Supplementary Information

Metal-Organic Framework-Derived Hollow CoS_x@MoS_2 Microcubes as Superior Bifunctional Electrocatalysts for Hydrogen Evolution and Oxygen Evolution Reactions

Lifan Yang[a,b,c], Li Zhang[a,b,c,d,*], Guancheng Xu[a,b,c], Xin Ma[a,b,c], Weiwei Wang[a,b,c], Huijun Song[a,b,c], Dianzeng Jia[a,b,c,*]

[a] Key Laboratory of Energy Materials Chemistry, Ministry of Education, Xinjiang University, Shengli Road No. 666, Urumqi, 830046, China

[b] Key Laboratory of Advanced Functional Materials, Autonomous Region, Xinjiang University, Shengli Road No. 666, Urumqi, 830046, China

[c] Institute of Applied Chemistry, Xinjiang University, Shengli Road No. 666, Urumqi, 830046, China

[d] Physics and Chemistry Detecting Center, Xinjiang University, Shengli Road No. 666, Urumqi, 830046, China

* Corresponding author. E-mail: zhanglixju@163.com, jdz0991@gmail.com. Tel./Fax: +86-991-8580586

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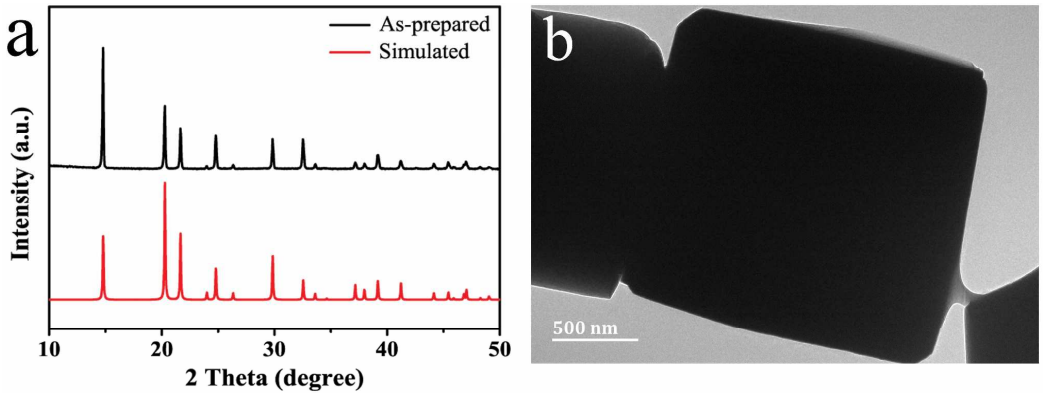

Figure S1. PXRD pattern (a) and TEM image (b) of Co-MOF.

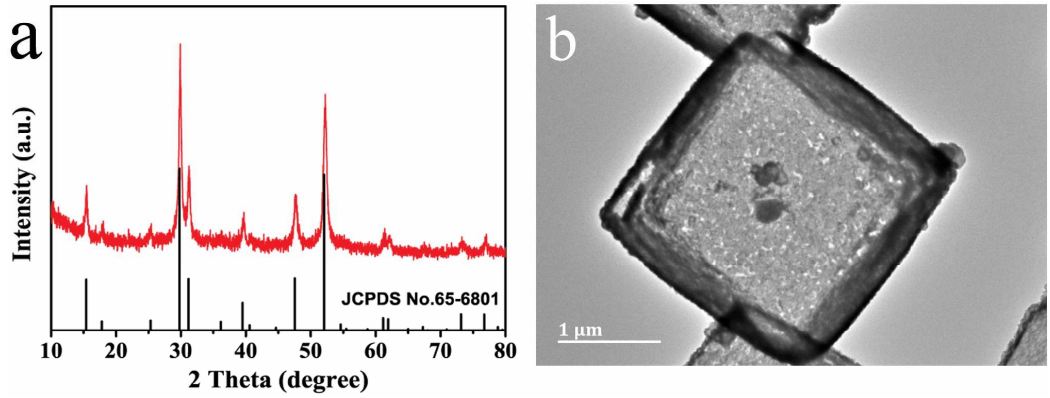

Figure S2. PXRD pattern (a) and TEM image (b) of Co_9S_8.

