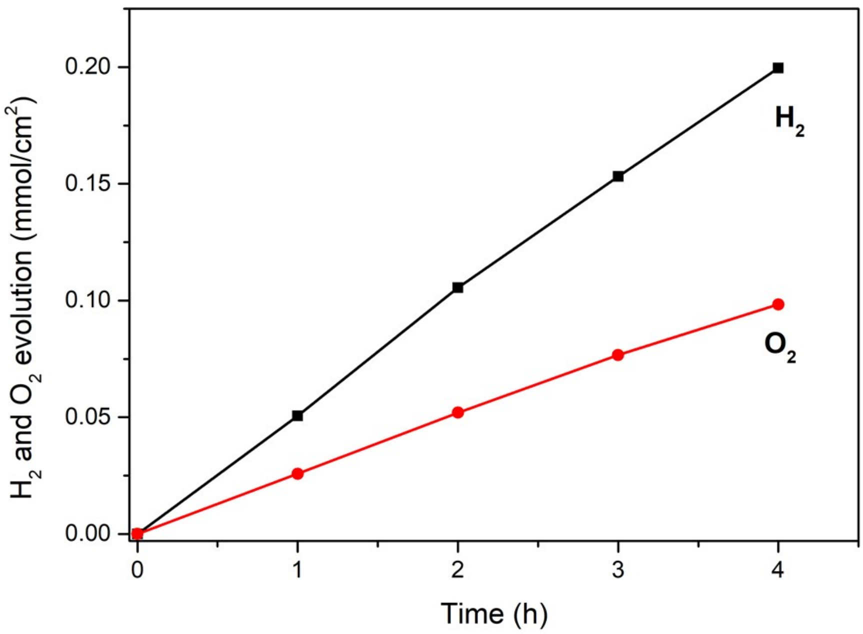

Fig. S10 H_2 and O_2 evolution of the F-Ti-Fe_2O_3/Co(salen) photoanode at 1.23 V vs. RHE under illumination.

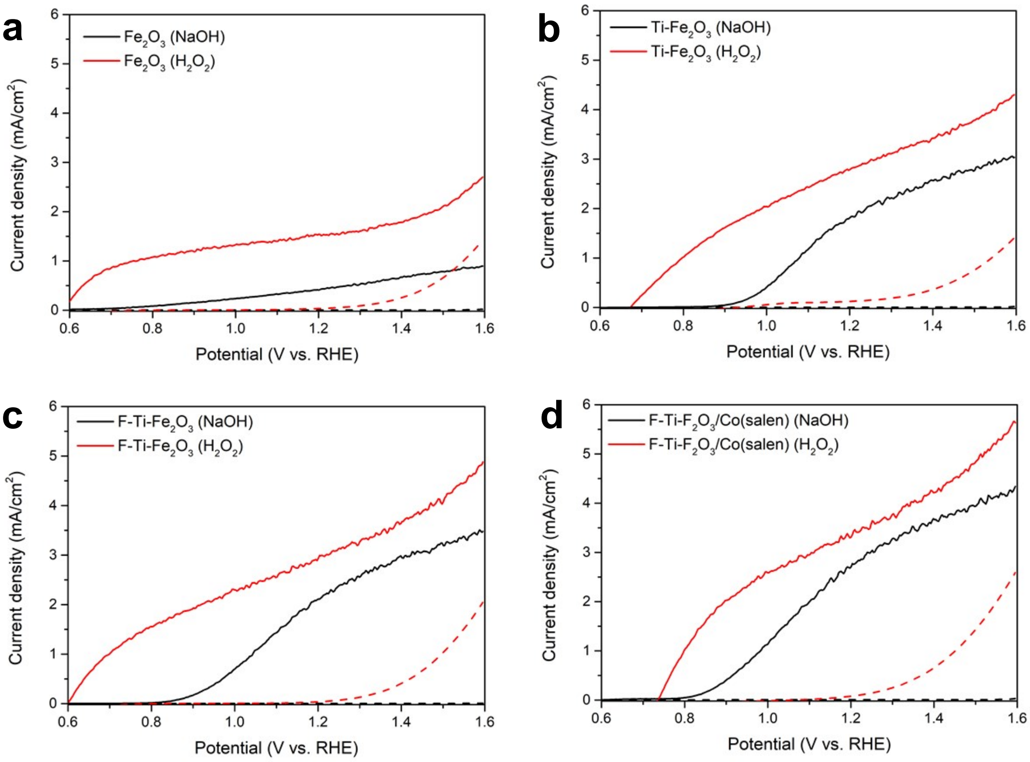

Fig. S11 LSV curves of photoanodes in 1 M NaOH and 1 M NaOH with 0.5 M H_2O_2 solution under illumination: (a) Fe_2O_3, (b) Ti-Fe_2O_3, (c) F-Ti-Fe_2O_3 and (d) F-Ti-Fe_2O_3/Co(salen) photoanodes.

