Electronic Supplementary Information

An electrochemically fabricated cobalt iron oxyhydroxide bifunctional electrode for an anion exchange membrane water electrolyzer

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Table S1 Electrodeposition condition of of CoO_xH_y/TP, $Co_zFe_{1-z}O_xH_y$/TP, and FeO_xH_y/TP

Electrodes	Electrolyte concentration (mM)				Deposition conditions	
	$CoSO_4 \cdot 7H_2O$	$FeSO_4 \cdot 7H_2O$	Na_2SO_4	$Na_3C_6H_5O_7$	Potential (V_{SCE})	Time (s)
CoO_xH_y/TP	35.0	-	100.0	100.0	−1.8	600.0
$Co_{65}Fe_{35}O_xH_y$/TP	30.0	5.0	100.0	100.0	−1.8	600.0
$Co_{52}Fe_{48}O_xH_y$/TP	17.5	17.5	100.0	100.0	−1.8	600.0
$Co_{47}Fe_{53}O_xH_y$/TP	10.0	25.0	100.0	100.0	−1.8	600.0
FeO_xH_y/TP	-	35.0	100.0	100.0	−1.8	600.0

Table S2 HER and OER performances of CoO_xH_y/TP, $Co_zFe_{1-z}O_xH_y$/TP, and FeO_xH_y/TP

Electrode	Co/Fe ratio	Overpotential @ 10 mA cm_{geo}^{-2} (mV)	Tafel slope for OER (mV dec^{-1})	Overpotential @−10 mA cm_{geo}^{-2} (mV)	Tafel slope for HER (mV dec^{-1})
CoO_xH_y/TP	-	385	97	152	112
$Co_{65}Fe_{35}O_xH_y$/TP	1.86	335	57	150	75
$Co_{52}Fe_{48}O_xH_y$/TP	1.08	357	47	151	77
$Co_{47}Fe_{53}O_xH_y$/TP	0.89	375	71	198	67
FeO_xH_y/TP	0	481	92	292	94

Table S3 Operation conditions and performances of AEMWE using bifunctional $Co_{65}Fe_{35}O_xH_y$/TP and previously reported non noble metal-based electrodes

MEA configuration			Electrolyte (cm^{-3} min^{-1})	Operating temperature (°C)	Current density @ 2.0 V_{cell} (A cm^{-2})	Reference
Catalyst (Anode and cathode)	Membrane	MEA fabrication				
$Co_{65}Fe_{35}O_xH_y$/TP	X37-50	CCS	1 M KOH (20)	50	0.61	This study
$Fe_{0.2}Ni_{0.8}$-$P_{0.5}S_{0.5}$	FAA-3–50	CCS	1 M KOH (50)	60	2.5	48
Ni foam	C-PVA-ABPBI	CCM	15 wt% KOH (-)	70	0.45	49
$VCoCO_x$	FAA-3-50	CCS	1 M KOH (-)	45	0.20	50
Ni foam	PF-41	-	20 wt% KOH (1)	60	0.8	51
Ni foam	PAEK-APMBI	-	10 wt% KOH (-)	60	0.64	52
Ni foam	FAA-3	-	10 wt% KOH (-)	60	0.03	53
$NiCo_2O_4$-HSp	PAni-1.03	CCS	1 M KOH (10)	50	0.4 @ 2 V	54
$Ni_{12}P_5/Ni_3(PO_4)_2$	YAB	CCS	1 M KOH (5)	50	0.36 @ 1.87 V	55
Ni	A201	CCS	1 M KOH (1)	50	0.19 @ 1.8 V	56
CoP NS	YAB	CCS	1 M KOH (5)	50	0.42 @ 1.8 V	57

