Supporting Information

A Bifunctional Hexa-filamentous Microfibril Multi-metallic Foam: An Unconventional High-Performance Electrode for Total Water Splitting Under Industrial Operation Conditions

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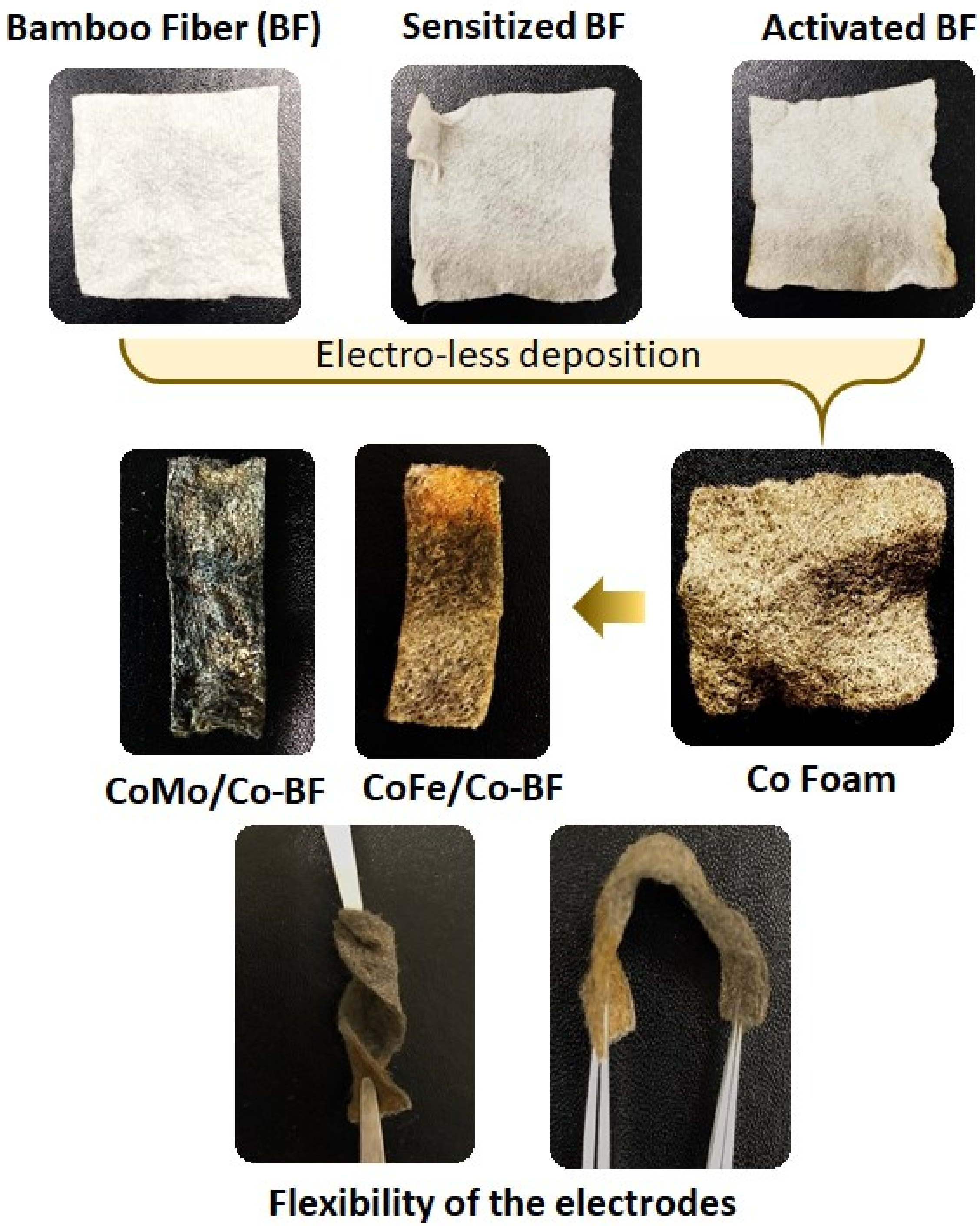

