Supporting Information

MOF Template-Derived Carbon Shell Embedded CoP Hierarchical Nanosheet as Bifunctional Catalyst for Overall Water Splitting

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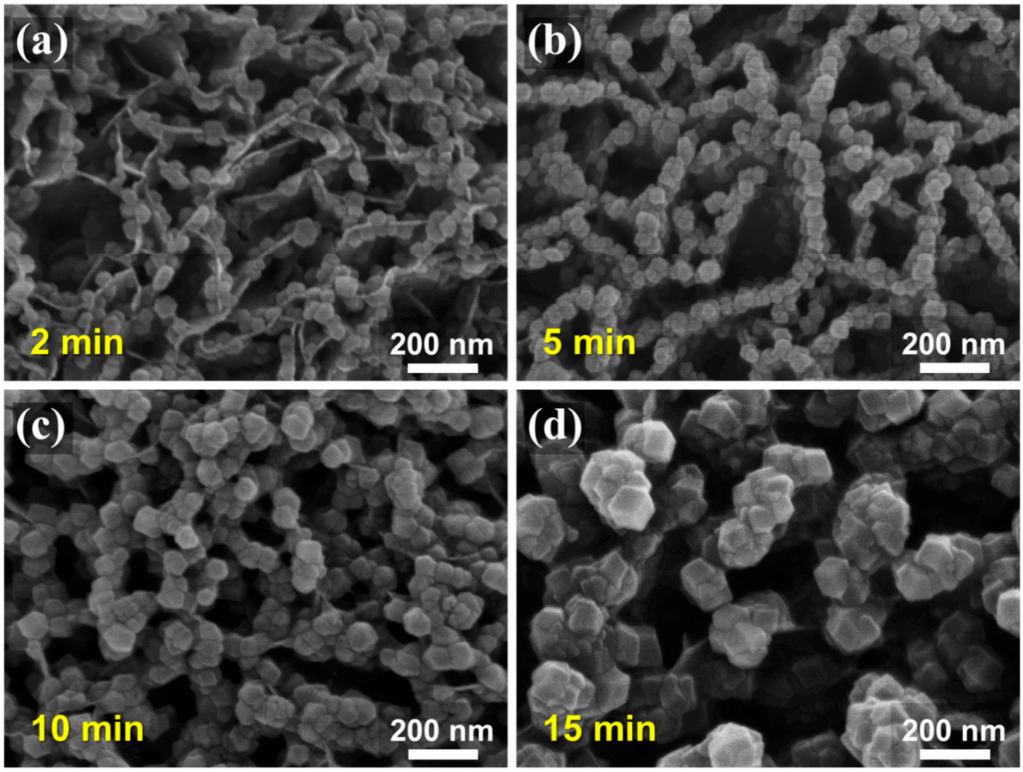

Figure S1. SEM images of ZIF-67 crystals grown on $Co(OH)_2$ nanosheets for (a) 2 min, (b) 5 min, (c) 10 min and (d) 15 min.

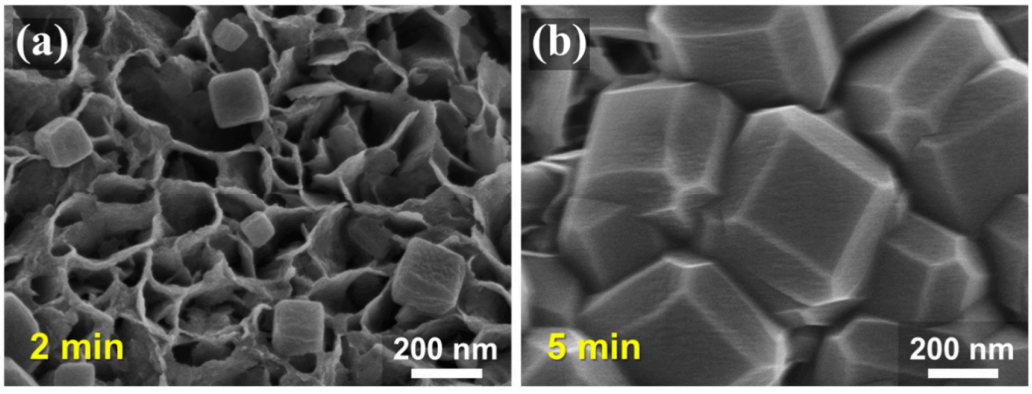

Figure S2. SEM images of ZIF-67 crystals grown on $Co(OH)_2$ nanosheets for (a) 2 min and (b) 5 min without the acceleration of TEA.

