Electronic Supplementary Material (ESI) for Inorganic Chemistry Frontiers.

Synthesis of $CoS_2/SnO_2@MoS_2$ nanocubes heterostructures for achieving enhanced electrocatalytic hydrogen evolution in acidic media

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Materials

Tin chloride pentahydrate ($SnCl_4·5H_2O$, AR), Cobalt chloride hexahydrate ($CoCl_2·6H_2O$, AR), sodium citrate dihydrate ($C_6H_{15}Na_3O_7·2H_2O$, ≥99%), ammonium molybdate tetrahydrate ($(NH_4)_6Mo_7O_{24}·4H_2O$, AR) and ammonium sulfide ($(NH_4)_2S$, AR) were purchased from Aladdin Chemistry Co., Ltd. Ethanol (CH_3CH_2OH, ≥99.7%), sodium hydroxide (NaOH, AR), aqueous ammonia solution ($NH_3·H_2O$, 25%~28%) and sulfuric acid (H_2SO_4, 95%~98%) were acquired from Tianjin Zhiyuan Chemical Reagent Co., Ltd,. Nafion solution (5 wt%) and commercial Pt/C (20 wt%) was acquired from Sigma-Aldrich and Shanghai Hesen Electric Co., Ltd, respectively. All reagents were used directly without any further purification. Water deionized with a Millipore system was used in this work.

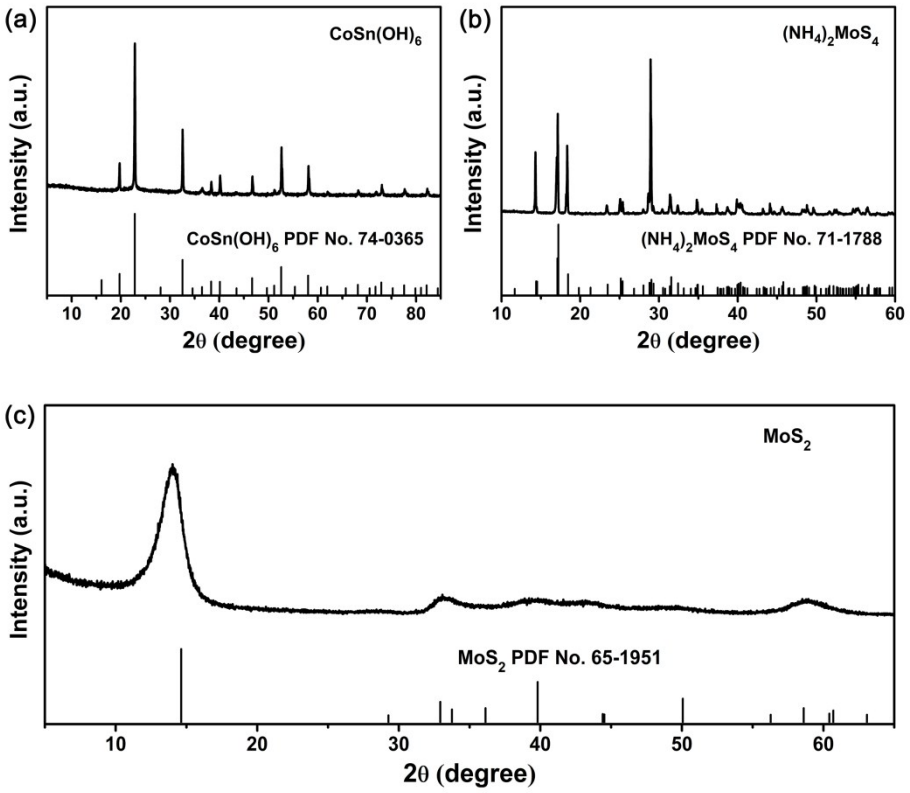

Fig. S1 XRD patterns of (a) $CoSn(OH)_6$ nanocubes; (b) $(NH_4)_2MoS_4$ particles and (c) MoS_2 particles.