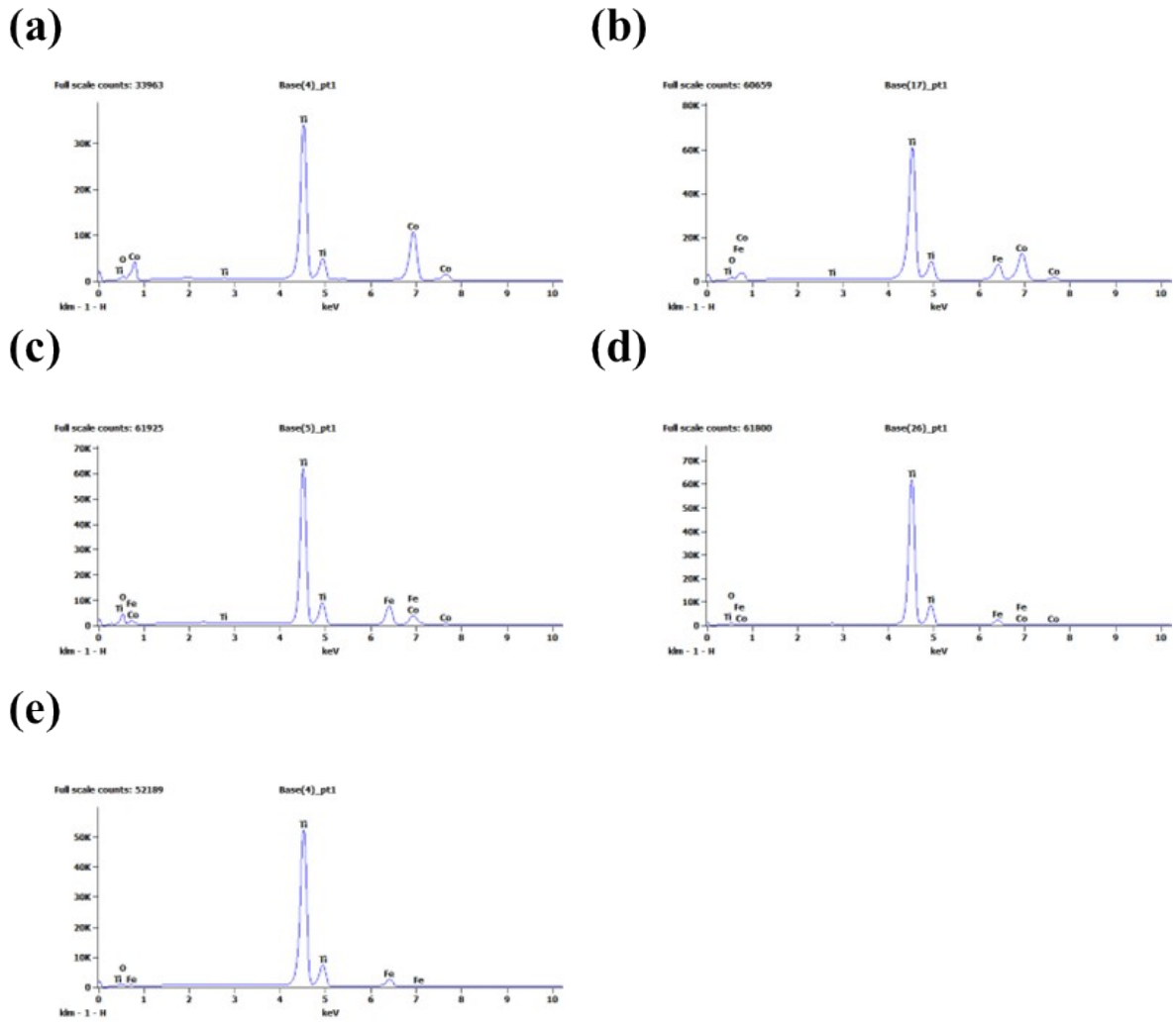

Fig. S1 EDS spectra for (a) CoO_xH_y/TP, (b) $Co_{65}Fe_{35}O_xH_y$/TP, (c) $Co_{52}Fe_{48}O_xH_y$/TP, (d) $Co_{47}Fe_{53}O_xH_y$/TP, and (e) FeO_xH_y/TP.

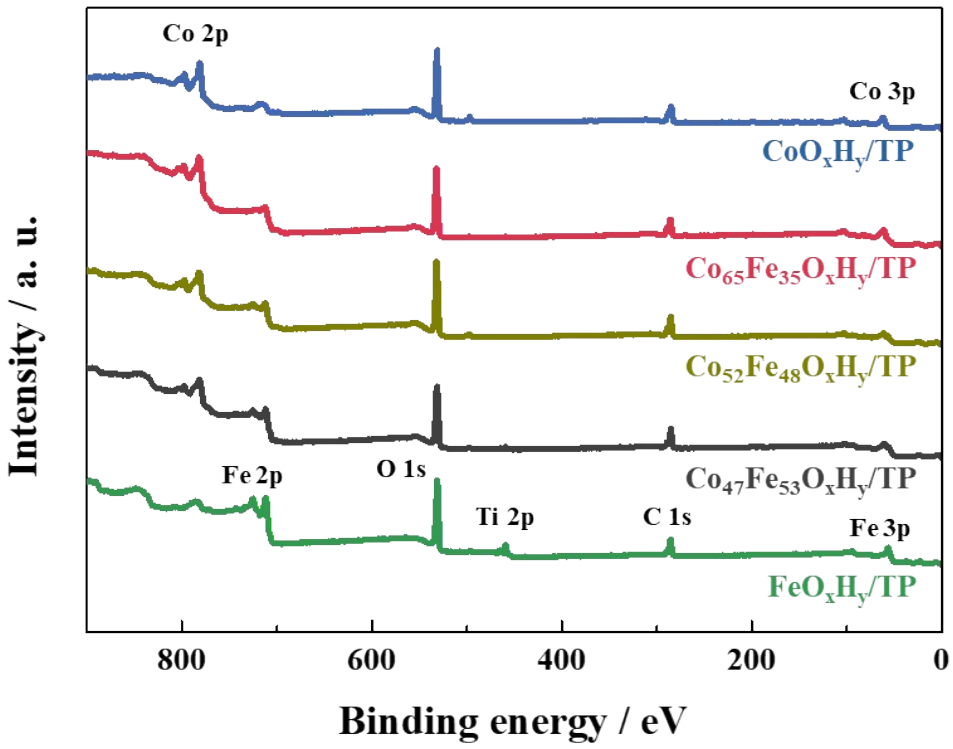

Fig. S2 XPS spectra of CoO_xH_y/TP, $Co_zFe_{1-z}O_xH_y$/TP, and FeO_xH_y/TP.

