Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Ultrafine CoPS nanoparticles encapsulated in N, P, S tri-doped porous carbon as an efficient bifunctional water splitting electrocatalyst in both acid and alkaline solution

Yiping Hu,[a,b] Feng Li,[a,b] Yu Long,[a,b] Haidong Yang,[a,b] Lili Gao,[a,b] Xuefeng long,[a,b] Haiguo Hu,[a,b] Na Xu,[a,b] Jun Jin*[a,b] and Jiantai Ma*†[a,b]

a State Key Laboratory of Applied Organic Chemistry (SKLAOC), College of Chemistry and Chemical Engineering, Lanzhou University, Lanzhou 730000, (P. R. China).
b The Key Laboratory of Catalytic Engineering of Gansu Province and Chemical Engineering, College of Chemistry and Chemical Engineering, Lanzhou University, Lanzhou 730000, (P. R. China).

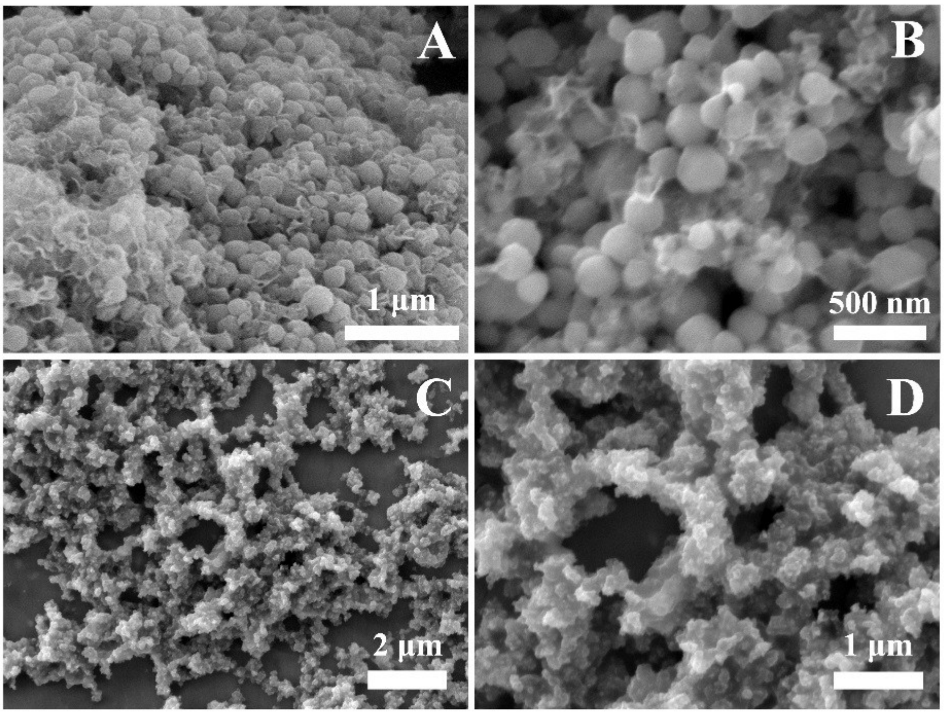

Figure S1 SEM images of Co-MOF@XC-72 (A, B) and CoPS@NPS-C (C, D).