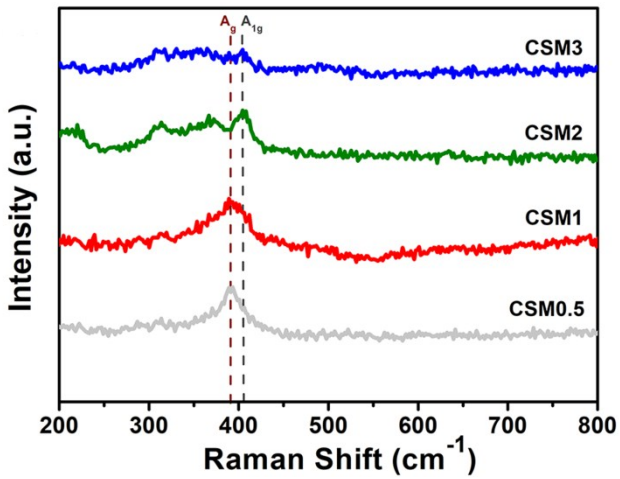

Fig. S2 Raman spectra of corresponding CSMy (y = 0.5, 1, 2 and 3) nanocubes.

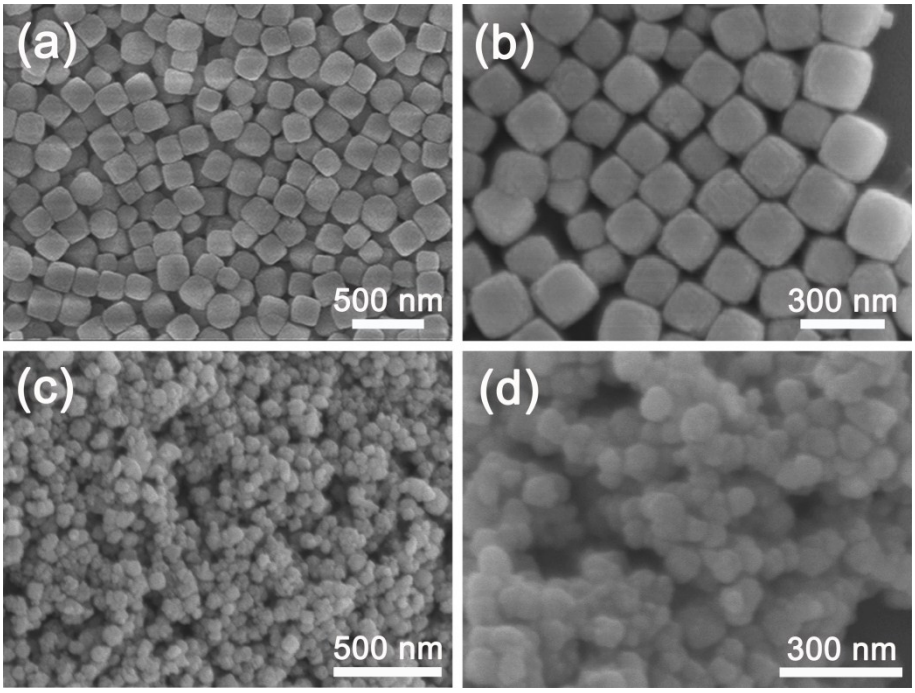

Fig. S3 SEM images of (a) and (b) $CoSn(OH)_6$ nanocubes; (c) and (d) CSM0.5 nanocubes.