Figure S1. The stepwise preparation of BF electrodes and their flexible nature

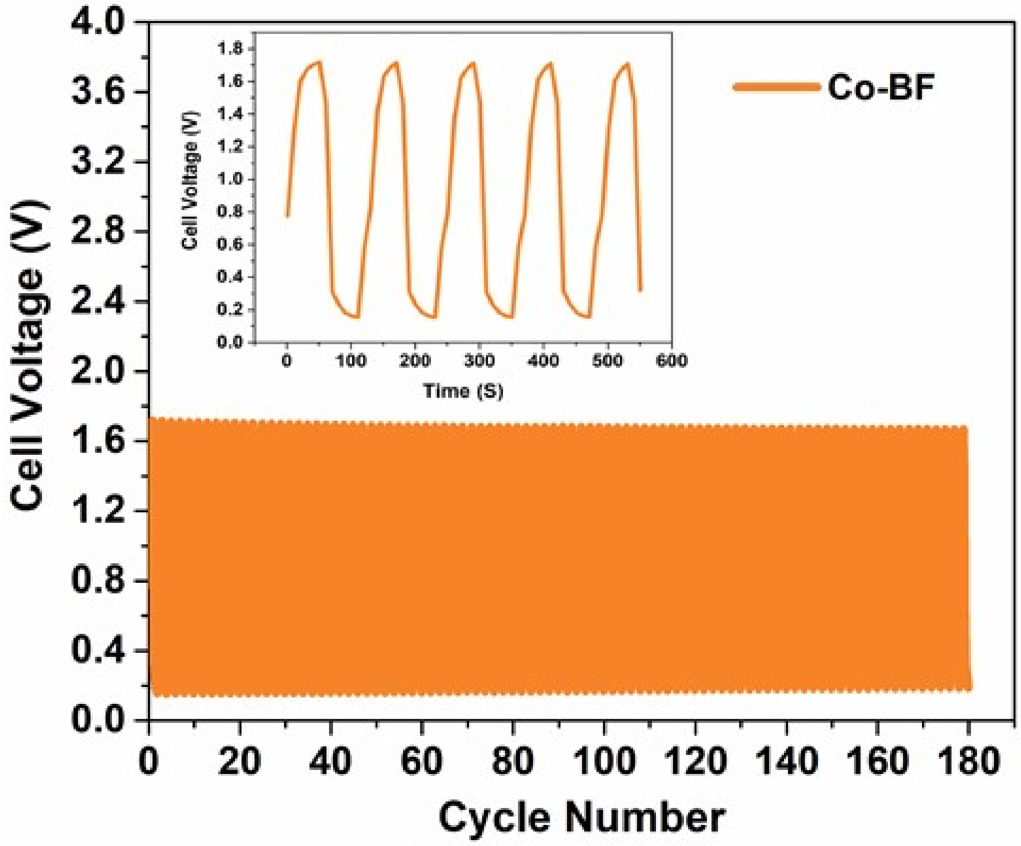

Figure S2. Charge-discharge performance of Co-BF as cathode for Zn-air battery application. Insets show first 5 cycles of charge-discharge curve of Co-BF.

The bare Co-BF substrate was tested as cathode for Zn-air battery against zinc metal anode in (0.2 M zinc acetate in 1M KOH) an alkaline electrolyte medium at a current density of 5 mA cm^{-2} . The charge-discharge performance was tested for 6 hours at a rate of 2 minutes per cycle (1-minute discharge, 1-minute charge) for 180 cycles. The zinc-air cell delivered a stable charge-discharge performance which indicates the high conductivity, durability and stability of the Co-BF electrode.

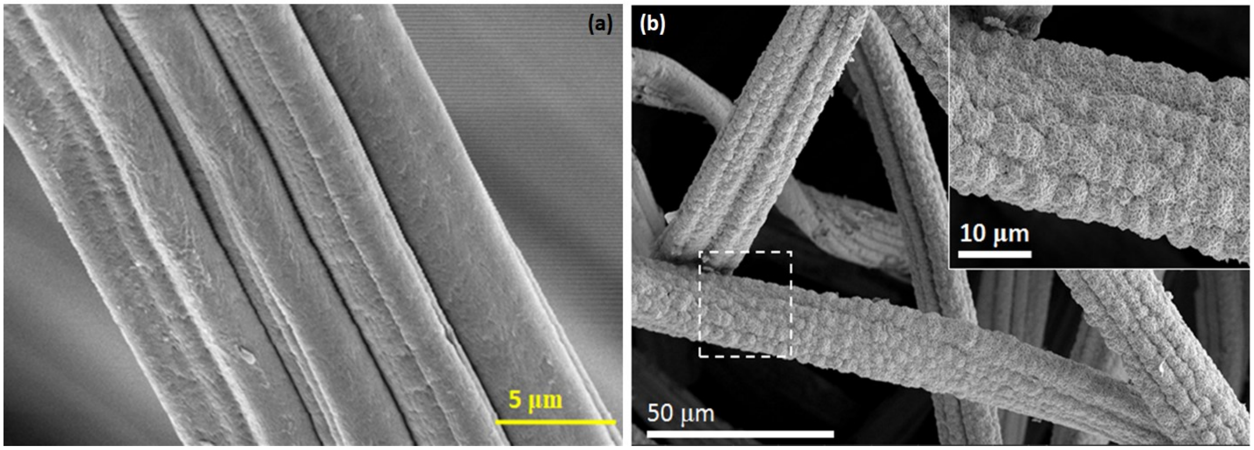

Figure S3. High magnification SEM micrographs of (a) BF and (b) Co-BF.

