Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supporting Information

Supporting Information contains:
Supplementary Discussions
Number of Figures: 11 (Figure S1 – S11)

Supplementary Discussions

Experimental section

ZIF-67@POM hybrids: 0.012 g of CTAB was added in deionized water (25 mL) to form a clear solution. $Co(NO_3)_2·6H_2O$ (0.772 g) was then added to the obtained solution. Phosphomolybdic acid (0.100g) was rapidly added in deionized water (10 mL). Mixed and stirred the above two solutions for 30 minutes. 2-methylimidazole (1.629 g) was rapidly added in deionized water (25 mL). The two solutions were then mixed together and the mixture immediately turned purple. After 2.5 hours of agitation, the bluish-purple sediment was collected. The blue precipitates were continuously rinsed with methanol and deionized water. The precipitates were dried at 60 °C for 10 h.

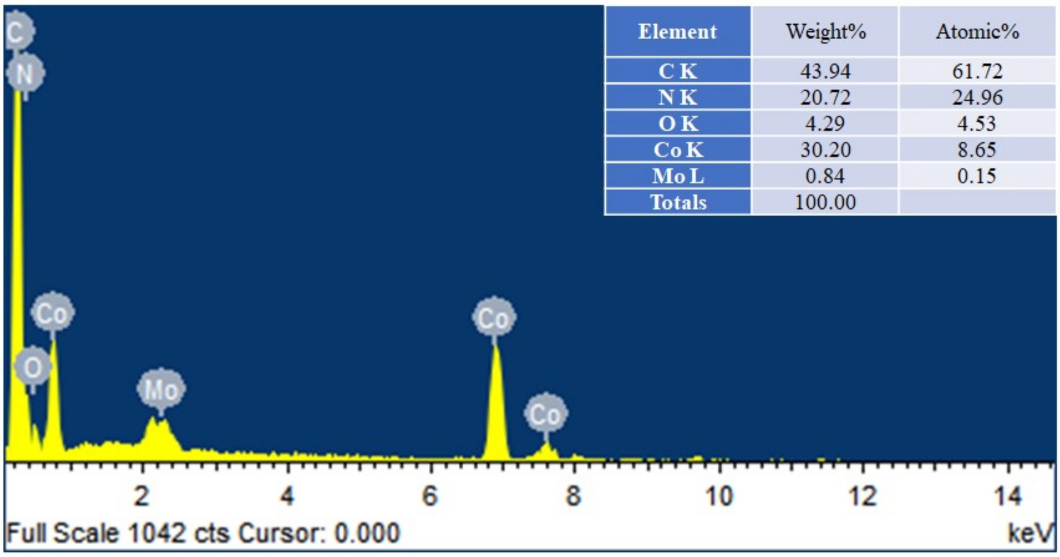
Mo-CoP-100: The ZIF-67@POM powder was placed in a ceramic vessel containing 0.300 g of $NaH_2PO_2·H_2O$ upstream of a horizontal tubular furnace. And subsequent calcination in nitrogen flow at 400 °C for 2 h gave rise to willow-shaped two-dimensional Mo-CoP nanostructures.

Characterization of Mo-CoP-100 hybrids

The morphology and structure of the samples were characterized on a Hitachi S4800 scanning electron microscope (SEM). Transmission electron microscope (TEM) and highresolution transmission electron microscope (HRTEM) images were taken on a FEI Tecnai G2 F20 field emission TEM. And energy-dispersive X-ray spectroscopy were utilized to create elemental maps (EDS). X-ray diffraction (XRD) patterns were recorded on a Rigaku RINT-2200 X-ray diffractometer with a Cu Ka source (40 kV, 20 mA) in the range 2θ = 10-80°. The X-ray photoelectron spectroscopy (XPS) was used to study the surface chemistry of the samples by Thermo ESCALAB 250Xi analyzer (Al Kα radiation, hν = 1486.6 eV). XPS peaks were assigned using MultiPak Spectrum software and Perkin-Elmer Handbook of X-ray Photoelectron Spectroscopy data analysis and the peak deconvolution by using Gaussian−Lorentzian curve fitting based on Shirley background correction was accomplished with OriginPro 2016 software. The Raman spectra were recorded on a laser micro-Raman spectrometer (HORIBA Scientific, HR Evolution)