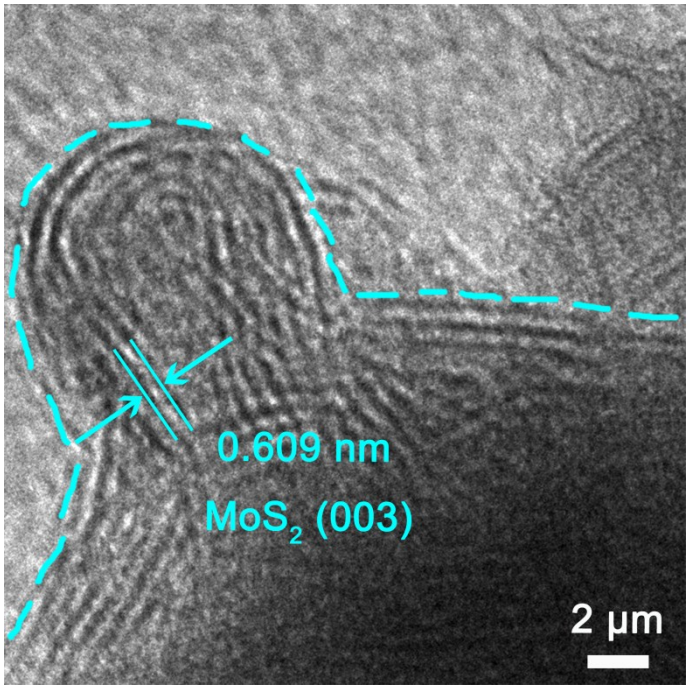

Fig. S4 HRTEM image of CSM1 nanocubes.

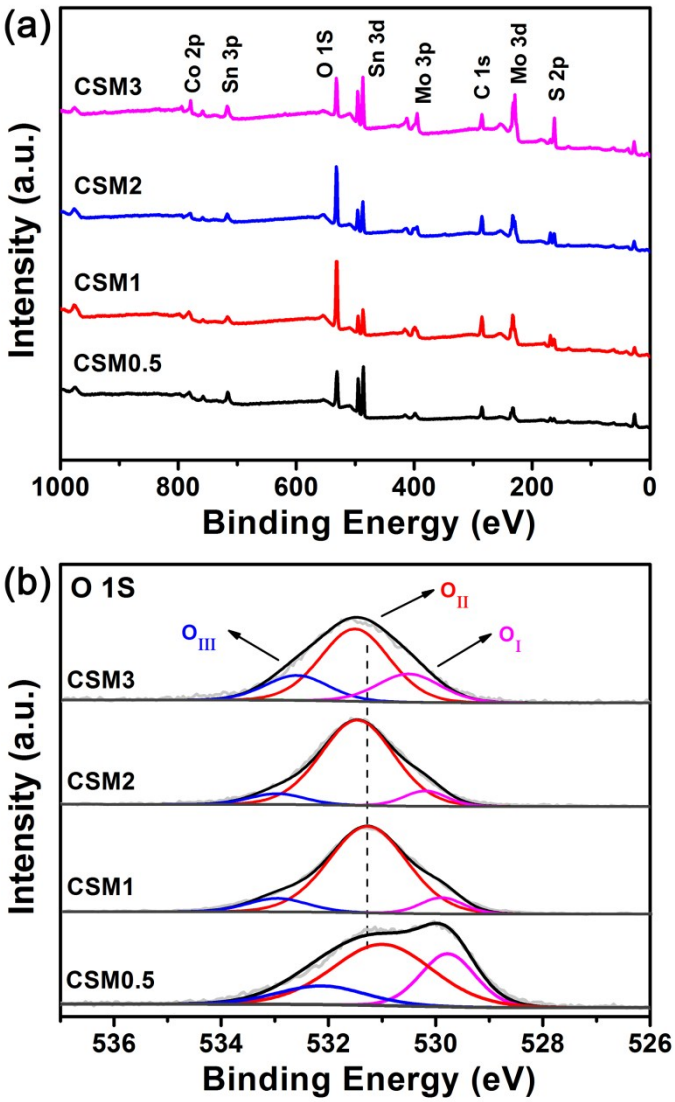

Fig. S5 XPS spectra of the CSMy (y = 0.5, 1, 2 and 3) nanocubes (a) survey and (b) O 1s.