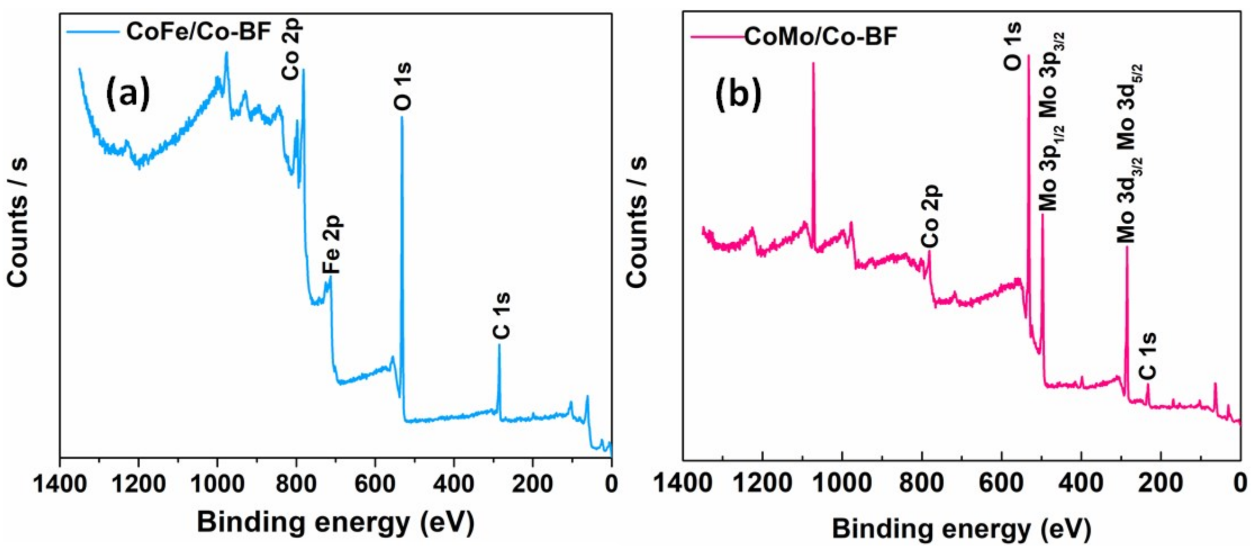

Figure S4. XPS survey spectra and fittings of CoFe/Co-BF and CoMo/Co-BF.

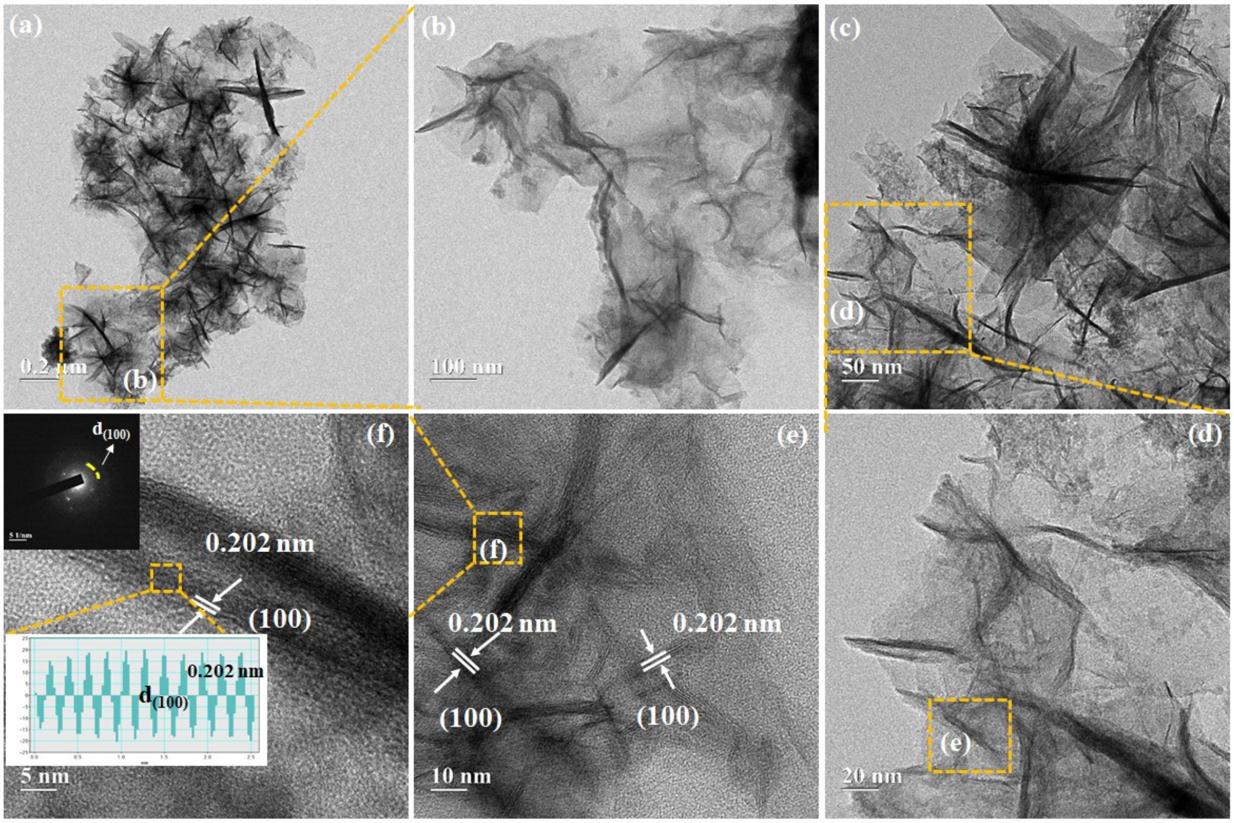

Figure S5. HR-TEM micrograph and corresponding SAED pattern of electrodeposited CoFe/Co-BF electrode (with nanoflower like morphology).