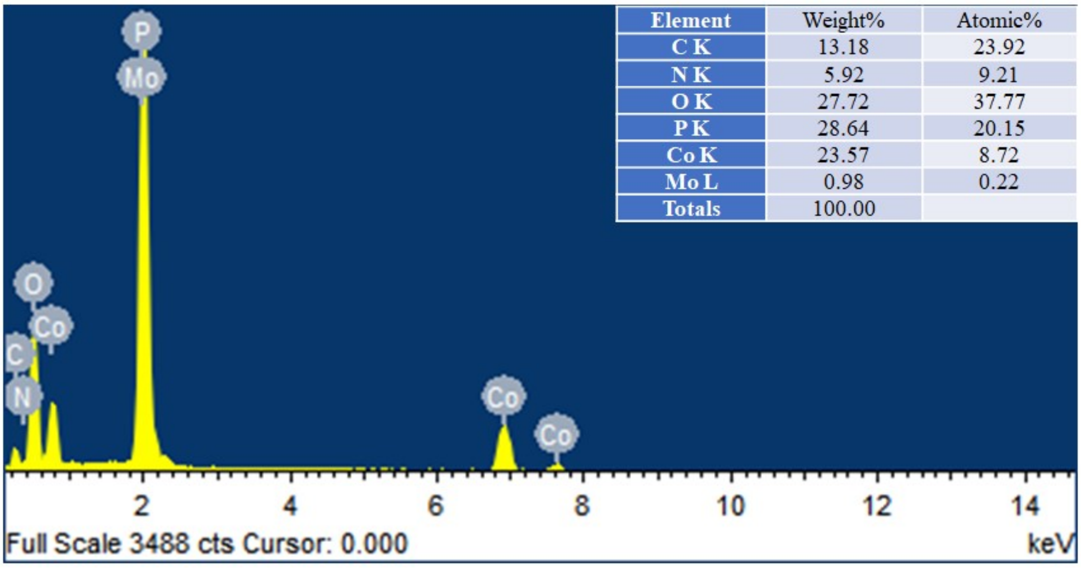
Electrochemical measurements

A CHI660E electrochemical workstation (CH Instrument Inc., shanghai) was used to measure the electrocatalytic activities. All electrochemical measurements were performed with a three-electrode configuration and carried out at room temperature, using electrocatalysts as the working electrode, a carbon rod as the counter electrode, and Hg/HgO (pH =14) were used as reference electrodes. All the measured potentials in this work were converted to reversible hydrogen electrode (RHE) potential according to the Nernst equation ($E_{RHE} = E_{(vs.Hg/HgO)} + 0.098 + 0.059 \times pH$). Linear sweep voltammetry (LSV) were measured at a scanning rate of 2 mV s^{-1}. The Tafel curves were plotted according to the overpotential vs log |*j*| from LSV data. Electrochemical impedance spectroscopy (EIS) was performed in a frequency range from 10^5 to 10^{-2} Hz and an amplitude of 5 mV. ECSA was calculated by the doublelayer capacitance (C_{dl}), which was evaluated by cyclic voltammetry (CV) curves at different scan rates in the potential ranges of 0.98 V to 1.08 V (vs. RHE) for OER.



Element	Weight%	Atomic%
C K	43.94	61.72
N K	20.72	24.96
O K	4.29	4.53
Co K	30.20	8.65
Mo L	0.84	0.15
Totals	100.00	

Fig S1. EDX pattern of ZIF-67@POM



Element	Weight%	Atomic%
C K	13.18	23.92
N K	5.92	9.21
O K	27.72	37.77
P K	28.64	20.15
Co K	23.57	8.72
Mo L	0.98	0.22
Totals	100.00	