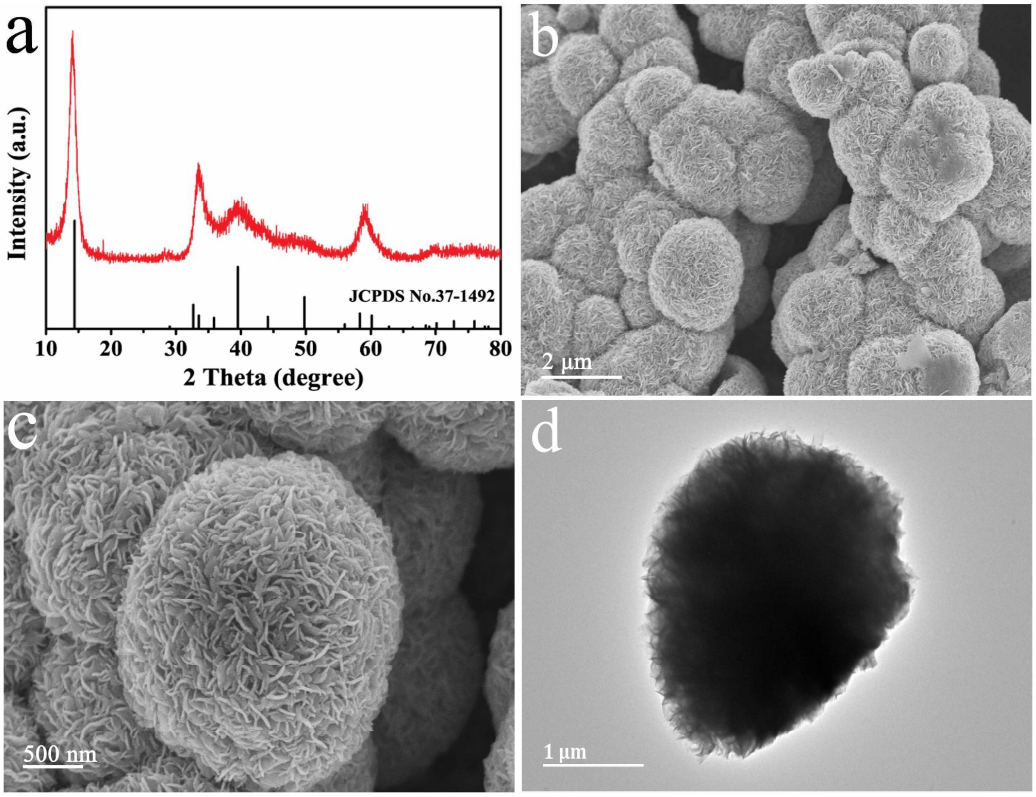

Figure S3. PXRD pattern (a), FESEM (b, c) and TEM images (d) of MoS_2.

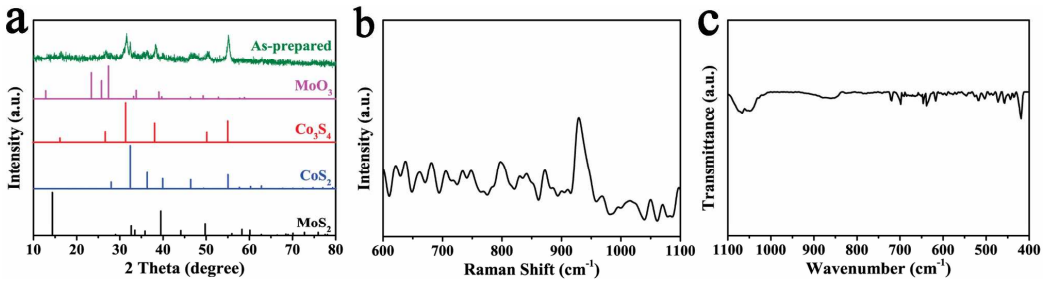

Figure S4. PXRD pattern (a), Raman spectrum (b) and FTIR spectrum (c) of CoS_x@MoS_2.