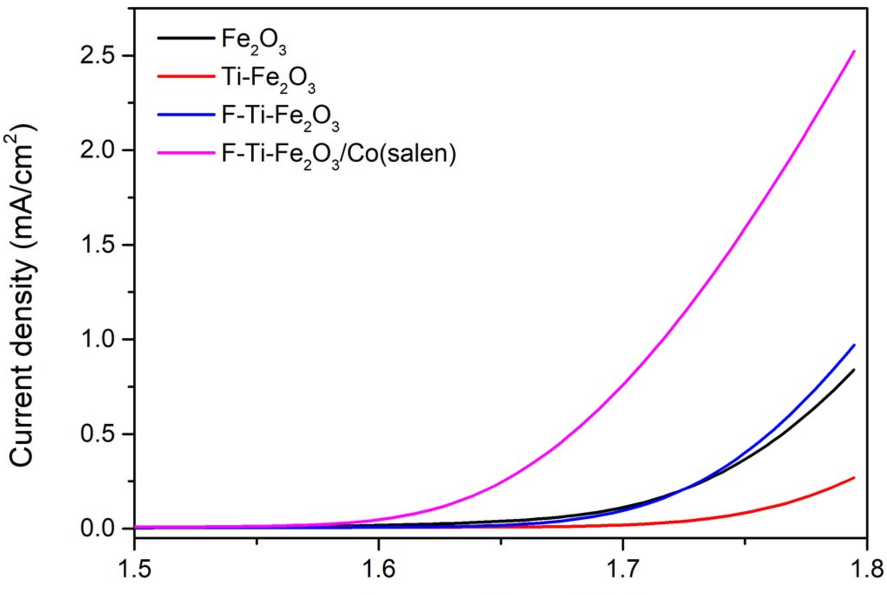

Fig. S12 Polarization curves for OER performance of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes in the dark.

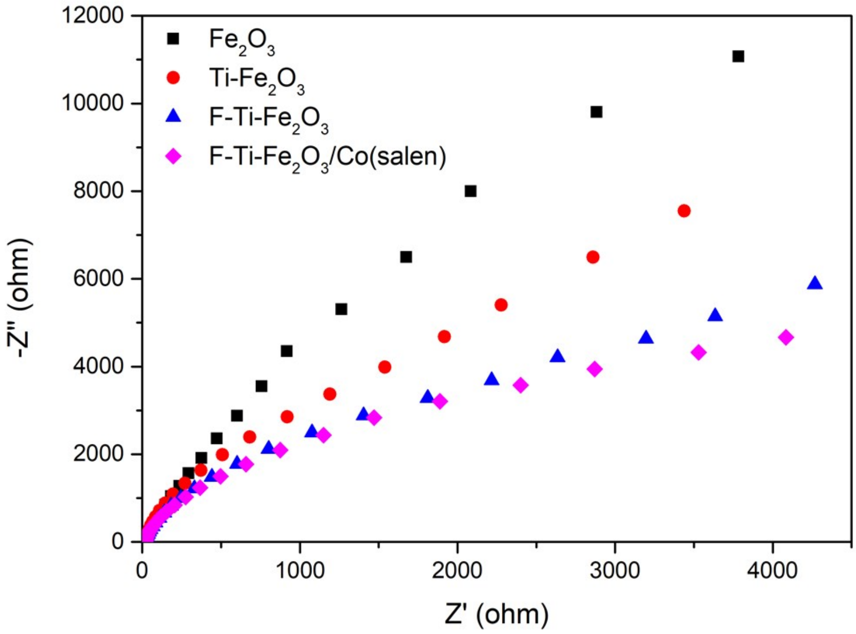

Fig. S13 EIS spectra of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes in the dark.