Fig S2. EDX pattern of Mo-CoP-100

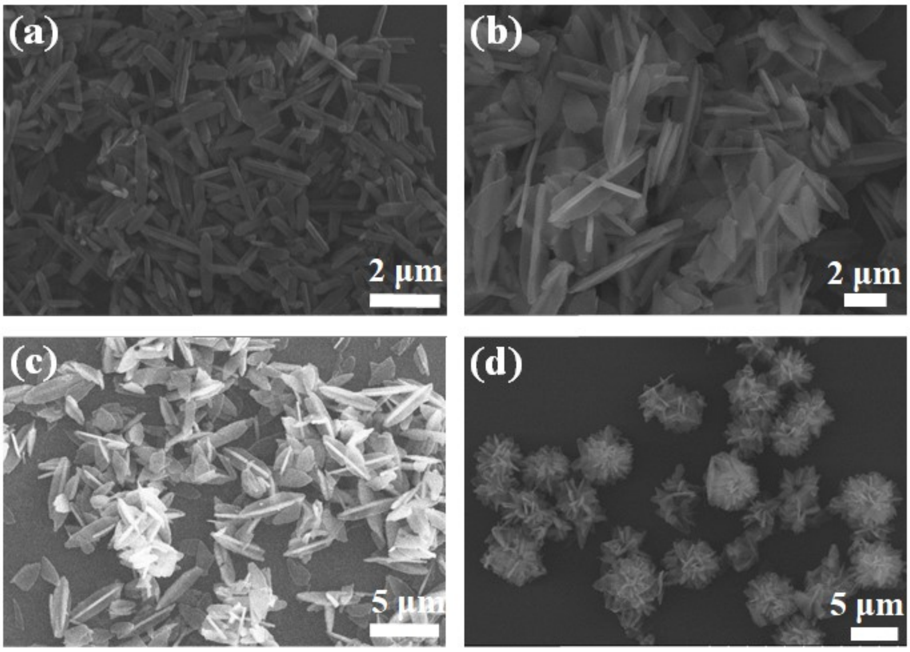


Fig S3. SEM images of (a) CoP; (b) Mo-CoP-50; c) Mo-CoP-100; d) Mo-CoP-200

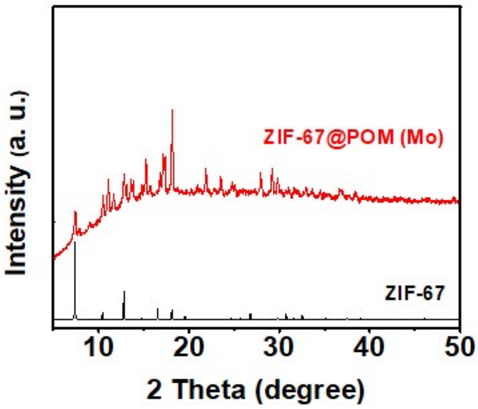


Fig. S4 XRD patterns of ZIF-67@P0M(Mo) and ZIF-67;

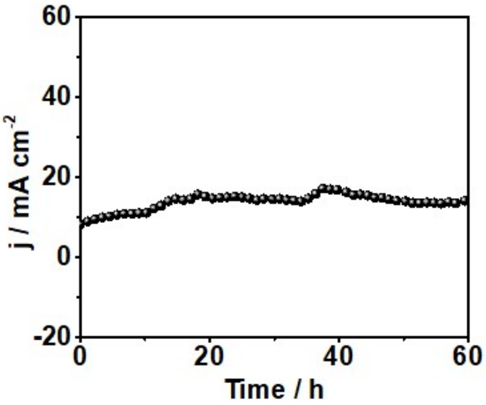


Fig. S5 Chronoamperometric testing of Mo-CoP-100 for 60 h.

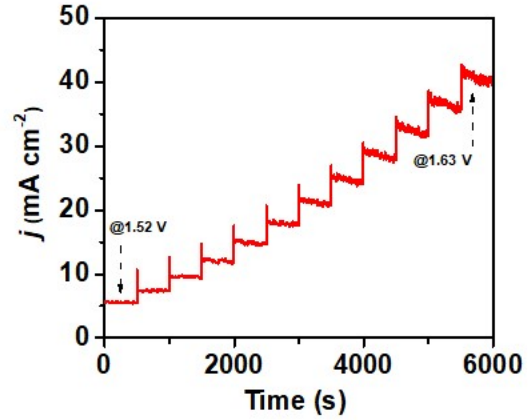


Fig. S6 Multicurrent OER processes of Mo-CoP-100 with a step of 0.01 V every 500 s