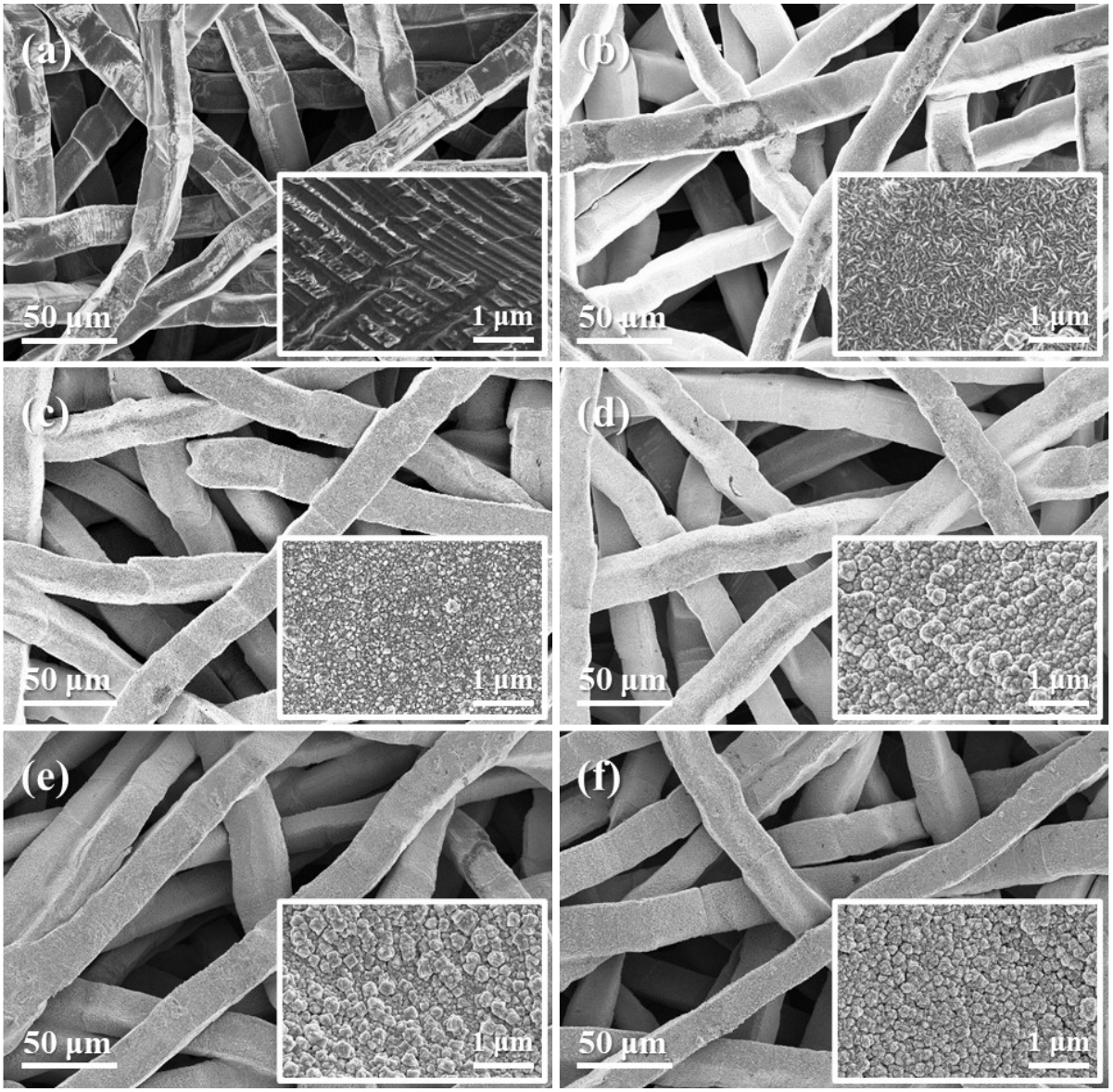

Fig. S3 FESEM images of (a) bare TP, (b) CoO_xH_y/TP, (c) $Co_{65}Fe_{35}O_xH_y$/TP, (d) $Co_{52}Fe_{48}O_xH_y$/TP, (e) $Co_{47}Fe_{53}O_xH_y$/TP, and (f) FeO_xH_y/TP. Insets: corresponding images at a higher magnification.