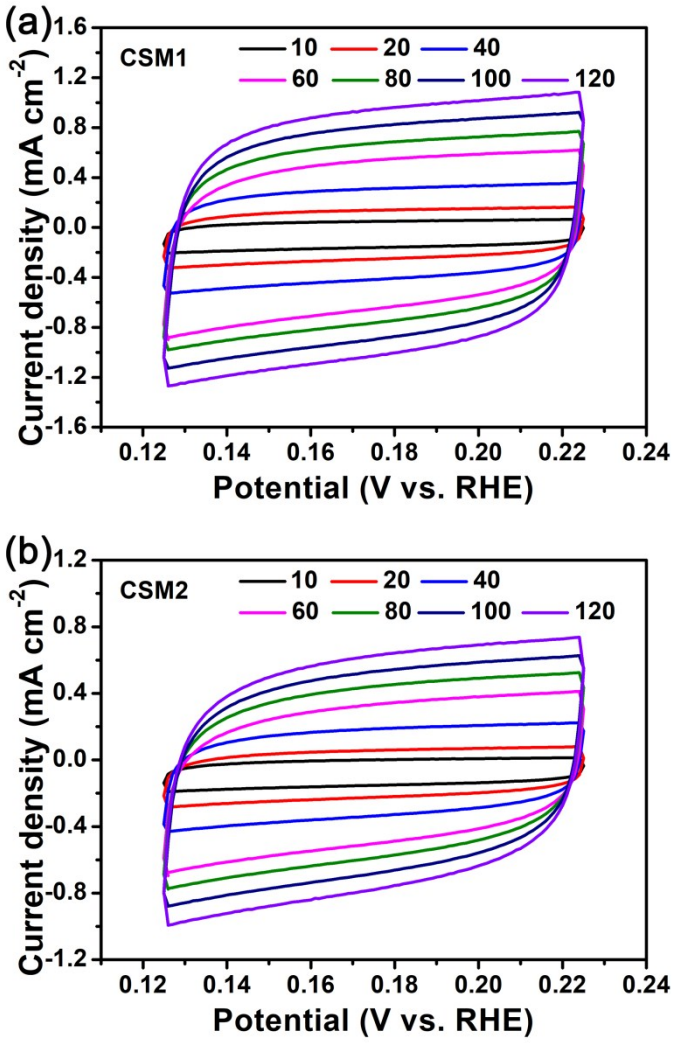

Fig. S6 CV curves of (a) CSM1 and (b) CSM2 modified electrodes in the double layer region at scan rate of 10, 20, 40, 60, 80, 100 and 120 mV s^{-1} in 0.5 M H_2SO_4.

