Supporting Information

In-Situ Generated Cu-Co-Zn Trimetallic Sulfides Nanoflowers on Copper Foam: a Highly Efficient OER Electrocatalyst

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Some descriptions of the principles and the reaction process as follows. Eqs. (1)-(9).

Pretreated copper hydroxide was grown on CF:

$$Cu + 4NaOH + (NH_4)_2S_2O_8 \rightarrow Cu(OH)_2 + 2Na_2SO_4 + 2NH_3\uparrow + 2H_2O \quad (1)$$

The precipitation and infusion of multiple cations lead to an increment in the extent of redox reactions. Adding urea served as aconstant source of CO_3^{2-} and OH^- ions, which on reaction with precursor metal ions, stabilized the formation of hydroxides. The presence of NH_4F is beneficial to maintain the needle-like morphology:

$$CO(NH_2)_2 + H_2O \rightarrow 2NH_3 + CO_2 \quad (2)$$

$$NH_3 + H_2O \rightarrow NH^{4+} + OH^- \quad (3)$$

$$CO_2 + H_2O \rightarrow CO_3^{2-} + 2H^+ \quad (4)$$

$$Co^{2+} + Cu^{2+} + Zn^{2+} + yOH^- \rightarrow CuCoZn(OH)_y \quad (5)$$

When Na_2S is added, metal ions react with sulfur ions and the reaction process is roughly as follows:

$$Na_2S \rightarrow 2Na^+ + S^{2-} \quad (6)$$

$$9Co^{2+} + 8S- \rightarrow Co_9S_8 \quad (7)$$

$$Zn^{2+} + S^{2-} \rightarrow ZnS \quad (8)$$

$$2Cu^{2+} + S^{2-} \rightarrow Cu_2S + S\downarrow \quad (9)$$

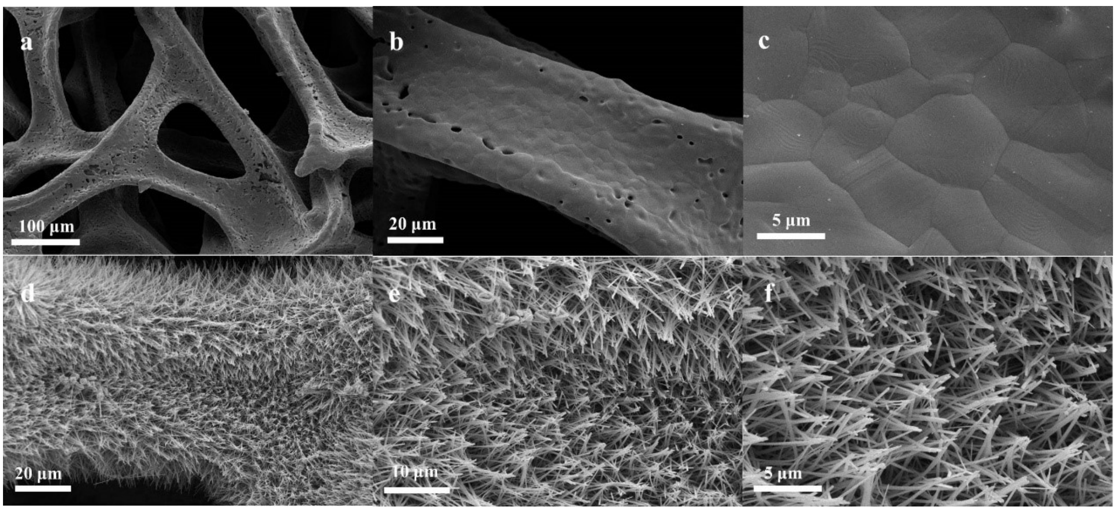

Fig. S1. SEM images of (a-c) Cu foam at high and low magnifications and images of (d-f) $Cu(OH)_2$.