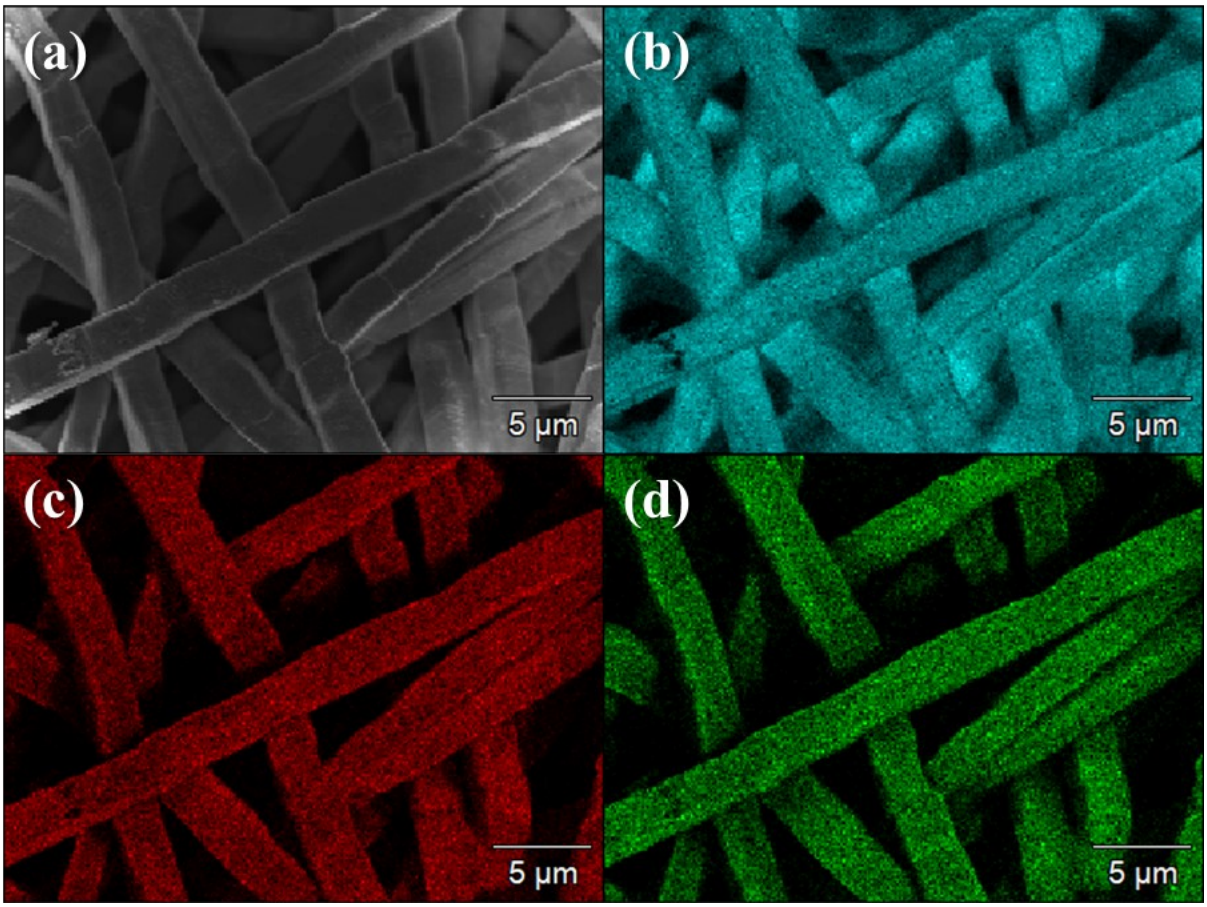

Fig. S4 EDS mapping of $Co_{65}Fe_{35}O_xH_y$/TP. (a) FESEM image and elemental mapping images of: (b) O, (c) Co, and (d) Fe.

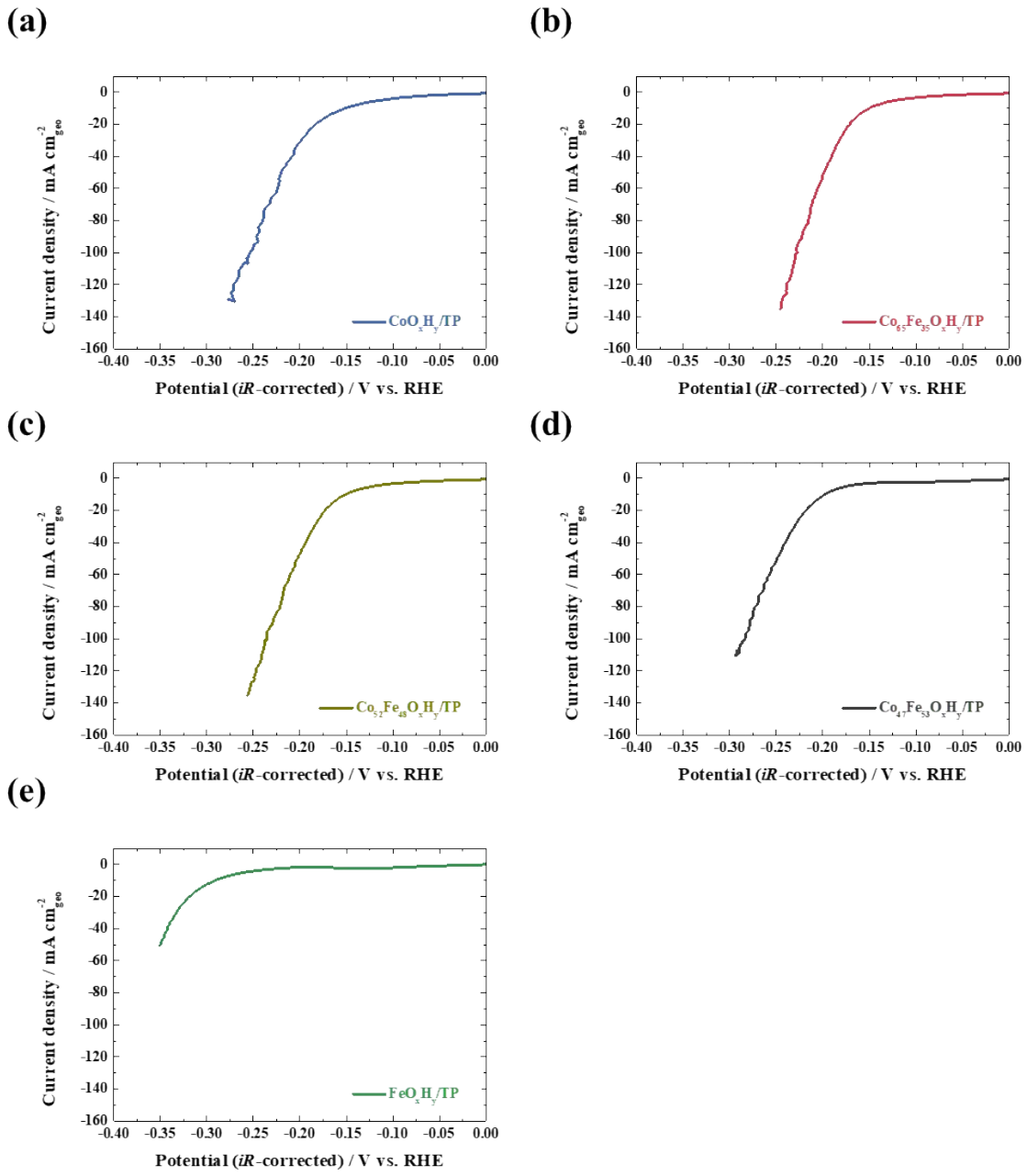

Fig. S5 Polarization curves of HER activity at 5 mV/s in 1.0 M KOH: (a) CoO_xH_y/TP, (b) $Co_{65}Fe_{35}O_xH_y$/TP, (c) $Co_{52}Fe_{48}O_xH_y$/TP (d) $Co_{47}Fe_{53}O_xH_y$/TP, and (e) FeO_xH_y/TP.