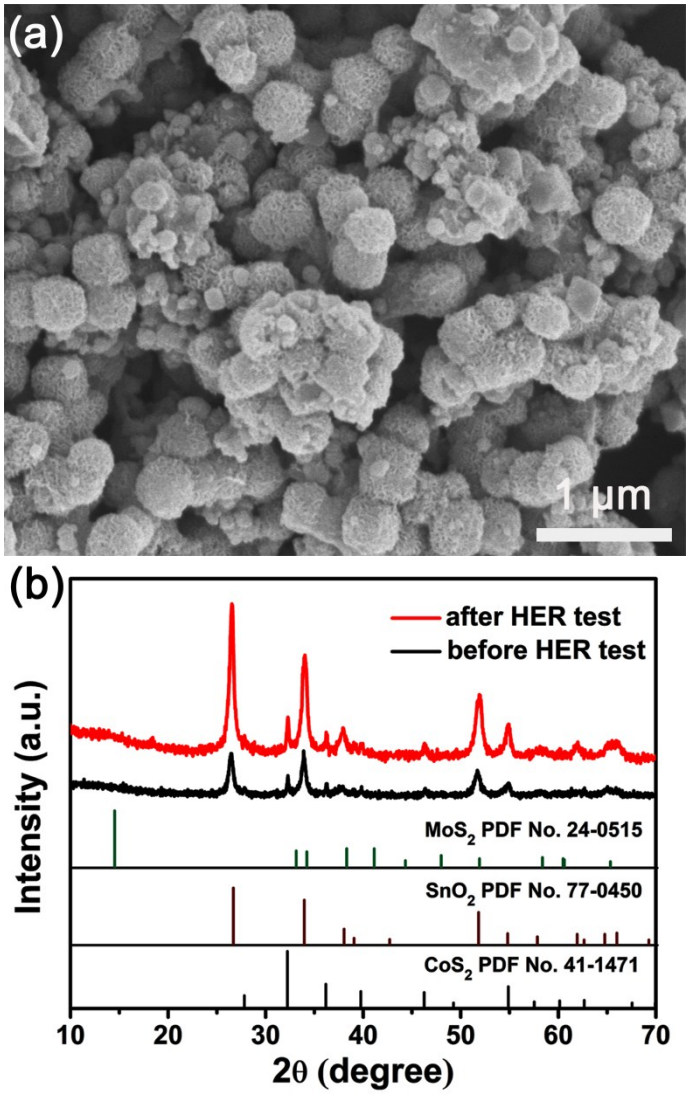

Fig. S7 (a) SEM images of CMS1 nanocubes after HER stability test. (b) The XRD spectra of CMS1 nanocubes before and after OER stability test in 0.5 M H_2SO_4.

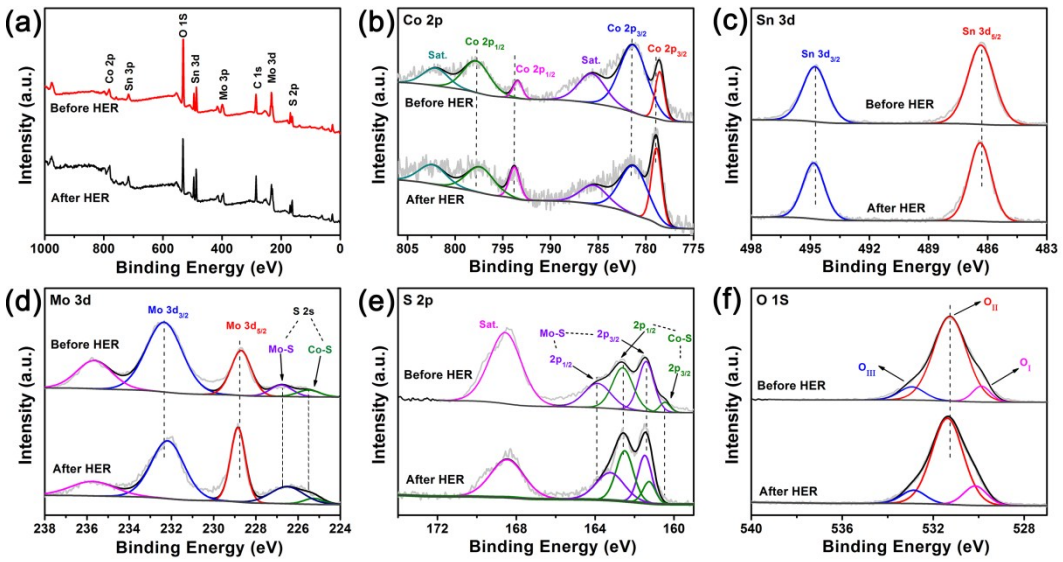

Fig. S8 XPS spectra of CMS1 nanocubes before and after OER stability test in 0.5 M H_2SO_4 (a) survey, (b) Co 2p, (c) Sn 3d, (d) Mo 3d, (e) S 2p and (f) O 1s.

Table S1 Electrochemical performance of molybdenum sulfide-based electrocatalysts in 0.5 M H_2SO_4

Catalyst	Current density (j, mA cm^{-2})	η at corresponding j (mV)	Tafel slope (mV dec^{-1})	References (Year)
CSM1	**10**	**196**	**69**	**This work**
m-CNMS	10	215	50.2	[1] (2019)
VMS2	10	194	59	[2] (2019)
CoS_2@MoS_2	10	290	85.9	[3] (2017)
Cu-MoS_2	10	211	86	[4] (2017)
Ni-MoS_2	11	300	89	[5] (2017)
Co_3S_4@MoS_2	10	210	88	[6] (2017)
$Co_XMo_{1-X}S_2$	10	357	120	[7] (2017)
1.0Ni-MoS_2	10	173	69	[8] (2019)
mPF-MoS_2	10	210	90	[9] (2017)
MCM@MoS_2–Ni	10	161	81	[10] (2018)
VS_2@MoS_2	10	177	54.9	[11] (2017)

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