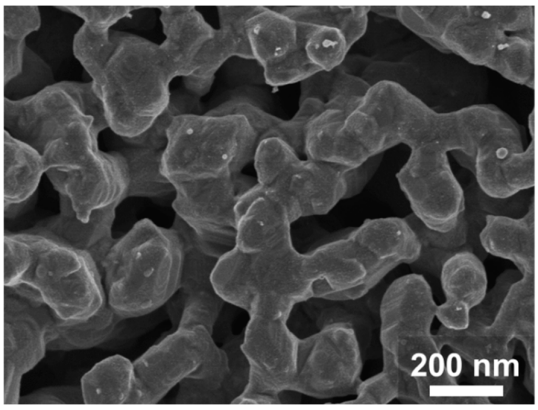

Figure S3. SEM image of ZIF-67@$Co(OH)_2$-C prepared by directly pyrolytic carbonization of ZIF-67@$Co(OH)_2$.

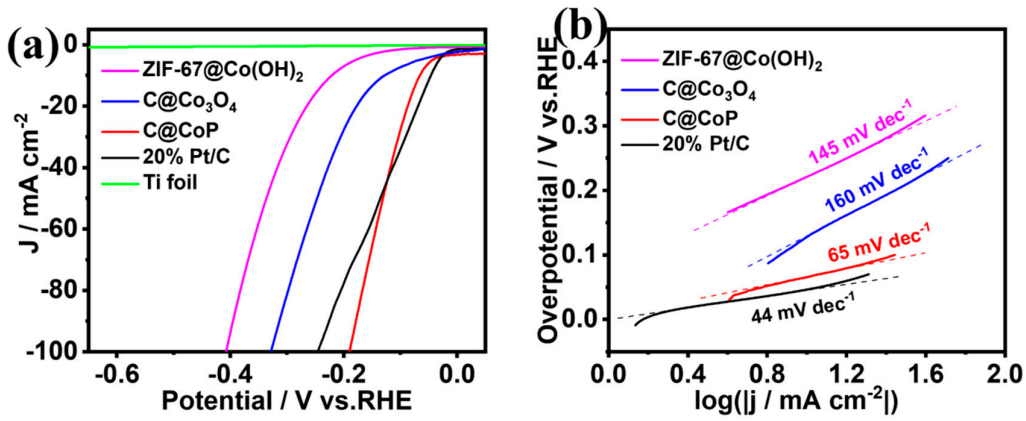

Figure S4. (a) HER Polarization curves and corresponding (b) Tafel plots for C@CoP and reference materials.