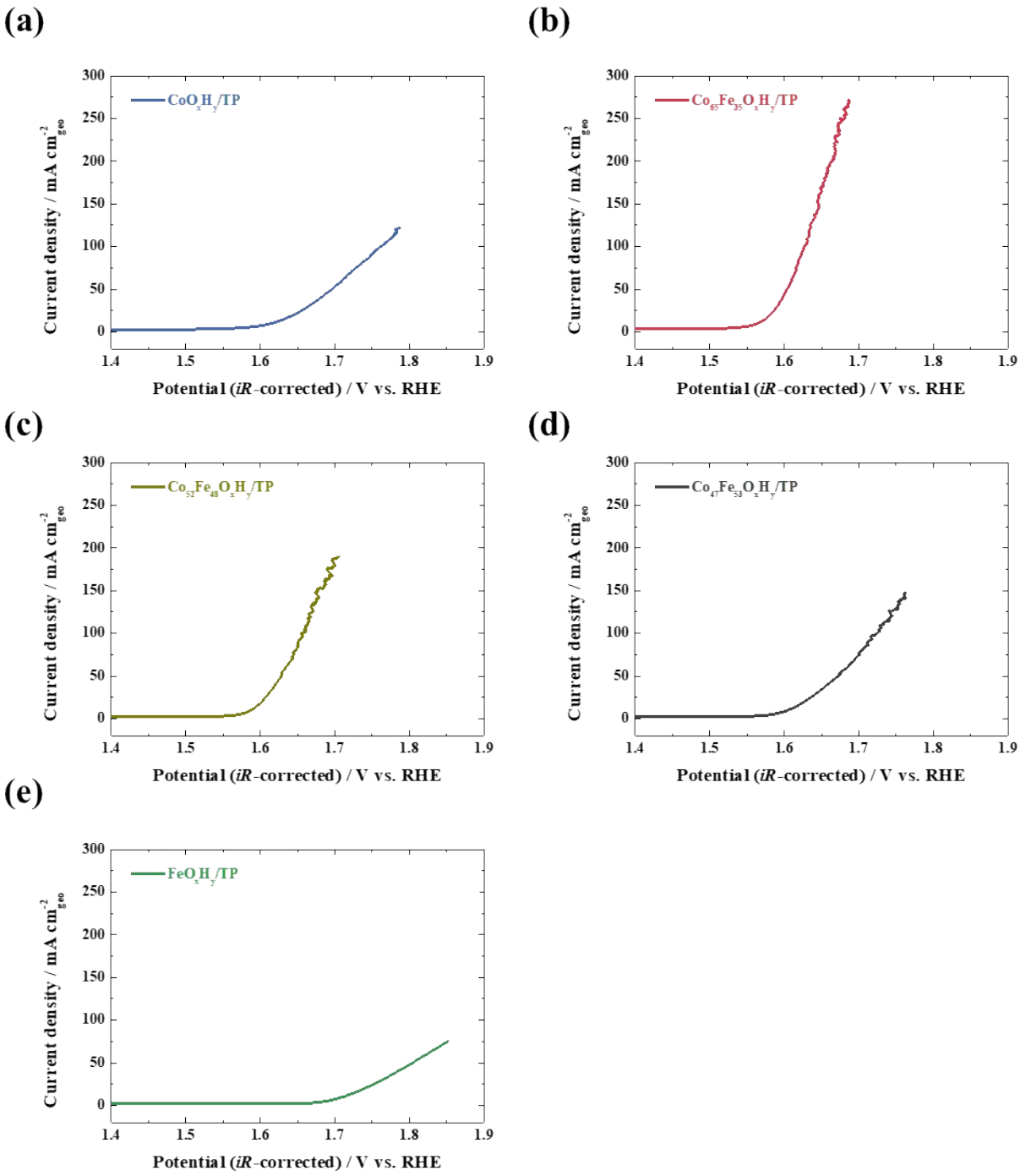

Fig. S6 Polarization curves of OER activity at 5 mV/s in 1.0 M KOH: (a) CoO_xH_y/TP, (b) $Co_{65}Fe_{35}O_xH_y$/TP, (c) $Co_{52}Fe_{48}O_xH_y$/TP (d) $Co_{47}Fe_{53}O_xH_y$/TP, and (e) FeO_xH_y/TP.

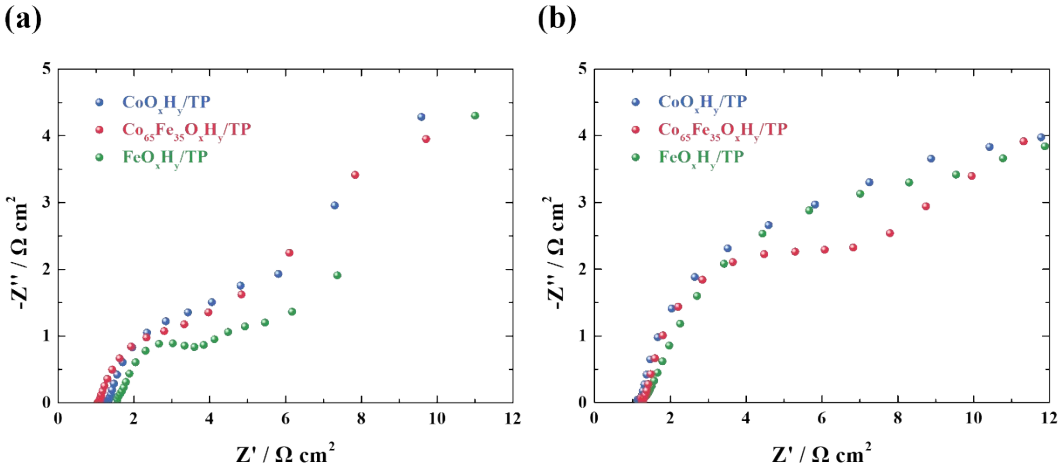

Fig. S7 Nyquist plot of each electrode measured at current density of (a) 10 mA cm^{-2} for OER, and (b) –10 mA cm^{-2} for HER.