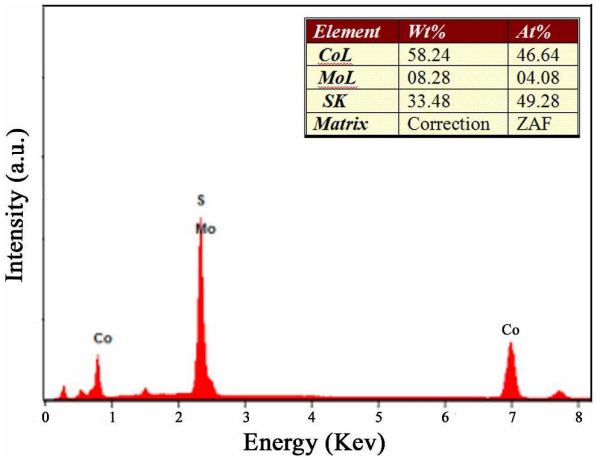

Figure S5. EDX spectrum of hollow CoS_x@MoS_2 microcubes.

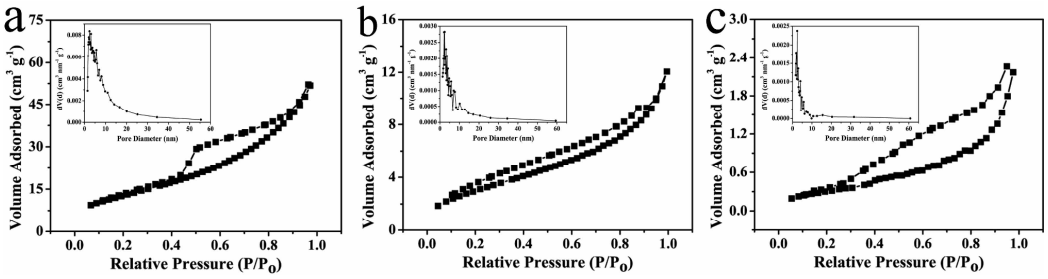

Figure S6. Nitrogen adsorption–desorption isotherms of CoS_x@MoS_2 (a), Co_9S_8 (b), MoS_2 (c) and corresponding pore size distributions (insets).