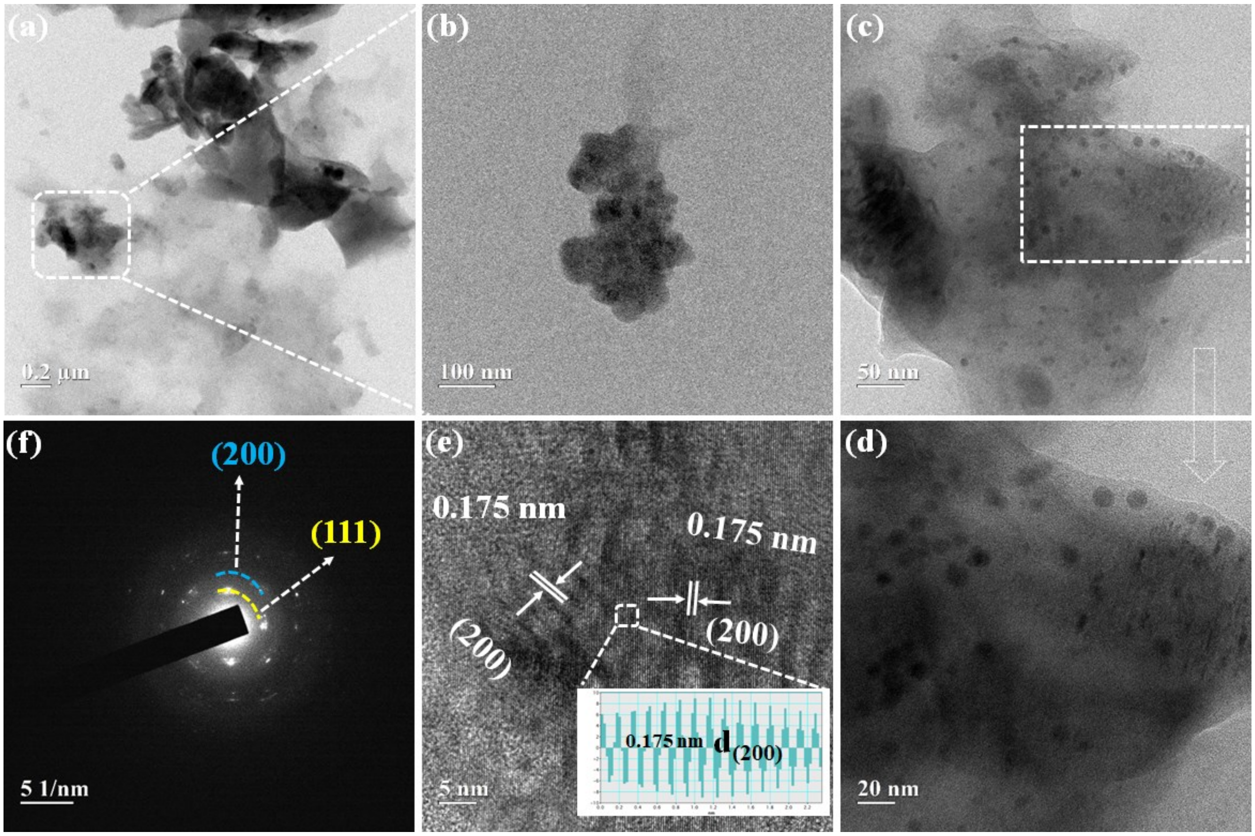

Figure S6. HR-TEM micrographs and corresponding SAED pattern of electrodeposited CoMo/Co-BF electrode.

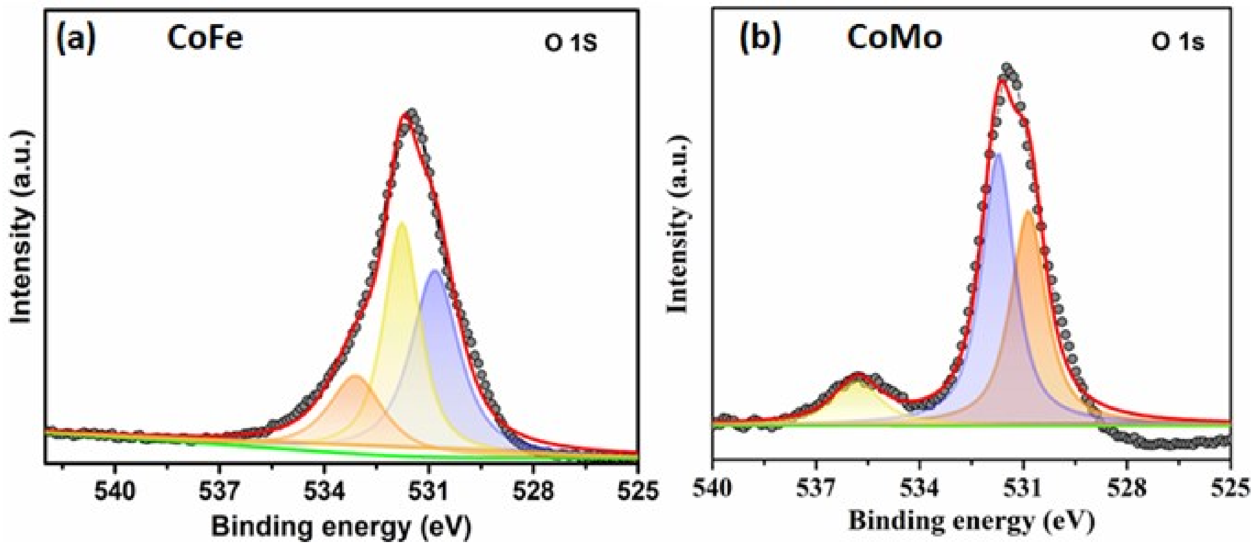

Figure S7. (a,b) High resolution XPS spectra in O1s region.