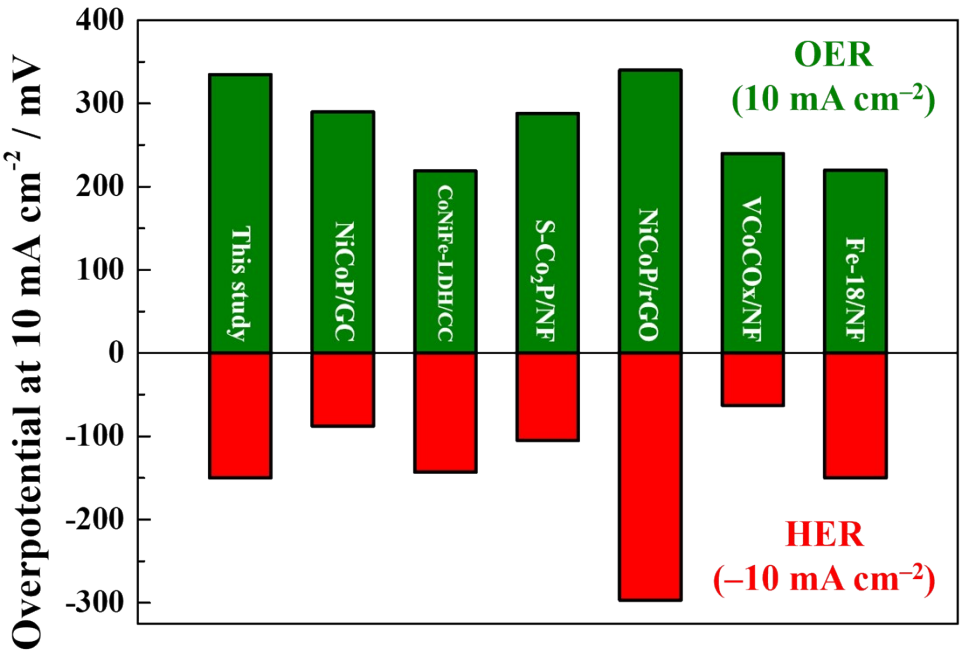

Fig. S8 Comparison of OER/HER overpotential in alkaline condition.

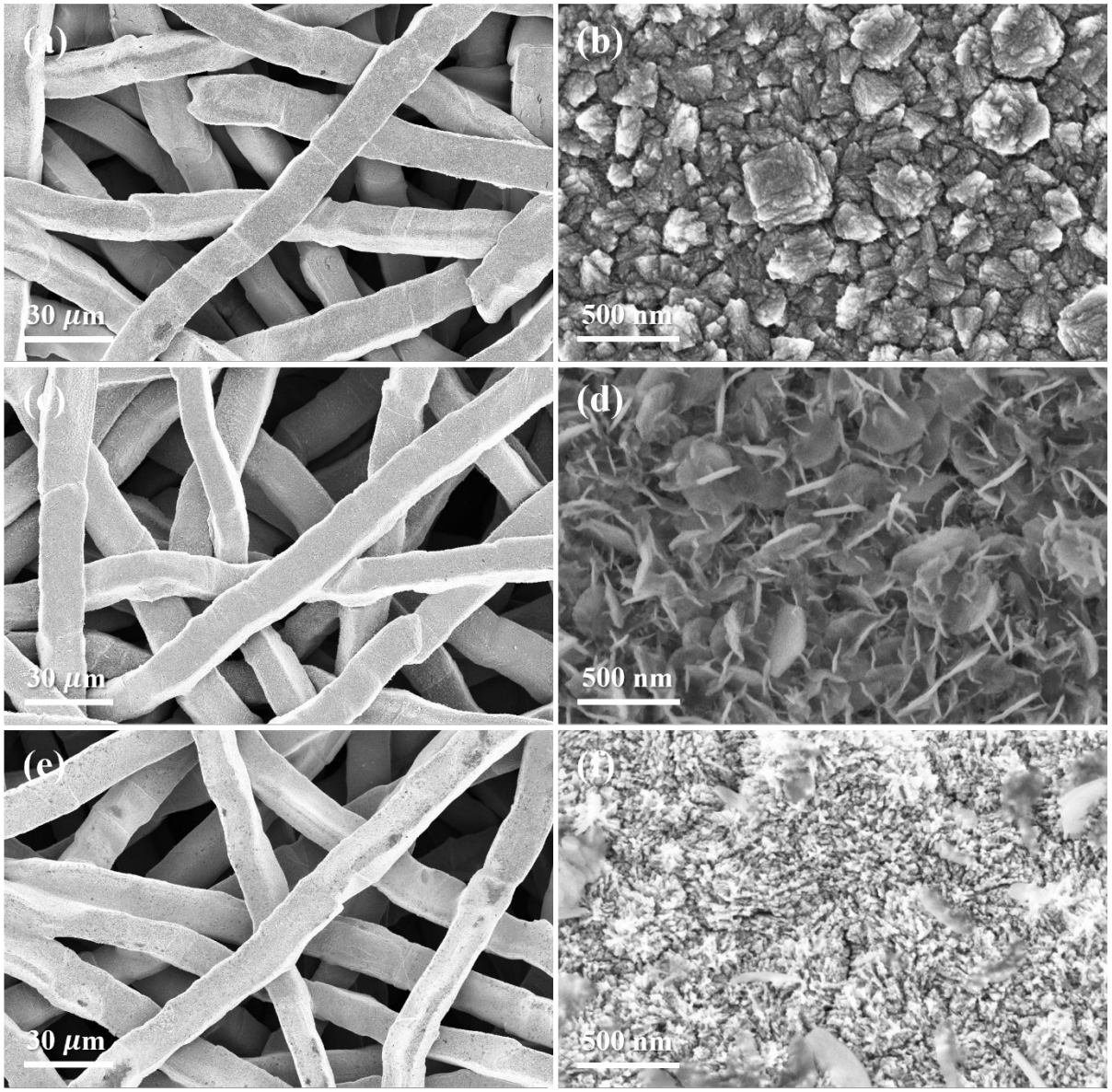

Fig. S9 FESEM images of $Co_{65}Fe_{35}O_xH_y$/TP electrode. (a-b) pristine $Co_{65}Fe_{35}O_xH_y$/TP, (b) (c-d) $Co_{65}Fe_{35}O_xH_y$/TP after OER long-term stability test, (e-f) $Co_{65}Fe_{35}O_xH_y$/TP HER long-term stability test.