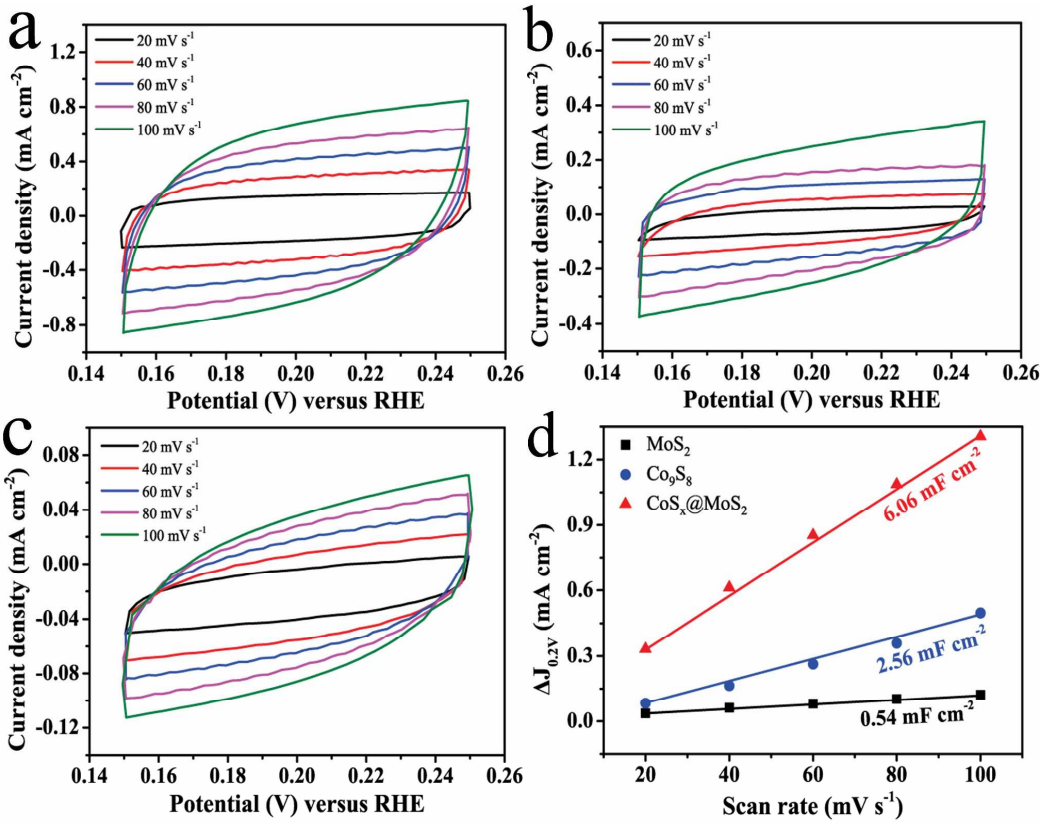

Figure S7. Cyclic voltammograms of CoS_x@MoS_2 (a), Co_9S_8 (b) and MoS_2 (c) measured at various scan rates in 0.5 M H_2SO_4, corresponding linear slopes at 0.2 V vs RHE (d). The double-layer capacitance (C_{dl}) is equivalent to half the slope.