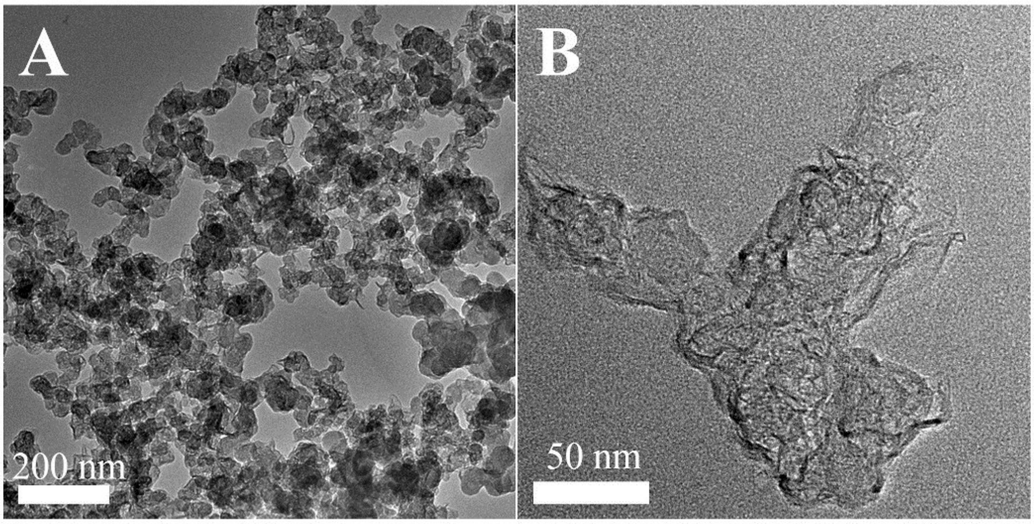

Figure S2 TEM images of pure XC-72.

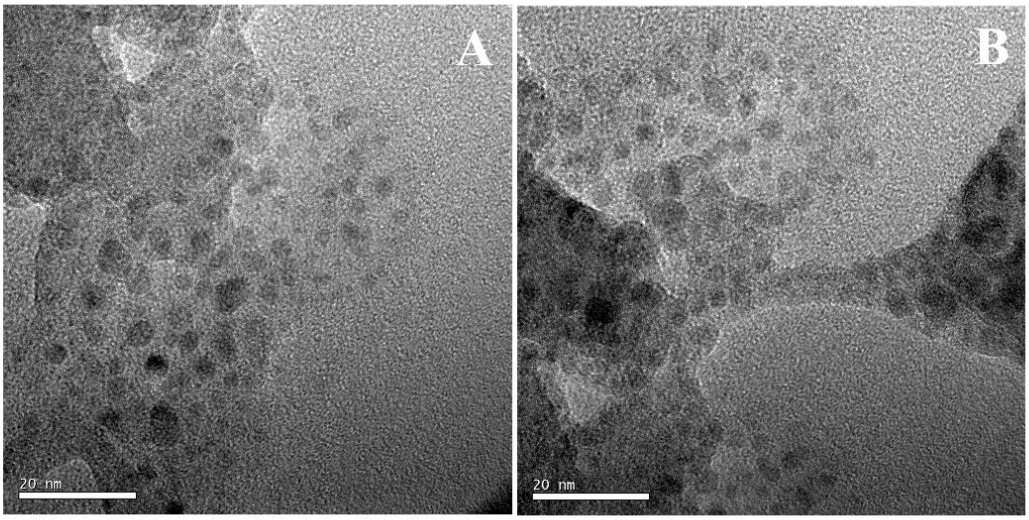

Figure S3 TEM images of CoPS@NPS-C.

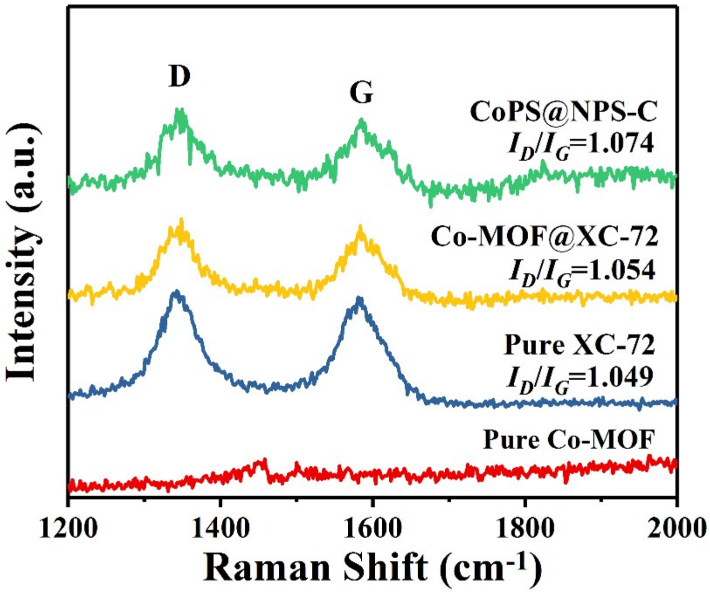

Figure S4 Raman spectra of pure Co-MOF, pure XC-72, Co-MOF@XC-72 and CoPS@NPS-C (4 wt.%).