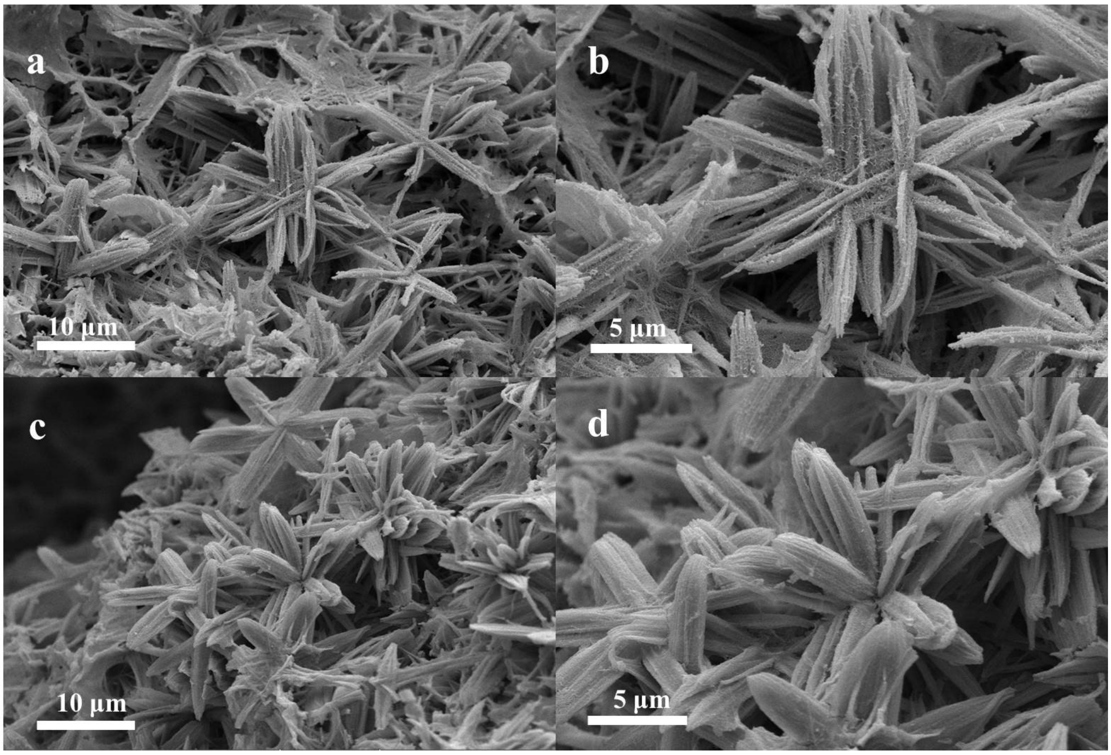

Fig. S2. SEM images of (a,b) CuCoZn-S-1 and (c,d) CuCoZn-S-6.

Table S1. Elemental composition of Cu, Co and Zn determined by ICP-OES.

Element	Cu	Co	Zn
Content (Wt %)	90.16	6.10	3.20

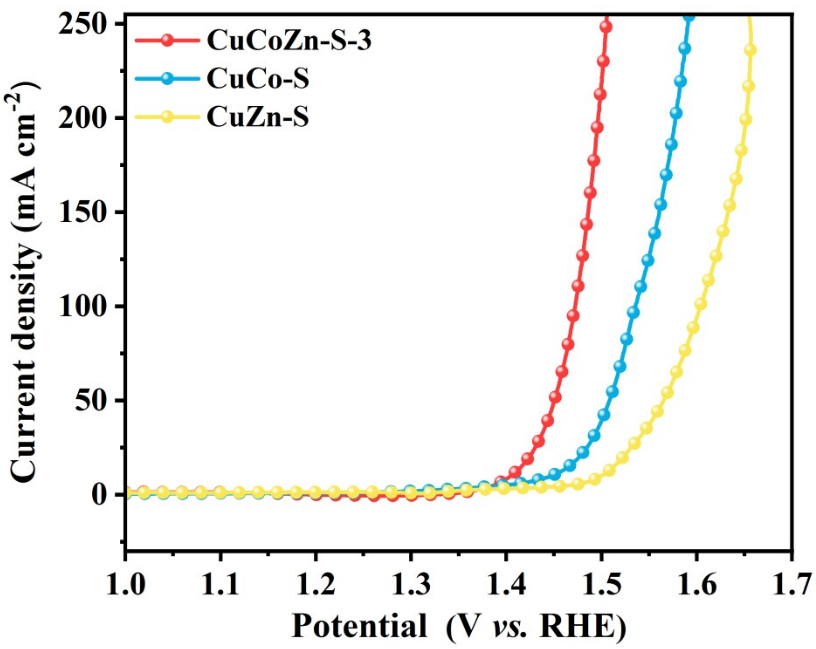

Fig. S3. LSV curves of CuCoZn, CuCo-S and CuZn-S cured for 3 h.