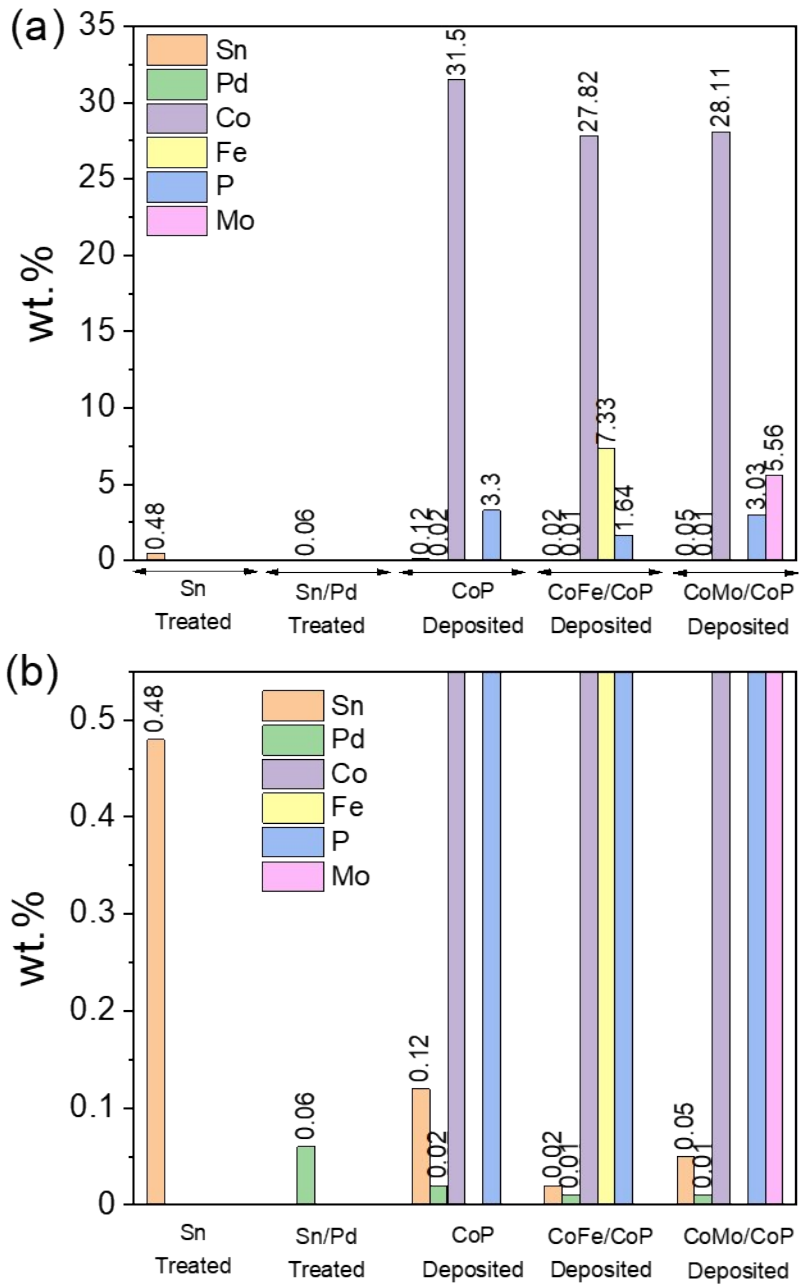

Figure S8: (a-b) ICP-MS data showing the wt.% of elements Sn, Pd, Co, P, Fe, and Mo.

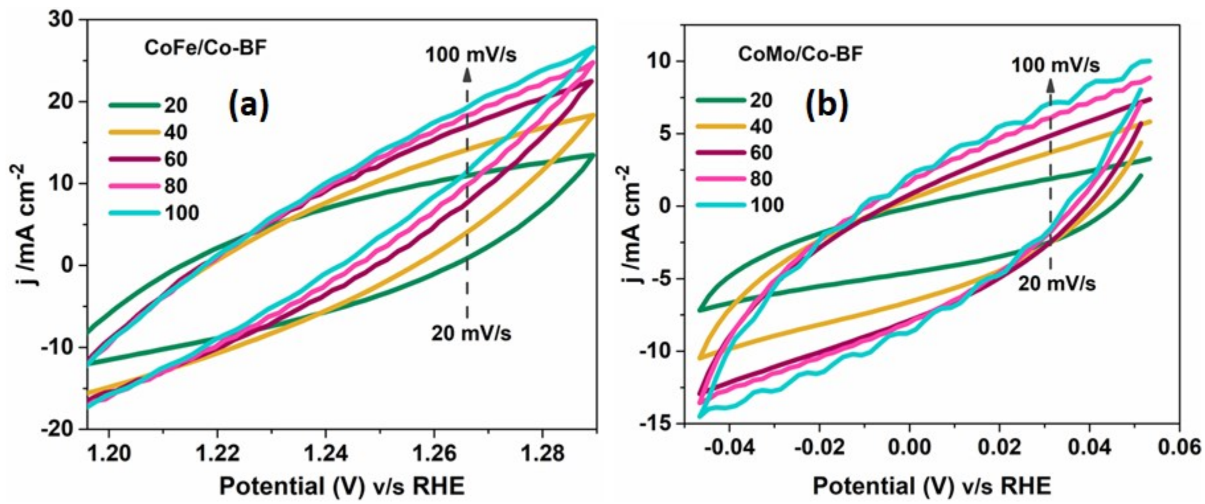

Figure S9. ECSA estimation determined from C_{dl}. (a,b) CV cycle recorded in non-faradic region at different scan rates for CoFe/Co-BF and CoMo/Co-BF.