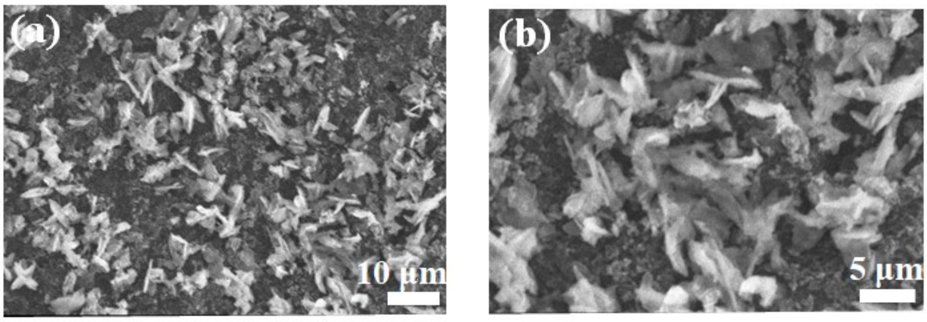


Fig. S7 SEM of Mo-CoP after accelerated durability test for 100 h.

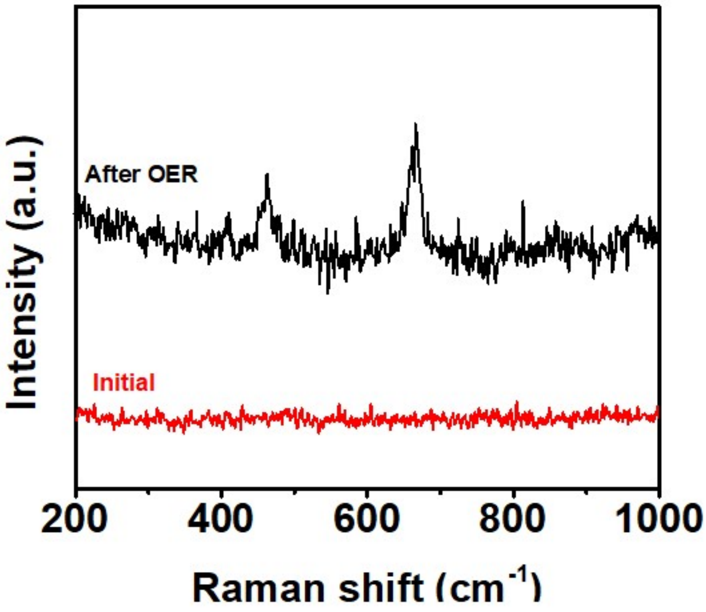


Fig. S8 Raman spectrum after the durability test.