Table S2. The comparison of OER catalytic performances between CuCoZn-S-3 and other materials recently reported in the literatures.

Catalyst	Overpotential (mV)	Tafel slope (mV dec^{-1})	Electrolyte	Reference
CuCoZn-S-3	175@10	62.3	1.0M KOH	This work
$MoNiFeS_x@FeNi_3$	192@10	72.8	1.0M KOH	1
$NiFeCoS_x@FeNi_3$	210@10	45	1.0M KOH	2
$Fe\text{-}Ni_3S_2@FeNi_3\text{-}8$	213@10	83	1.0M KOH	3
$(Ni,Fe)S_2/MoS_2$	270@10	43.21	1.0M KOH	4
Ni-Co-S-P	280@10	69	1.0M KOH	5
$FeNi/(FeNi)_9S_8$	283@10	95.1	1.0M KOH	6
$MoS_2/NiCoS$	290@10	77	1.0M KOH	7

Table S3. The comparison of OER catalytic performances of other trimetallic oxides and phosphide materials recently reported in the literatures.

Electrocatalysts	Overpotential (mV)	Tafel slope (mV dec^{-1})	Electrolyte	Reference
$In_2O_3/ZnO/Co_3O_4$	398	88	1.0 M KOH	8
$Cu_xMo_x/Co_{1-x}O$ NPs@RGO	250	61	1.0 M KOH	9
$Co_3Fe_4V_3O_x$	249	41	1.0 M KOH	10
CoFeNi-O-1	244	55.4	1.0 M KOH	11
NiFeCoP@CAP/NF,	202	28.9	1.0 M KOH	12
CoNiFeP	261	49.5	1.0 M KOH	13
np-NiFeCoP	244	41.4	1.0 M KOH	14
NiCoFe-P-NP@NiCoFe-PBA	223	78	1.0 M KOH	15