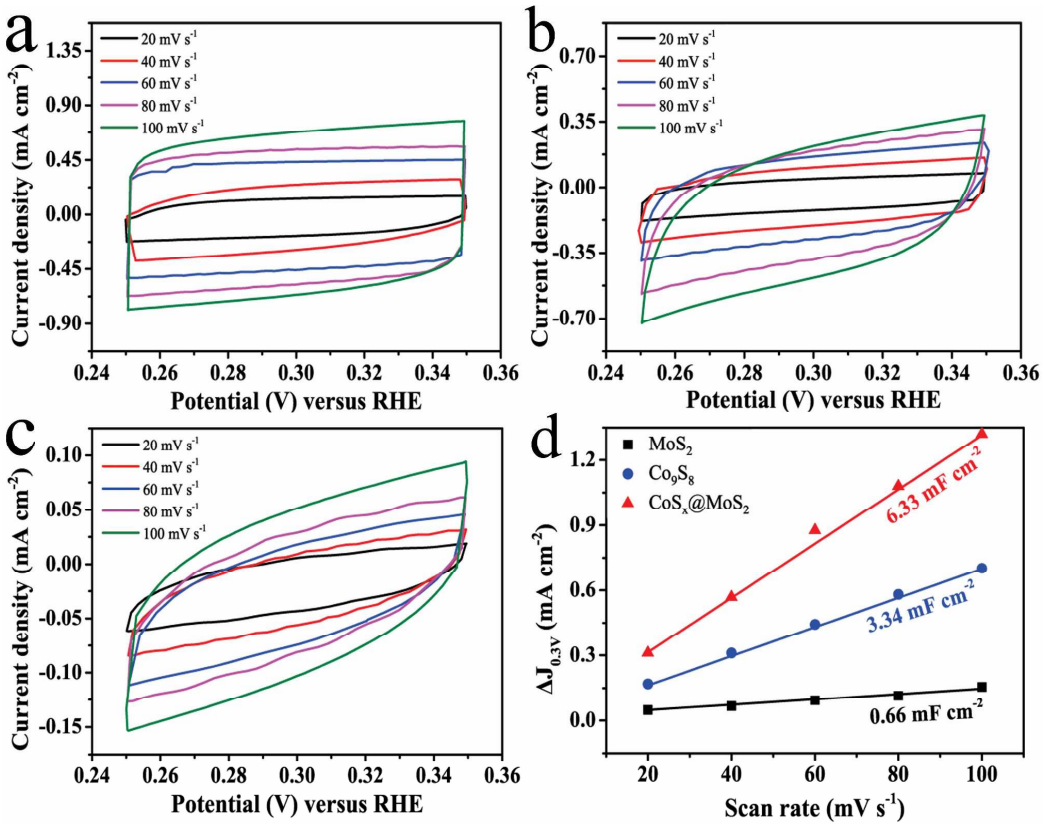

Figure S8. Cyclic voltammograms of CoS_x@MoS_2 (a), Co_9S_8 (b) and MoS_2 (c) measured at various scan rates in 1 M KOH, corresponding linear slopes at 0.3 V vs RHE (d). The double-layer capacitance (C_{dl}) is equivalent to half the slope.

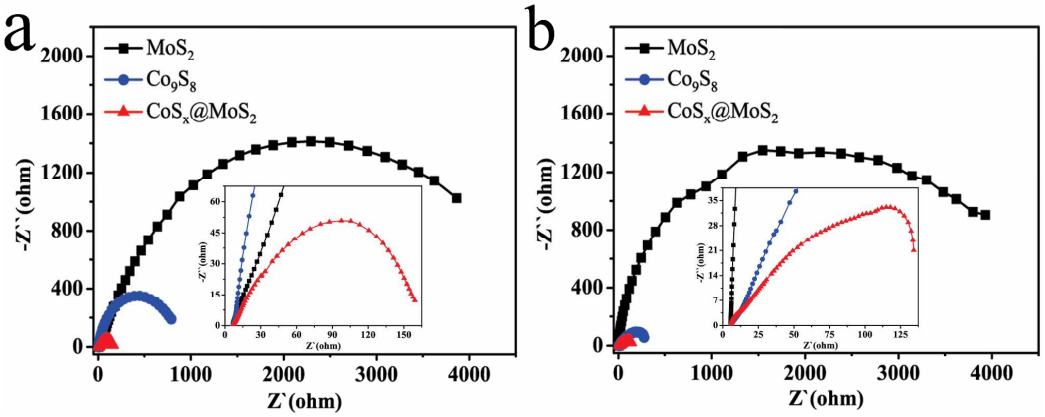

Figure S9. Nyquist plots of $CoS_x@MoS_2$, Co_9S_8 and MoS_2 for HER collected at -0.15 V vs RHE (a), for OER collected at 1.5 V vs RHE (b).

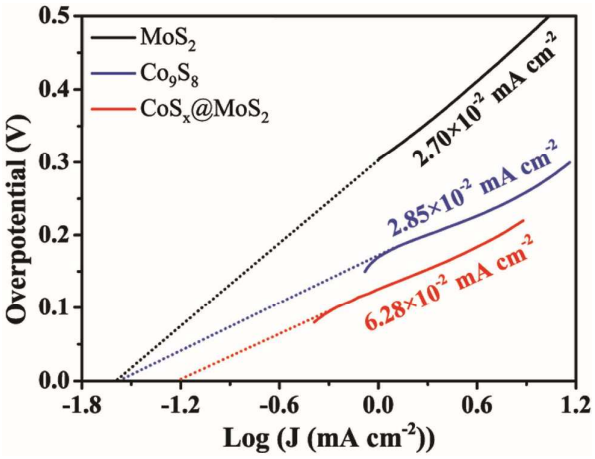

Figure S10. Exchange current densities of MoS_2, Co_9S_8 and $CoS_x@MoS_2$ for HER.