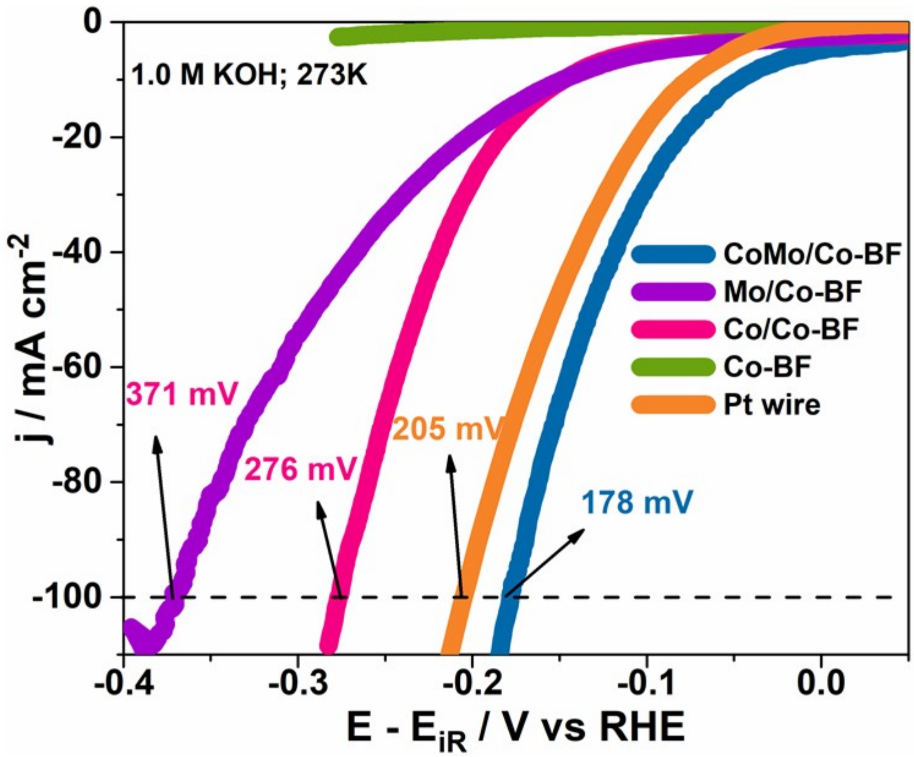

Figure S10. Overpotential at high current density from iR corrected polarization curves of CoMo/Co-BF, Co/Co-BF, Mo/Co-BF and Co-BF recorded at scan rate of 5mV s^{-1}.

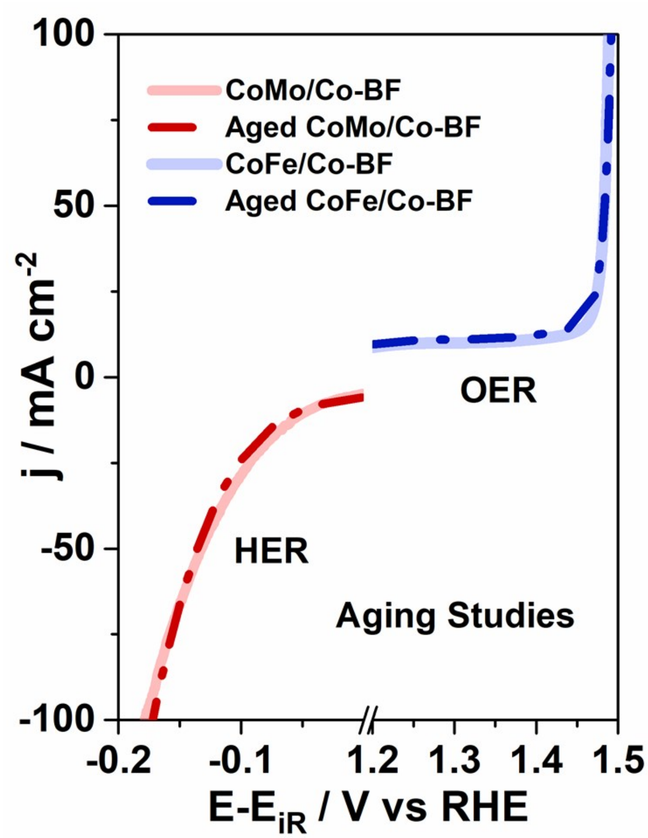

Figure S11. The HER and OER performance of the aged CoMo/Co-BF and CoFe/Co-BF electrodes, respectively, measured after few months (90 days).