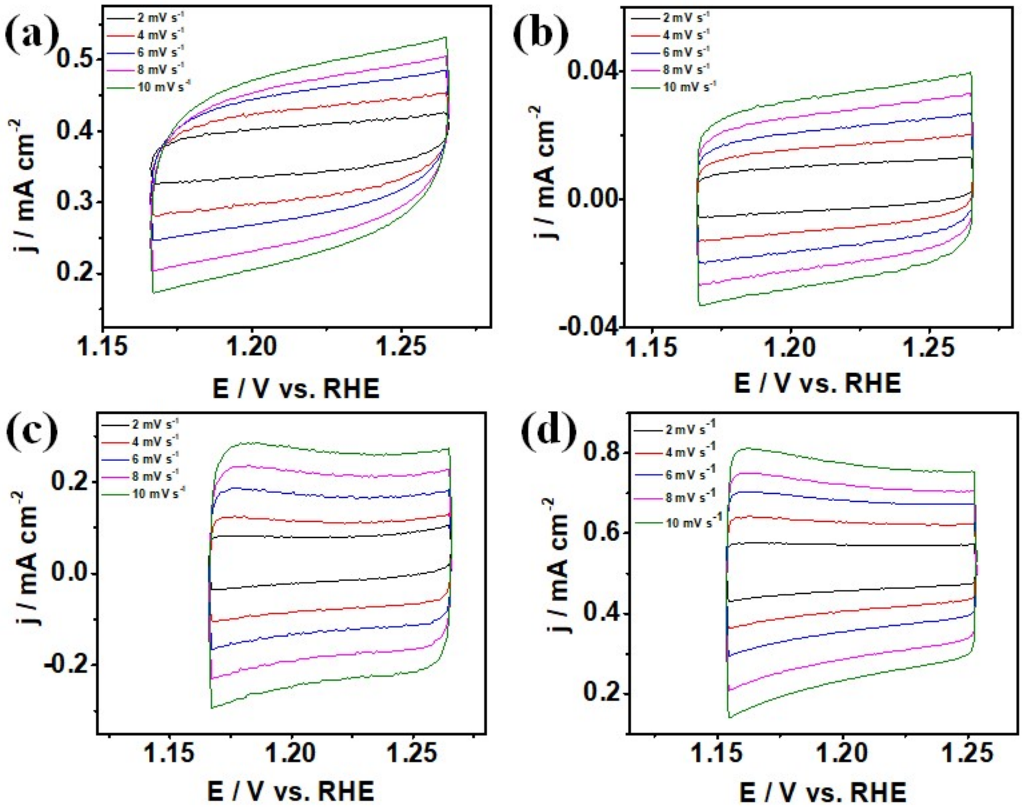


Fig. S9 CV curves of (a) ZIF-67, (b)CoP, (c) ZIF-67@POM, (d) Mo-CoP-100.

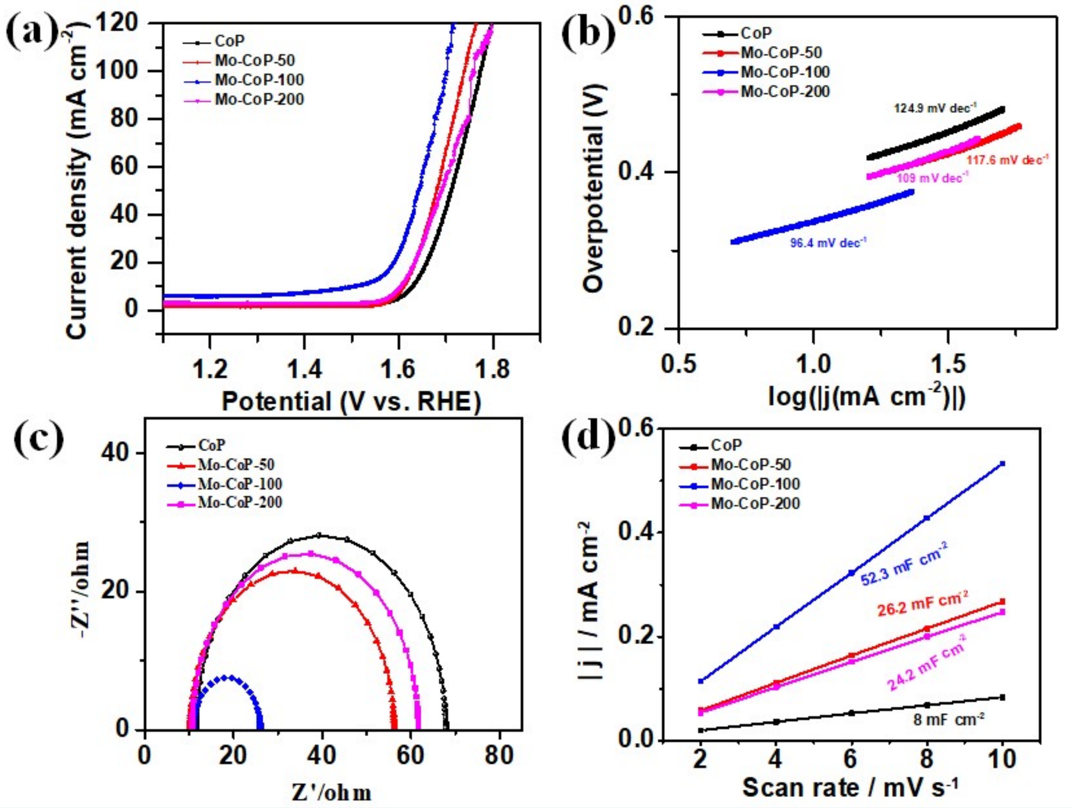


Fig. S10. (a) OER polarization curves of Mo-CoP-r at different amounts in 1.0 M KOH solution at a scan rate of 2 mV s^{-1}. (b) Tafel plots of Mo-CoP-r at different amounts catalysts derived from OER curves. (c) Electrochemical impedance

spectra (EIS) of of Mo-CoP-r at different amounts. (d) Plots of the current density at 1.03 V vs. the scan rate to determine the double layer capacitance (C_{dl}) of Mo-CoP-r at different amounts.