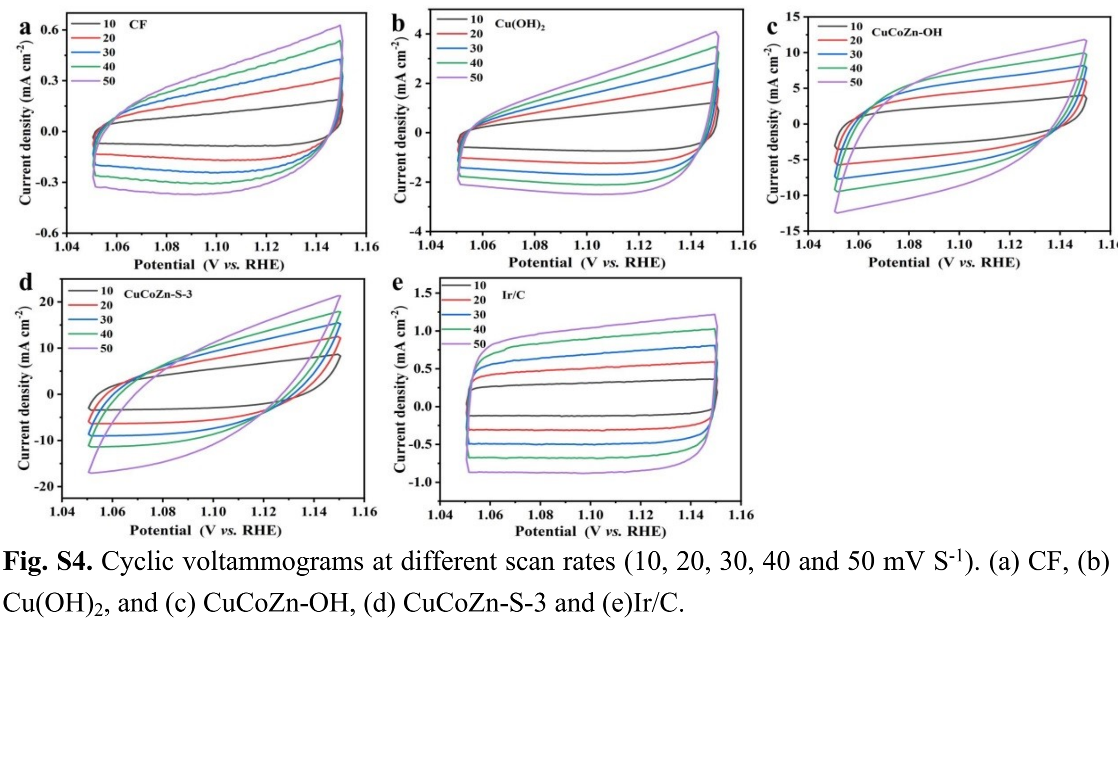

Fig. S4. Cyclic voltammograms at different scan rates (10, 20, 30, 40 and 50 mV S^{-1}). (a) CF, (b) $Cu(OH)_2$, and (c) CuCoZn-OH, (d) CuCoZn-S-3 and (e)Ir/C.

Table S4. Comparison of OER activity of CuCoZn-S catalysts with different time at 1 M KOH.

Catalysts	η_{10} (mV)	η_{100} (mV)
CuCoZn-S-1	180	262
CuCoZn-S-6	188	286

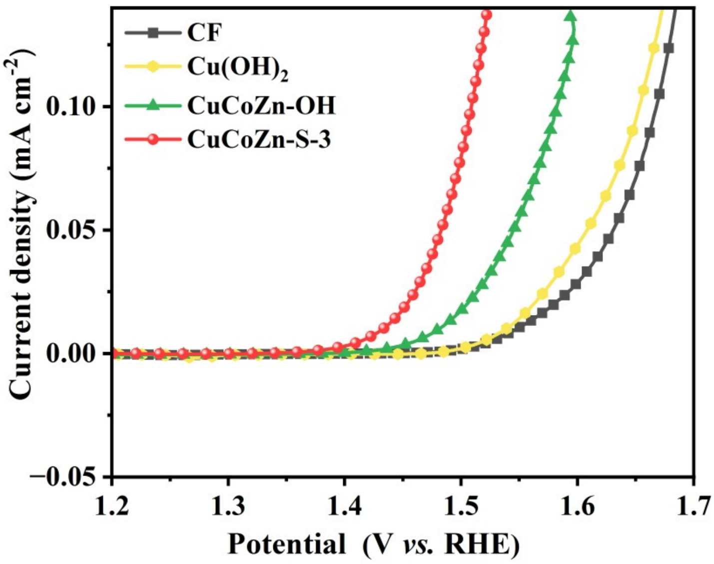

Fig. S5. ECSA-normalized LSV curves of CF, $Cu(OH)_2$,CuCoZn-OH and CuCoZn-S-3.