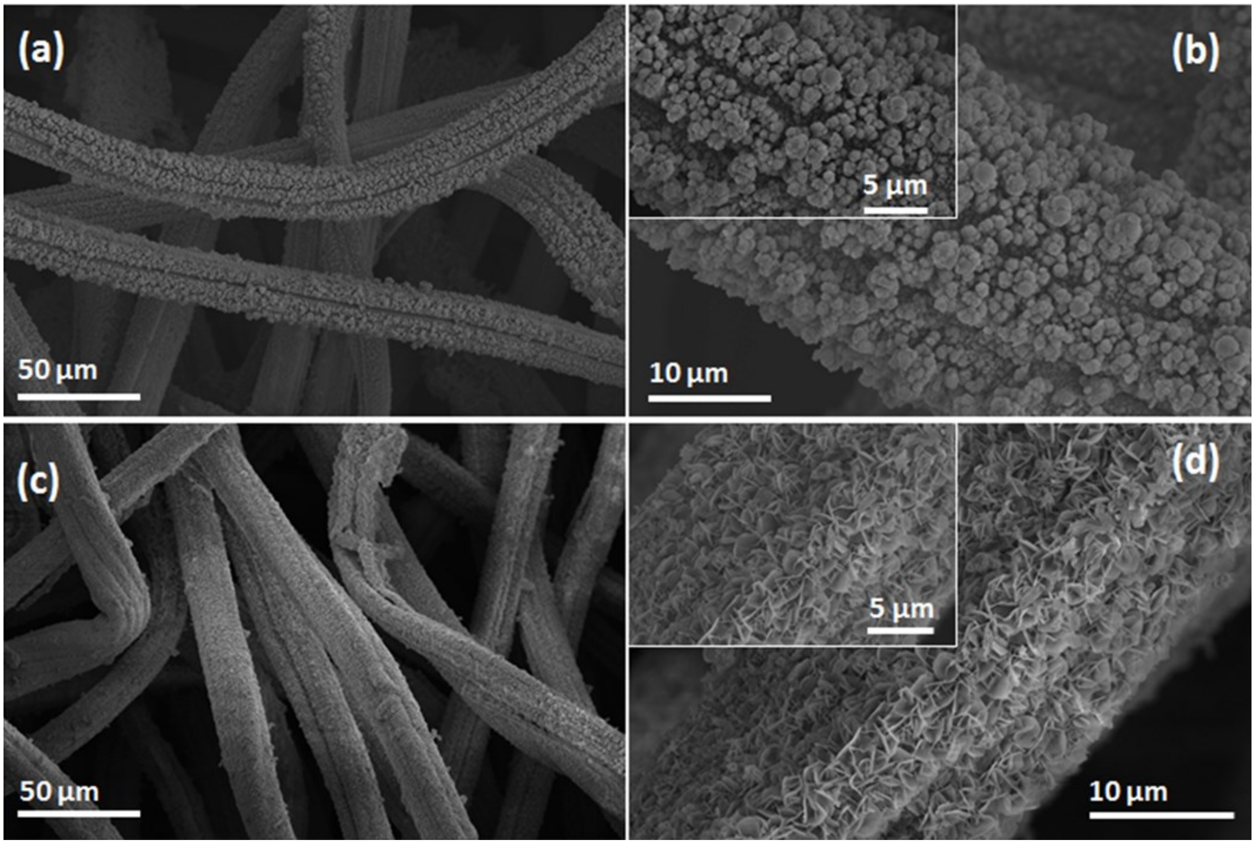

Figure S12. The FE-SEM micrographs of (a, b) anode (CoFe/Co-BF) and (c, d) cathode (CoMo/Co-BF) after prolonged electrolysis at a high current density (200 mA cm^{-2}) showed increased roughness due to aging effect.

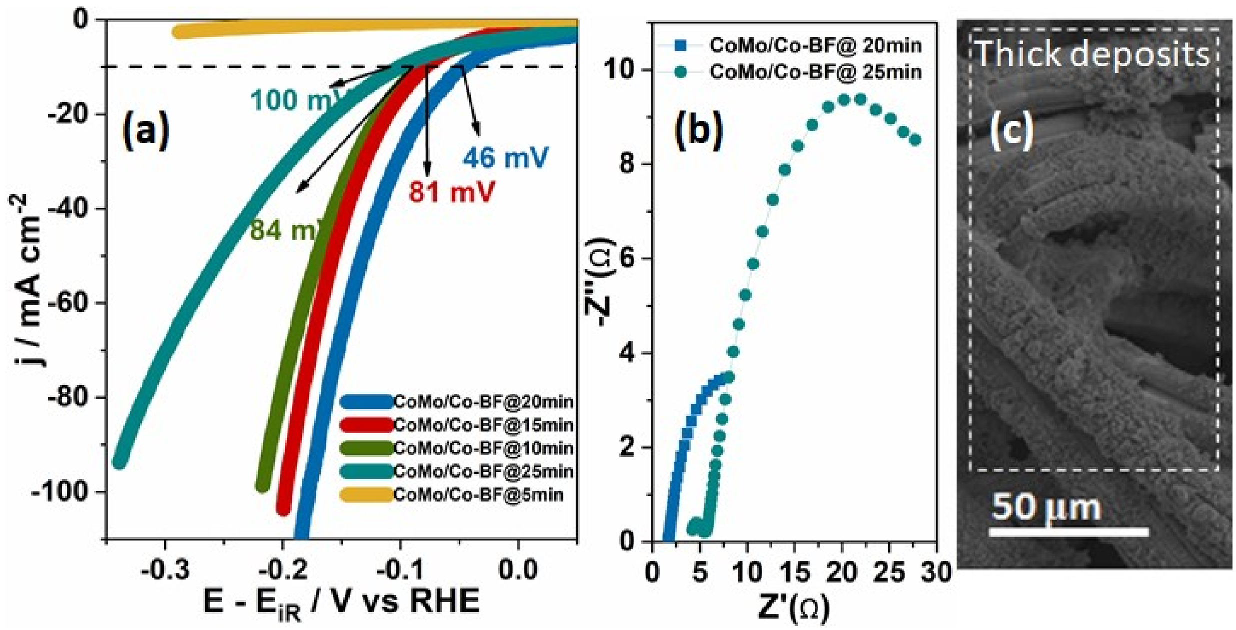

Figure S13. **(a)** The HER performance of the CoMo/Co-BF electrodes with respect to the catalyst loading (5, 10, 15, 20 and 25 min of loading, refer experimental section), (b) electrochemical impedance spectroscopy of electrodes with 20 min and 25 min deposition with optimum catalyst loading, (c) SEM micrograph of CoMo/Co-BF with maximum deposition time used showing thick deposits on the Co-BF.