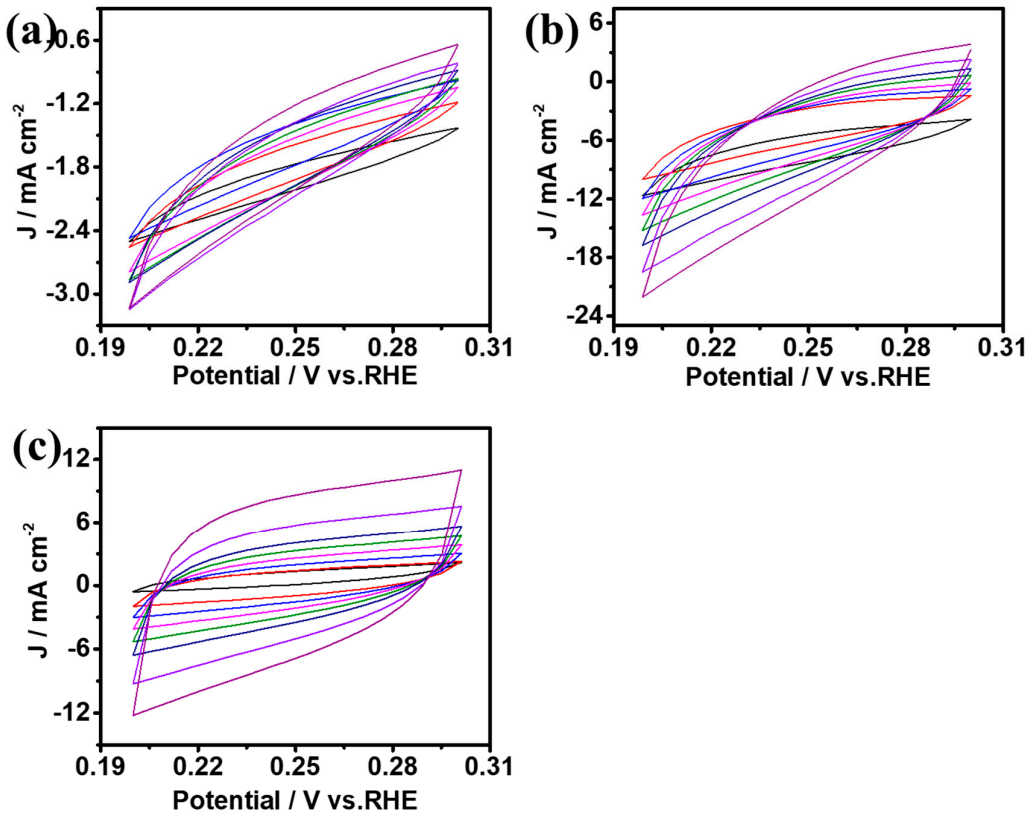

Figure S5. CV curves of (a) C@Co_3O_4, (b) CoP and (c) C@CoP in the range of 0.2−0.3 V vs.RHE. The curves from inside to outside correspond to the scanning rate of 10, 20, 30, 40, 50, 60, 80 and 100 mV s -1, respectively.

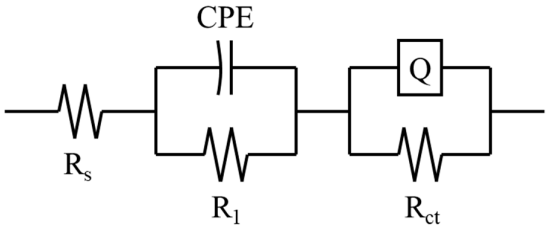

Figure S6. Equivalent circuit fitted according to the Nyquist diagram in Figure 5d and Figure 6d .

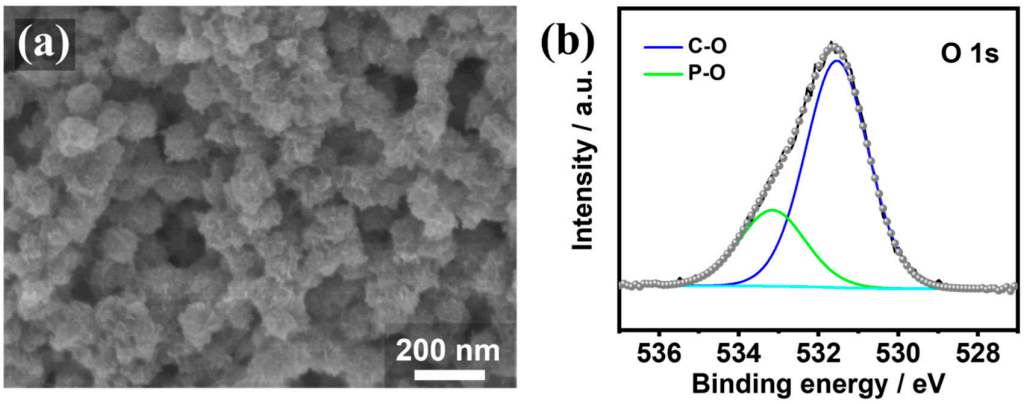

Figure S7. (a) SEM image and (b) high-resolution XPS spectra of O 1s of C@CoP after long term HER test.

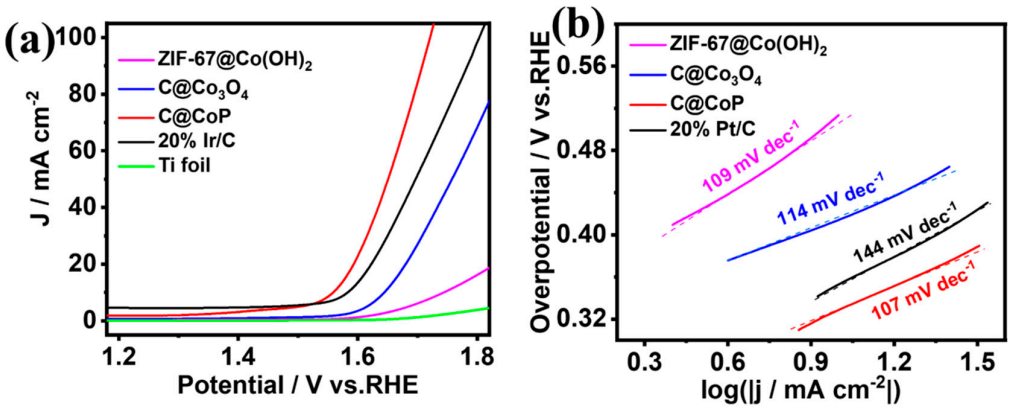

Figure S8. (a) OER Polarization curves and corresponding (b) Tafel plots for C@CoP and reference materials.