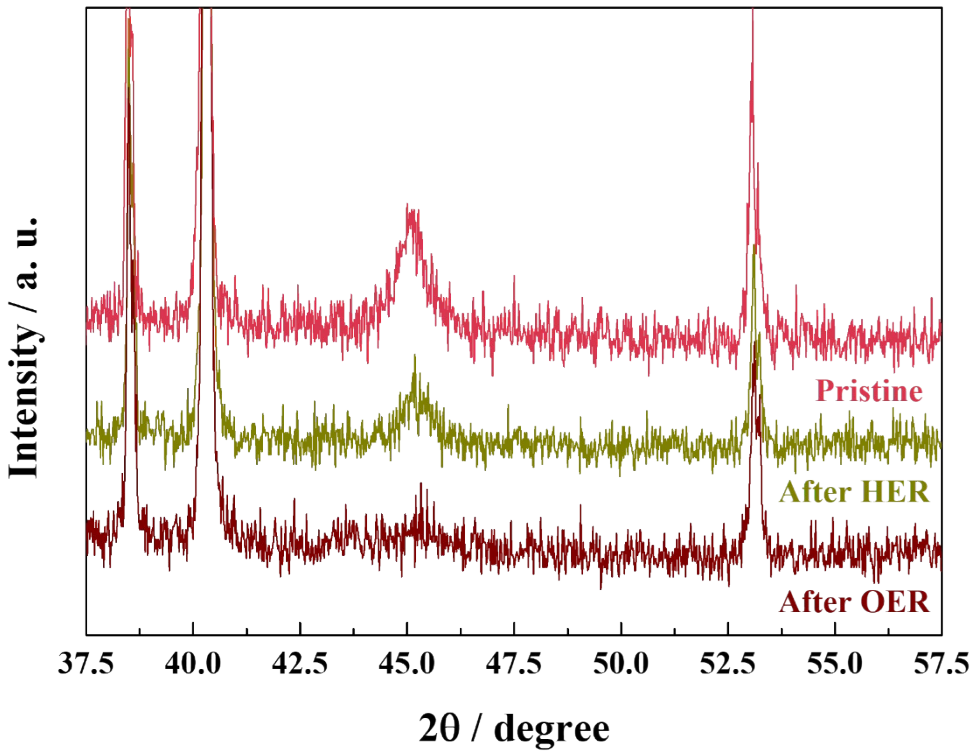

Fig. S10 XRD patterns of the $Co_{65}Fe_{35}O_xH_y$/TP after HER/OER stability test.

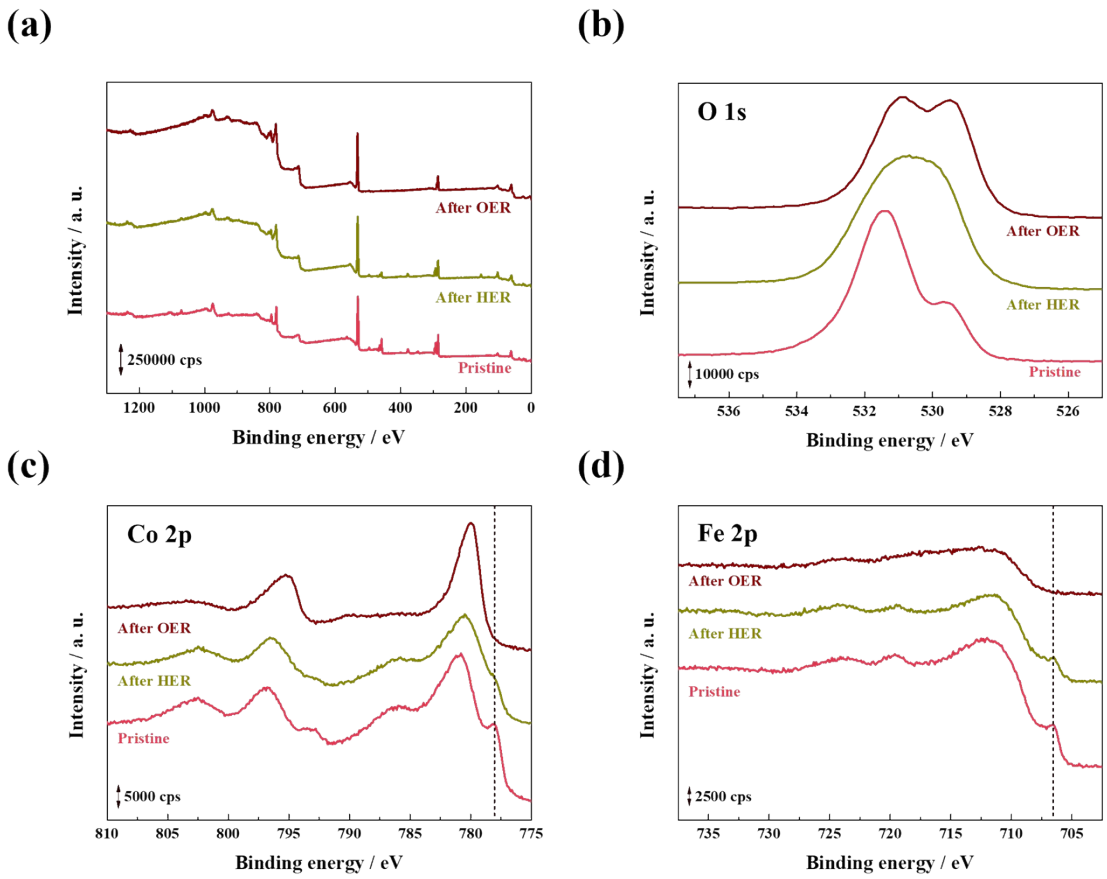

Fig. S11 XPS spectra of pristine and after stability test for (a) survey peaks, (b) O 1s, (c) Co 2p, and (d) Fe 2p.