Supplementary Table 1. Comparison of available robust non-noble OER catalyst with as synthesized CoFe/Co-BF

Entry	Catalyst material	η at 50 mA cm^{-2} (mV)	Reference
1	CoFe/Co-BF	250	This work
2	NiCoP/ Scrap copper wire	280	Adv. Energy Mater. 2018, 8, 1802615
3	FeP-rGO	348*	J. Mater. Chem. A 4, 9750-9754 (2016).
4	Electrodeposited CoP film	395*	Angew. Chem. Int. Ed. 54, 6251-6254 (2015).
5	CoP_2 /rGO	370*	J. Mater. Chem. A 4, 4686-4690 (2016).
6	$NiCo_2O_4$	320*	Angew. Chem. Int. Ed. 55, 6290-6294 (2016).
7	$Ni_{0.51}Co_{0.49}P$ film	321*	Adv. Funct. Mater. 26, 7644-7651 (2016).
8	NiFe LDH	360*	Science 345, 1593-1596 (2014).
9	$NiCo_2S_4$ nanowire array	330*	Adv. Funct. Mater. 26, 4661-4672 (2016)
10	LiCoBPO	400*	Energy Environ. Sci., 2019,12, 988-999
11	Ni_3Se_2	550*	Energy Environ. Sci., 2016,9, 1771-1782
12	$Ni_{11}(HPO_3)_8(OH)_6$	330*	Energy Environ. Sci., 2018,11, 1287-1298
13	$NiCo_2O_4$	290*	Angew. Chem. Int. Ed. 55, 6290-6294 (2016).

*The data were calculated according to the curves given in the literature

Supplementary Table 2. Comparing the catalytic performance of as prepared CoMo/Co-BF at j= -10 mA cm^{-2} in alkaline electrolyte with available earth abundant HER catalyst.

Entry	Catalyst material	η at -10 mA cm^{-2} (mV)	Reference
1	CoMo/Co-BF	46	This work
2	NiCoP/ Scrap copper wire	178	Adv. Energy Mater. 2018, 8, 1802615
3	Co/CoP nanocrystals	135	ACS Nano 11, 4358-4364 (2017).
4	CoP nanowire/CC	209	J. Am. Chem. Soc. 136, 7587-7590 (2014).
5	$Ni_{1-x}Co_xSe_2$ nanosheet	85	Adv. Mater. 29, 1606521 (2017).
6	MoP crystals	~140	Energy Environ. Sci. 7, 2624-2629 (2014)
7	FeP nanowire arrays	194	Chem. Commun. 52, 2819-2822 (2016).
8	Nanoporous Co_2P	60	Adv. Mater. 28, 2951-2955 (2016).
9	Electrodeposited CoP film	94	Angew. Chem. Int. Ed. 54, 6251-6254 (2015).
10	MoS_2 /Ni_3S_2	110	Angew. Chem. Int. Ed. 55, 6702-6707 (2016).
11	EG/$Co_{0.85}$Se/NiFe-LDH	260	Energy Environ. Sci. 9, 478-483 (2016).
12	$NiFeO_x$ /CFP	88	Nat. Commun. 6, 7261 (2015).
13	NiP/Ni	130	Adv. Funct. Mater. 26, 3314-3323 (2016).
14	NiCo2S4 nanowire array	210	Adv. Funct. Mater. 26, 4661-4672 (2016).
15	CoP_2 /rGO	88	J. Mater. Chem. A 4, 4686-4690 (2016)

Supplementary Table 3. Comparison of overall water splitting activities with recently reported robust catalysts on different substrates.

Electrode architecture (Electrocatalyst/substrate)		**η10, overall (V)**	**Reference**
CoFe/Co-BF‖CoMo/Co-BF	Bamboo fiber	1.55	This work
NiCoP films	Scrap copper wires	1.59	Adv. Energy Mater. 2018, 8, 1802615.
NiP/Ni	Nickel foam	1.61	Adv. Funct. Mater. 2016, 26, 3314
$Co_{0.85}Se$/NiFeLDH	Graphite foil	1.67	Energy Environ. Sci., 2017, 9, 478
CP/CT/Co-S	Carbon fiber paper	1.74	ACS Nano, 2016, 10, 2342
Ni-P	Carbon fiber paper	1.63	Adv. Funct. Mater. 2016, 26, 4067
$Ni_{0.33}Co_{0.67}S_2$ (anode) $NiCoO_4$ (cathode)	Titanium foil	1.73	Adv. Energy Mater. 2015, 5, 1402013
$NiCo_2O_4$	Nickel foam	1.65	Angew. Chem., Int., Ed. 2016, 55, 6290
CoP film	Copper foil	1.64	Angew. Chem., Int., Ed. 2015, 54, 6251
NiFe - LDH	Nickel foam	1.7	Science, 2014, 345, 1593
$FeNi_3N$	Nickel Foam	1.62	Chem. Mater. 2016, 28,6934
$NiCo_2S_4$	Carbon cloth	1.68	Nanoscale, 2015, 7,
NiFe/NiCo2O4/ Ni	Nickel Foam	1.67	Adv. Funct. Mater. 2016, 26, 3515