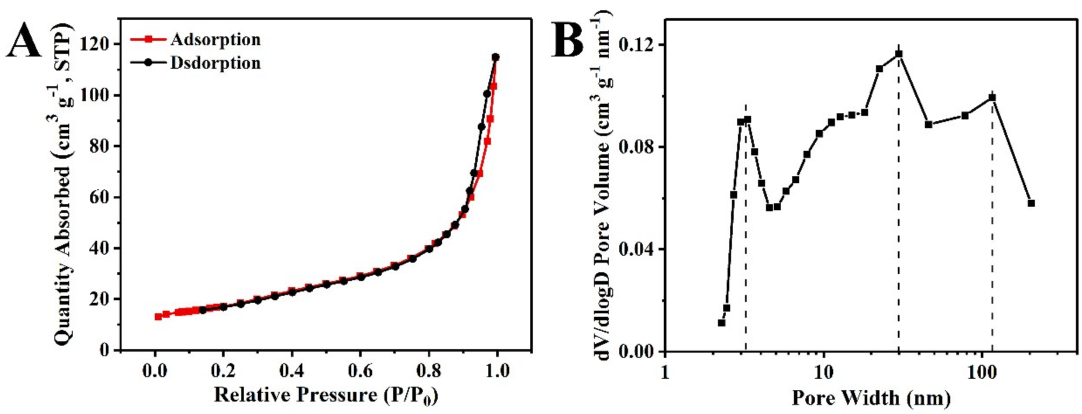

Figure S5 (A) Nitrogen adsorption/desorption isotherm of CoPS@NPS-C (4 wt.%), (B) The corresponding pore diameter distribution.

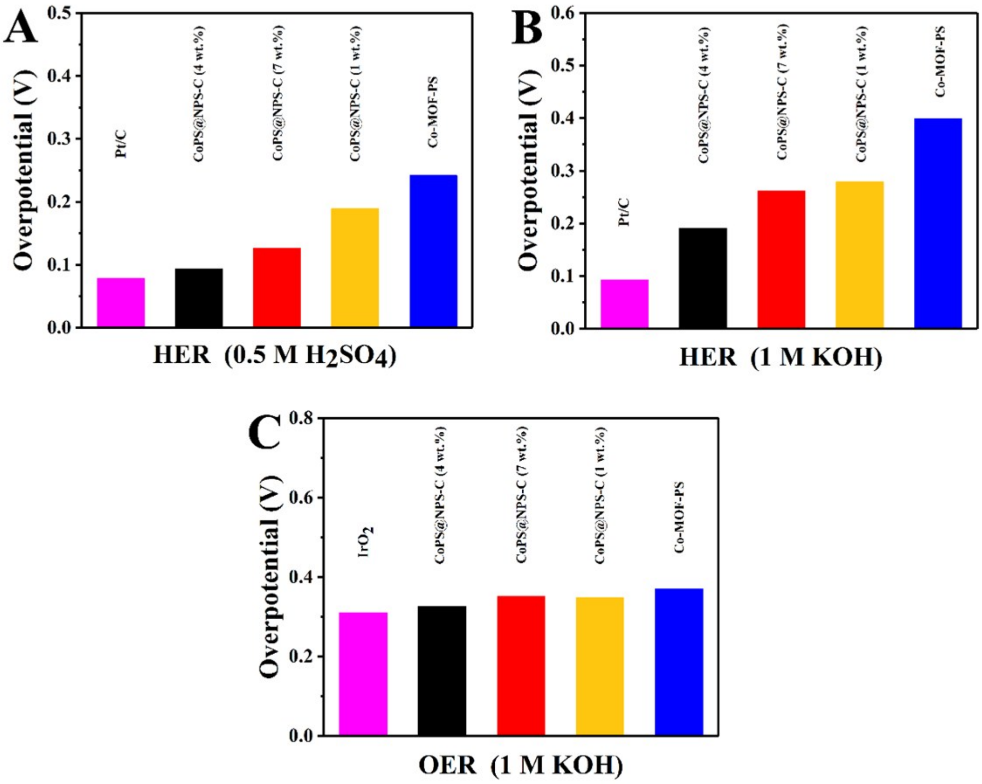

Figure S6 Comparison of the over-potentials for different catalysts at 10 mA cm^{-2} .