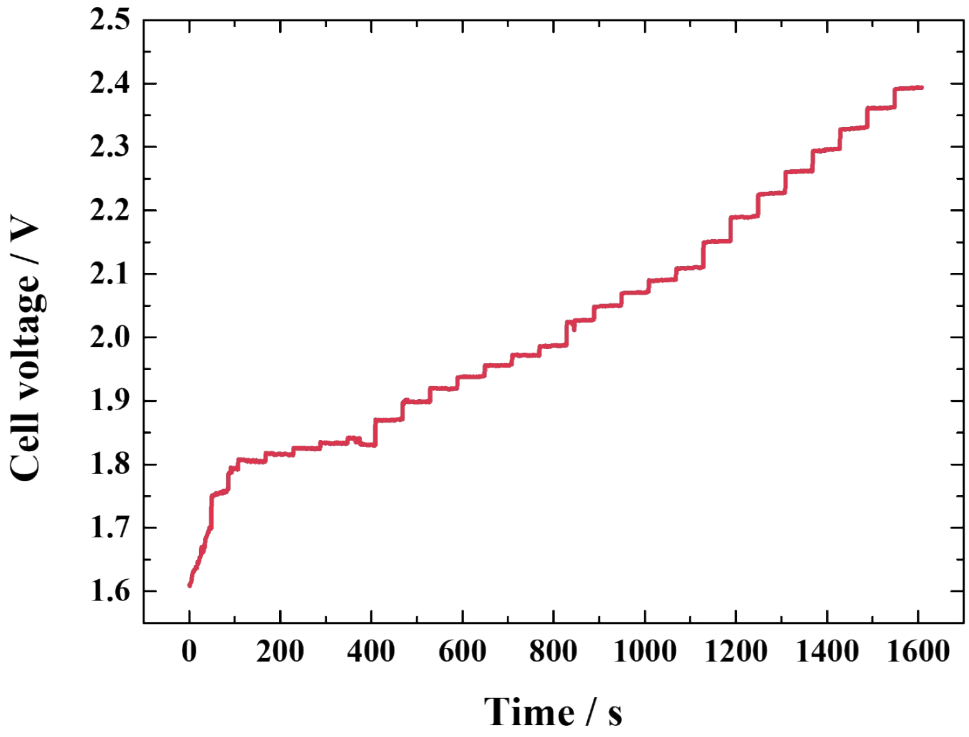

Fig. S12 Chronoamperometric curves for the AEMWE with bifunctional $Co_{65}Fe_{35}O_xH_y$/TP.

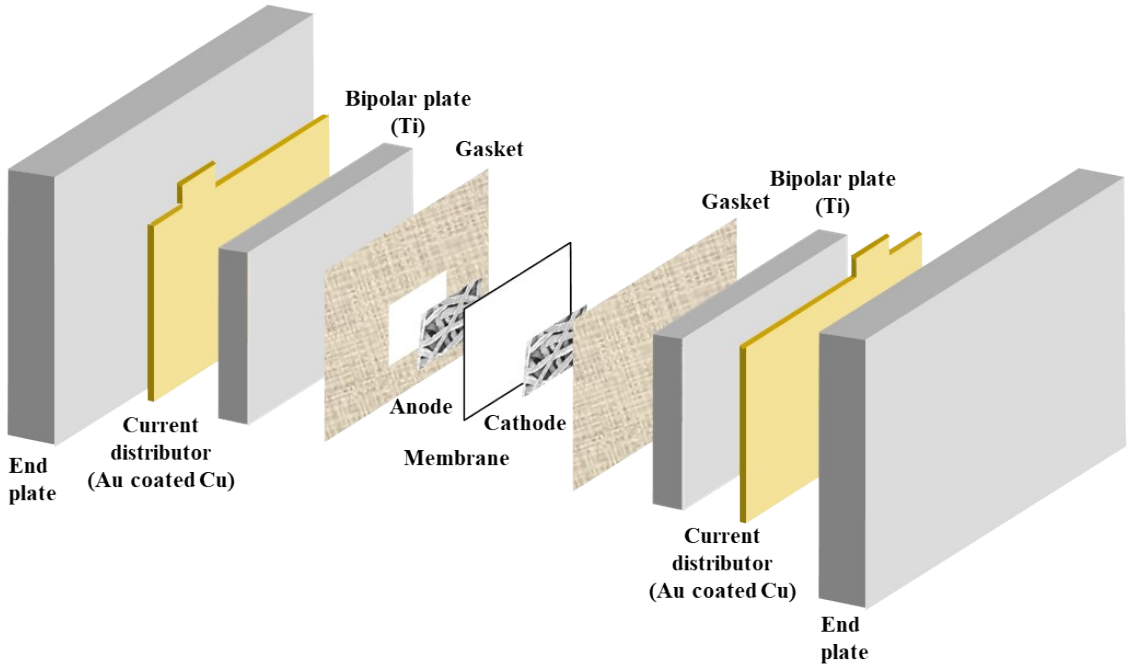

Fig. S13 Configuration of AEMWE single-cell.