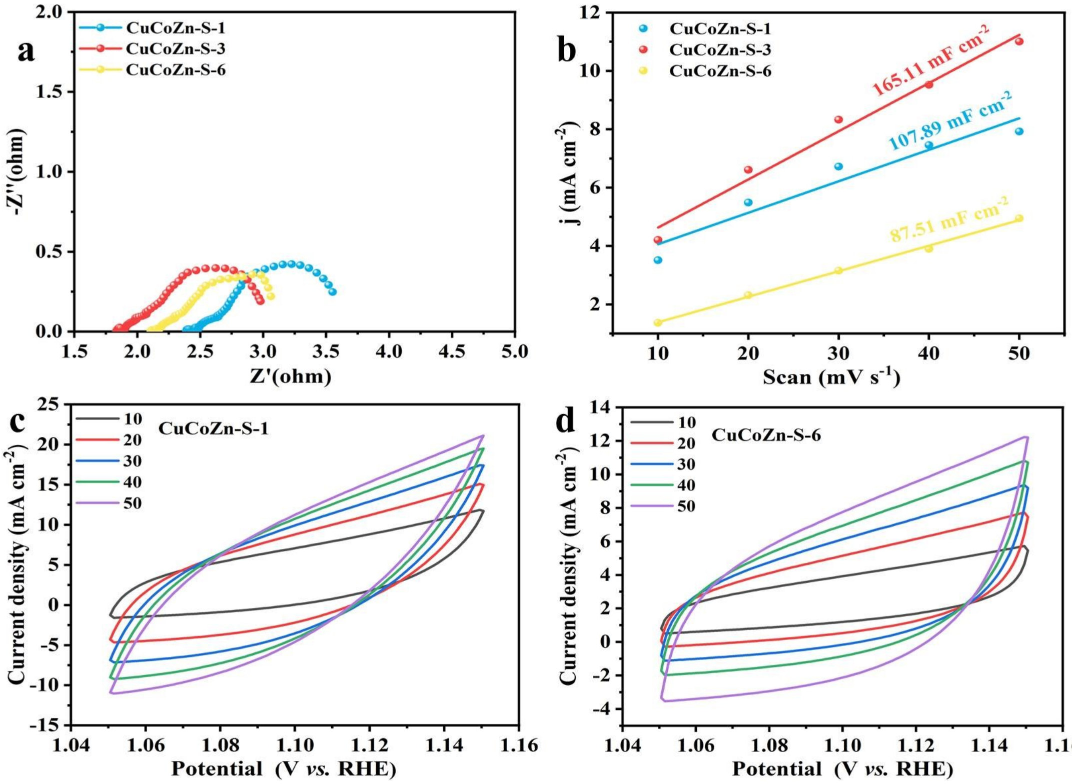

Fig. S6. Comparison image of different curing time. (a) Nyquist plots. (b) corresponding C_{dl} values. (c) Cyclic voltammograms of CuCoZn-S-1 and (d) Cyclic voltammograms of CuCoZn-S-6.

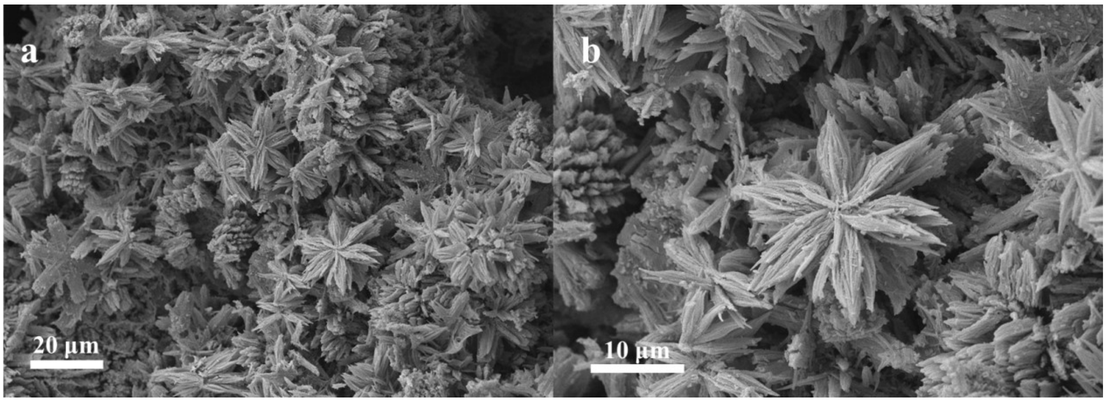

Fig. S7. SEM image of OER stability test.

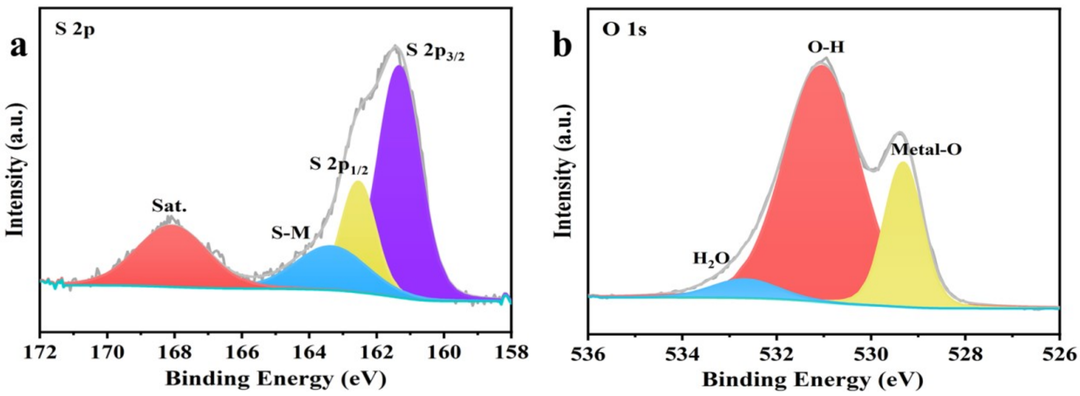

Fig. S8. XPS spectrum after OER stability test. (a) S 2p and (b) O 1s.

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