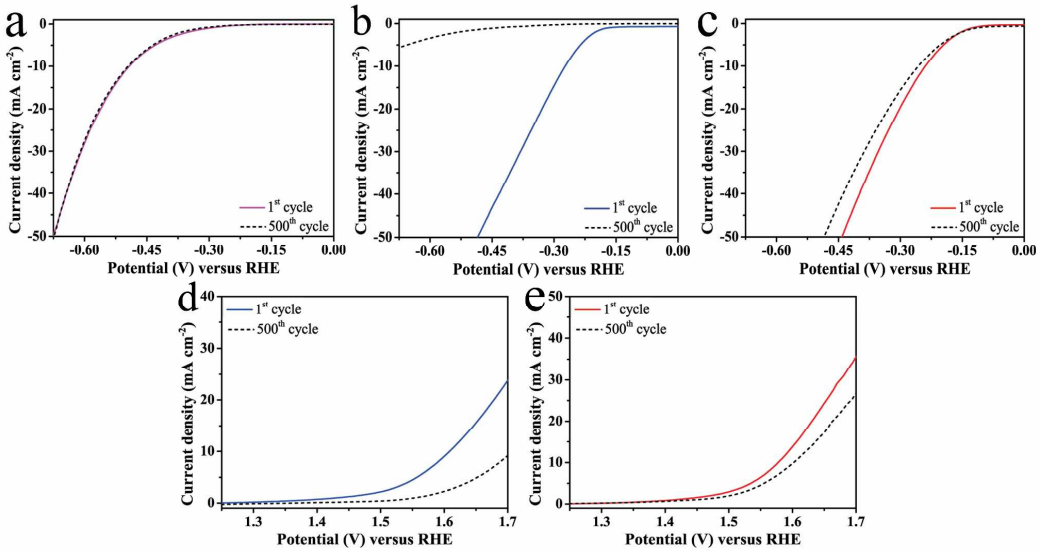

Figure S11. Stability tests of MoS_2 (a), Co_9S_8 (b) and CoS_x@MoS_2 (c) for HER. Stability tests of Co_9S_8 (d) and CoS_x@MoS_2 (e) for OER.

Table S1. Comparison of HER activities of CoS_x@MoS_2 with other reported electrocatalysts.

Catalyst	η_{10} (mV)	Tafel slope (mV dec^{-1})	Electrolyte	Ref.
Co_9S_8@MoS_2/CNFs	190	110	0.5 M H_2SO_4	Adv. Mater. 2015, 27, 4752-4759
MoO_3-MoS_2/FTO	310	50-60	0.5 M H_2SO_4	Nano lett. 2011, 11, 4168-4175
Hollow Co_3S_4	400	97	0.5 M H_2SO_4	Chem. Mater. 2017, 29, 5566−5573
MoS_2 microboxes	475	134	0.5 M H_2SO_4	Energy Environ. Sci. 2014, 7, 3302-3306
MoS_2	276	96	0.5 M H_2SO_4	J. Mater. Chem. A, 2017, 5, 22654–22661
CoS_x@MoS_2	239	103	0.5 M H_2SO_4	This work

Table S2. Comparison of OER activities of $CoS_x@MoS_2$ with other reported electrocatalysts.

Catalyst	η_{10} (mV)	Tafel slope (mV dec^{-1})	Electrolyte	Ref.
$Co_9S_8@MoS_2$/CNFs	430	61	1 M KOH	Adv. Mater. 2015, 27, 4752-4759
CoS-$Co(OH)_2@\alpha MoS_{2+x}$/NF	380	68	1 M KOH	Adv. Funct. Mater. 2016, 26, 7386
PNG-$NiCo_2O_4$	349	156	0.1 M KOH	ACS Nano 2013, 7, 10190-10196
Co_3S_4 nanosheets	363	90	0.1 M KOH	ACS Nano 2014, 8, 10909-10919
CoNC/CNF	430	89	1 M KOH	J. Mater. Chem. A, 2017, 5, 23898–23908
$CoS_x@MoS_2$	347	147	1 M KOH	This work