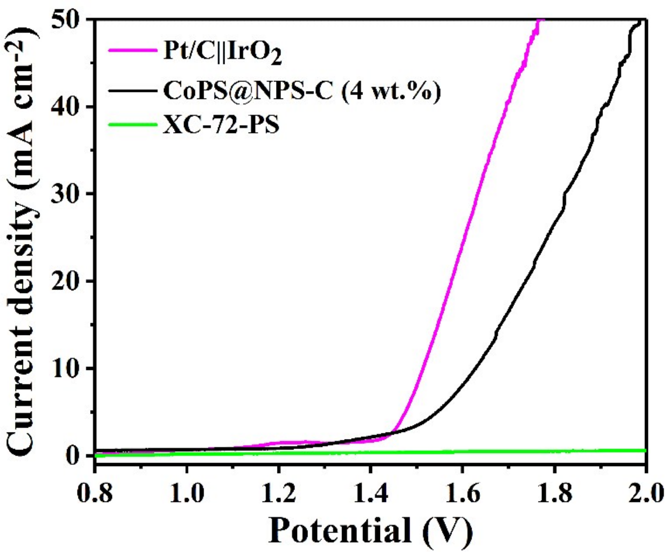

Figure S7 The LSV curves of overall water splitting with CoPS@NPS-C (4 wt.%) used as both anode and cathode (CoPS@NPS-C (4 wt.%)||CoPS@NPS-C (4 wt.%)), XC-72-PS as both anode and cathode (XC-72-PS||XC-72-PS), and IrO_2 as anode and commercial Pt/C as cathode (Pt/C||IrO_2) in a two-electrode configuration at a scan rate of 5 mV s^{-1} in 1.0 M KOH.

Table S1. Comparison of electrochemical activity of CoPS@NPS-C (4 wt.%) to the other reported HER catalysts

Catalysts	Mass loading/mg cm^{-2}	Overpotential η_j=10 mA cm^{-2} / mV	Acid	Alkaline	Reference
CoPS@NPS-C (4 wt.%)	0.35	93 (Acid) 191 (Alkaline)	⚐	⚐	This work
PNC/Co	0.35	298		⚐	1
rGO-few-layer $NiPS_3$	0.16	178 (Acid) 281 (Alkaline)	⚐	⚐	2
Ni-Co-P NP	0.158	180		⚐	3
$CoSe_2$/CC	N.A.	190		⚐	4
CoS_2 NWs	N.A.	145		⚐	5
CoeNeP-CNFs	0.229	0.248		⚐	6
Polymorphic $CoSe_2$	N.A.	150	⚐		7
CoP/CNT	0.285	122	⚐		8
Porous CoP concave polyhedron	0.35	133	⚐		9
$CoSe_2$ NP	0.28	139	⚐		10
Mo_2C/NPCNFs	~0.4	134	⚐		11
CoS_2/MoS_2/RGO	0.35	160	⚐		12

Table S2. Comparison of electrochemical activity of CoPS@NPS-C (4 wt.%) to the other reported OER catalysts in alkaline electrolyte.

Catalysts	Mass loading/mg cm^{-2}	Overpotential η_j=10 mA cm^{-2} / mV	Reference
CoPS@NPS-C (4 wt.%)	0.35	326	This work
CoP NP/C	0.71	320	13
CoOx@CN	1	260	14
Co/N-CNTs-700	0.20	390	15
Co-P film	N.A.	345	16
sea-urchin-like $(Co_{0.54}Fe_{0.46})_2P$	0.2	370	17
Co-UTSA-16	0.35	408	18
$Co_2V_2O_7$ nanosheet	0.28	340	19

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