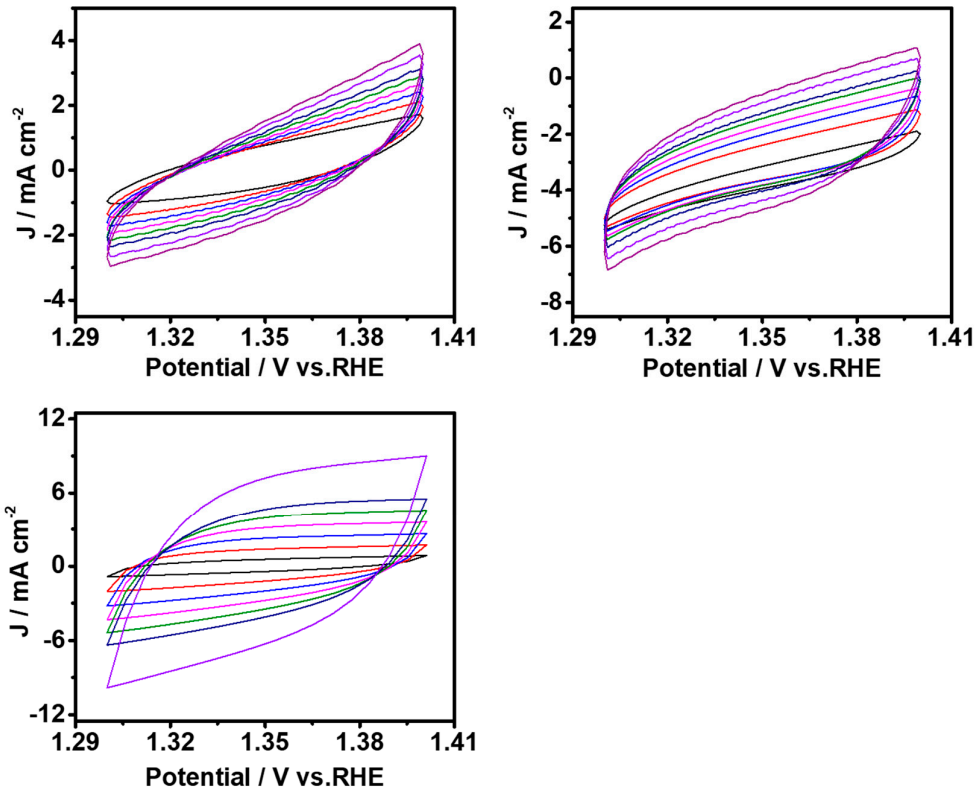

Figure S9. CV curves of (a) C@Co_3O_4, (b) CoP and (c) C@CoP in the range of 1.3−1.4 V vs.RHE. The curves from inside to outside correspond to the scanning rate of 10, 20, 30, 40, 50, 60, 80 and 100 mV s -1, respectively.

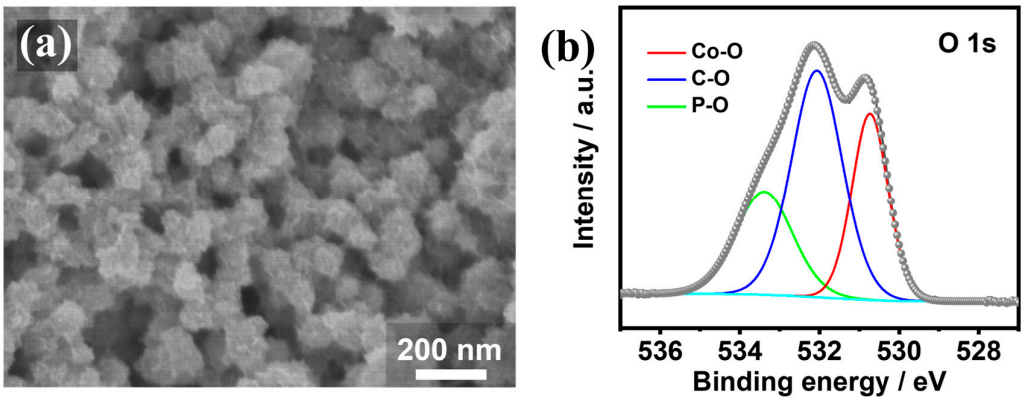

Figure S10. (a) SEM image and (b) high-resolution XPS spectra of O 1s of C@CoP after long term OER test.