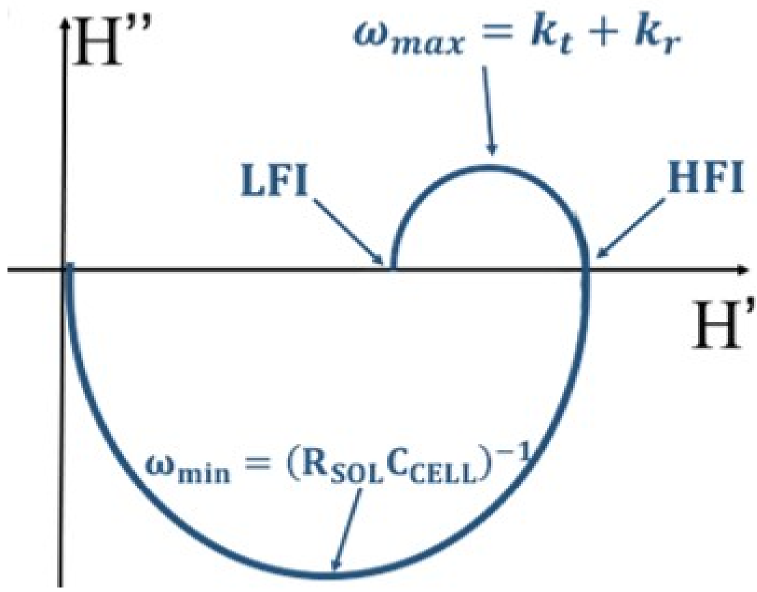

Fig. S14 Standard IMPS spectra in Nyquist coordinates.

Table S1 Comparison of our photoanode to other hematite-based photoanodes

Photoanodes	Electrolyte	J (mA/cm^2) at 1.23 V vs. RHE	Onset potential (V vs. RHE)	Ref.
Co-Pi/Ag/Fe_2O_3	1 M NaOH	4.32	0.70	1
α-Fe_2O_3/FeOOH/Au	1 M KOH	3.2	0.60	2
Fe_2O_3-TiP75-Co-Pi	1 M NaOH	2.9	0.85	3
ITO/Fe_2O_3/Fe_2TiO_5/Fe_2O_3	1 M NaOH	2.2	1.0	4
Rh-F-$TiFeO_5$/Fe_2O_5	1 M NaOH	2.12	0.72	5
C-Co-Ti- Fe_2O_3	1 M NaOH	2.24	0.70	6
NiOOH/Fe_2O_3/F-Fe_2O_3	1 M KOH	2.48	0.61	7
Oxygen vacancies+Ti-Fe_2O_3	1 M NaOH	2.25	1.0	8
g-C_3N_4/Ti-Fe_2O_3	1 M NaOH	2.55	0.95	9
Co-Pi-B-Ti-Fe_2O_3	1 M NaOH	2.61	0.90	10
FeOOH/M:B-Fe_2O_3	1 M NaOH	2.35	0.835	11
Fe_2O_3:Ti/NH_2-MIL-101(Fe)	1 M NaOH	2.27	1.0	12
Co-MOF/Fe_2O_3	1 M NaOH	2.0	0.64	13
F-Ti-Fe_2O_3/Co(salen)	1 M NaOH	3.02	0.81	This work

Table S2 Fitted parameters of the EIS spectra of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes under illumination.

Sample	R_{sol} ($\Omega \cdot cm^{-2}$)	R_{ss} ($\Omega \cdot cm^{-2}$)	R_t ($\Omega \cdot cm^{-2}$)
Fe_2O_3	18.7	580	215
Ti-Fe_2O_3	17.3	108	33.6
F-Ti-Fe_2O_3	17.6	65.4	32.0
F-Ti-Fe_2O_3/Co(salen)	17.3	55.4	28.0

Table S3 Transfer time, lifetime and charge collection efficiency of photo-induced electrons obtained from CIMP/VS of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes

Sample	τ_d (ms)	τ_n (ms)	Charge collection efficiency (%)
Fe_2O_3	0.587	4.74	87.6
Ti-Fe_2O_3	0.558	5.42	89.7
F-Ti-Fe_2O_3	0.467	6.15	92.4
F-Ti-Fe_2O_3/Co(salen)	0.372	6.16	94.0

Table S4 Transfer rate, recombination rate and transfer efficiency of photoinduced carriers obtained from CIMPS of Fe_2O_3, Ti-Fe_2O_3, F-Ti-Fe_2O_3 and F-Ti-Fe_2O_3/Co(salen) photoanodes

Sample	k_{tr} (s^{-1})	k_{re} (s^{-1})	η_{ct} (%)
Fe_2O_3	0.26	0.60	30.0
Ti-Fe_2O_3	3.59	0.92	79.6
F-Ti-Fe_2O_3	4.09	0.65	86.3
F-Ti-Fe_2O_3/Co(salen)	6.02	0.75	88.9

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