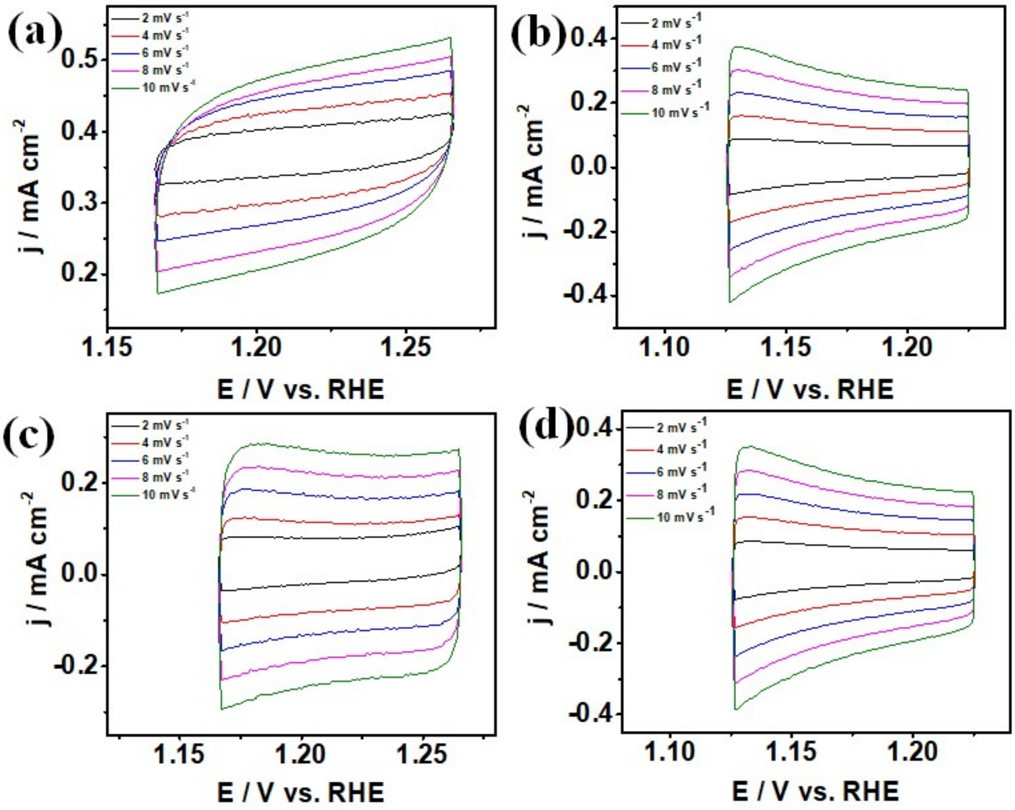


Fig. S11 CV curves of Mo-CoP-r at different amounts. (a) CoP, (b) Mo-CoP-50, (c) Mo-CoP-100, (d) Mo-CoP-200.

Catalysts	Overpotential at 10 mA cm^{-2}	Tafel slopes mV dec^{-1}	Electrolyte	Stability	Ref.
Mo-CoP	290	96.4	1.0 M KOH	100 h	This work
Ni_2P	320	105	1.0 M KOH	10 h	1
NiCoPO/NC	300	94	1.0 M KOH	10 h	2
NiCoP	281	42.7	1.0 M KOH	6 h	3
O-NiCoP	310	84	1.0 M KOH	40 h	4
Fe−Co−P	252	33	1.0 M KOH	24 h	5
D-Ni-MOF	219	48.2	1.0 M KOH	50 h	6
CoP/MoP@NC/CC	270	40	1.0 M KOH	20 h	7

Table 1. OER performance of metal phosphides

References

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