Table S1. Comparison of HER performance for C@CoP with other HER electrocatalysts

Catalyst	Overpotential (mV) at 10 mA/cm^2	Tafel slope (mV/dec)	Electrolyte	Reference
C@CoP	72	65	1.0 M KOH	This work
Ni-CoP/HPFs	144 92	62 34	0.5 M H_2SO_4 1.0 M KOH	[1]
Mn_2P-Mn_2O_3/PNCF	98	46	1.0 M KOH	[2]
FePx/ Fe-N-C /NPC	75 182	60 132	0.5 M H_2SO_4 1.0 M KOH	[3]
CoP/Co-MOF	27 34 49	43 56 63	0.5 M H_2SO_4 1.0 M KOH 1.0M PBS	[4]
PMA@ZIF-67-C-AT	570	222	0.2M PBS	[5]
Co_5Fe_5-C	165	70.7	1.0 M KOH	[6]
V-CoP_2/CC	50	32	0.5 M H_2SO_4	[7]
VCoCOx@NF	63	93	1.0 M KOH	[8]
Co_2P/CoP@Co@NCNT	118 136	46 49	1.0 M KOH 0.5 M H_2SO_4	[9]

Table S2. Electrochemical impedance parameters obtained by fitting the Nyquist plots of Figure 5d to the equivalent circuit model

Catalyst	R_s (Ω)	C (mF cm^{-2})	R_1 (Ω)	Q		R_{ct} (Ω)
				$Y_1(\Omega^{-1}s^n)$	n	
C@CoP	1.01	3.89	4.30	2.56×10^{-3}	0.480	4.30
CoP	1.17	5.43	5.43	5.03×10^{-3}	0.254	5.43
C@Co_3O_4	1.22	0.966	22.40	5.98×10^{-3}	0.872	22.40

Table S3. Comparison of OER performance of C@CoP with other reported electrocatalysts.

Catalyst	Overpotential (mV) at 10 mA/cm^2	Tafel slope (mV/dec)	Electrolyte	Reference
C@CoP	329	107	1.0 M KOH	This work
Co_5Fe_5-C	245	58.2	1.0 M KOH	[6]
$W_{0.2}Er_{0.1}Ru_{0.7}O_{2-\delta}$	168	66.8	0.5M H_2SO_4	[10]
np-Ir/NiFeO	197	29.6	1.0 M KOH	[11]
Mn_2P-Mn_2O_3/PNCF	370	86	1.0 M KOH	[2]
FePx/ Fe-N-C /NPC	325	79	1.0 M KOH	[3]
NiMoP@NiFe-LDH	299	23.3	1.0 M KOH	[12]
V-CoP2/CC	91	40	0.5 M H_2SO_4	[7]
VCoCOx@NF	240	65	1.0 M KOH	[8]
Co_2P/CoP@Co@NCNT	256	46	1.0 M KOH	[9]

Table S4. Electrochemical impedance parameters obtained by fitting the Nyquist plots of Figure 6d to the equivalent circuit model

Catalyst	R_s (Ω)	C (mF cm^{-2})	R_1 (Ω)	Q		R_{ct} (Ω)
				$Y_1(\Omega^{-1}s^n)$	n	
C@CoP	2.17	4.90	9.66	6.75×10^{-3}	0.604	0.59
CoP	2.68	6.75	8.55	4.45×10^{-3}	0.968	3.81

Table S5. Comparison of overall water splitting performance of C@CoP with recent representative works.

Catalyst	Cell voltage (V) at 10 mA/cm^2	Electrolyte	Reference
C@CoP	1.63	1.0 M KOH	This work
Mn_2P-Mn_2O_3/PNCF	1.6	1.0 M KOH	[2]
FePx/ Fe-N-C /NPC	1.58	1.0 M KOH	[3]
Ir_1@Co/NC	1.603	1.0 M KOH	[13]
Co-Fe NPs	1.92	1.0 M KOH	[14]
Fe-NiS_2/CF	1.722	1.0 M KOH	[15]
O-$Ni_{0.5}W_{0.5}Se_2$	1.56	1.0 M KOH	[16]
$Co_{0.75}Fe_{0.25}P$	1.63	1.0 M KOH	[17]
Co_2P/CoP@Co@NCNT	1.6	1.0 M KOH	[9]
Co/Mo2C@NC800-2	1.67	1.0 M KOH	[18]

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