Electronic Supplementary Information

Fabrication of nanocomposite MoC-Mo_2C@C/$Cd_{0.5}Zn_{0.5}S$: promoted electron migration and improved photocatalytic hydrogen evolution

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Characterization

The crystal phase of obtained photocatalysts were characterized by X-ray diffraction (XRD, D/max200PC, Rigaku Japan) using Cu Kα (λ = 1.5404 Å) radiation. The 2-Theta (degree) ranged from 10° to 80° with a scanning rate of 20° min^{-1}. Field-emission scanning electron microscopy (Hitachi SU-8000 FE-SEM) coupled with energy-dispersive X-ray (EDS) analysis were used to research morphology, crystallite sizes and surface chemical composition of all photocatalysts. Transmission electron microscopy (TEM, JEM-2100F) was also used to study the microstructure of the samples at an accelerating voltage of 200 kV. The UV-vis diffuse reflectance spectra (DRS) measurements were carried out on a UV-vis spectrophotometer (Varian Cary 500) in wavelength range from 300-800 nm. Barium sulfate was used as a reference material for baseline correction. X-ray photoelectron spectroscopy (XPS) measurements were carried out using USWHA150 with a monochromatic Al Kα source. Photoluminescence (PL) measurements were conducted on FLSP920 Edinburgh Fluorescence Spectrometer at room temperature.

Photoelectrochemical Measurements

Photoelectrochemical measurements were performed on 0.5 M Na_2SO_4 solution with a three-electrode system, which a SCE electrode as the reference electrode, a Pt foil as the counter electrode and the FTO coated with samples as the working electrode, respectively. A 300 W Xe lamp (Beijing Perfectlight Technology Corp., China) coupled with a optical filter (λ>420 nm) was used as a light source. Transient photocurrent experiments were carried out at constant bias of 0 V at room temperature. The electrochemical impedance spectroscopy (EIS) measurements were measured at -0.3 V with an AC amplitude of 50 mV in the frequency range from 0.1 Hz to 100 kHz under illumination. All results were measured on the CHI660C Electrochemical Workstation (Shanghai Chenhua Instrument Corp., China) at room temperature.

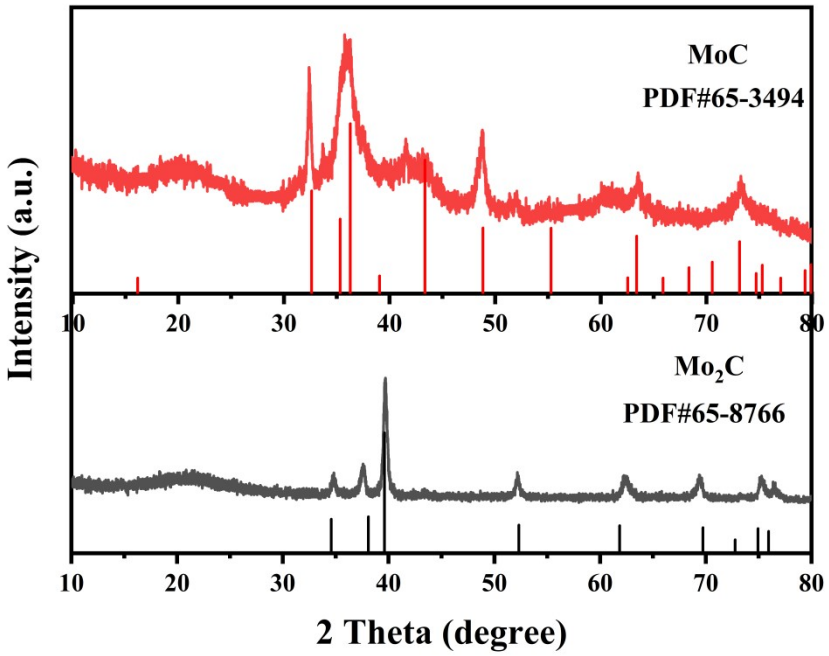

Fig. S1 XRD patterns of the MoC and Mo_2C.

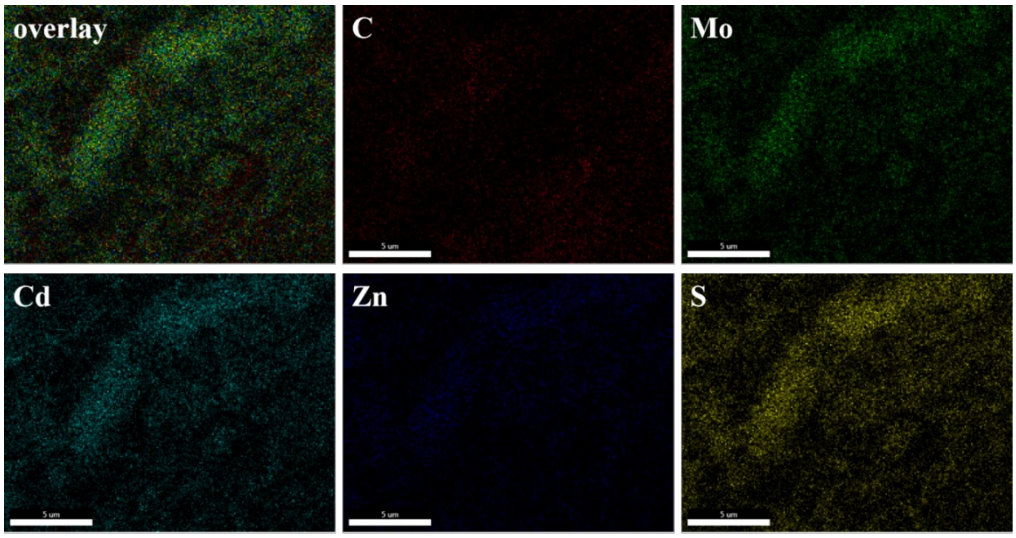

Fig. S2 SEM-mapping images of overlay, C, Mo, Cd, Zn and S in 2-MMC/ZCS.

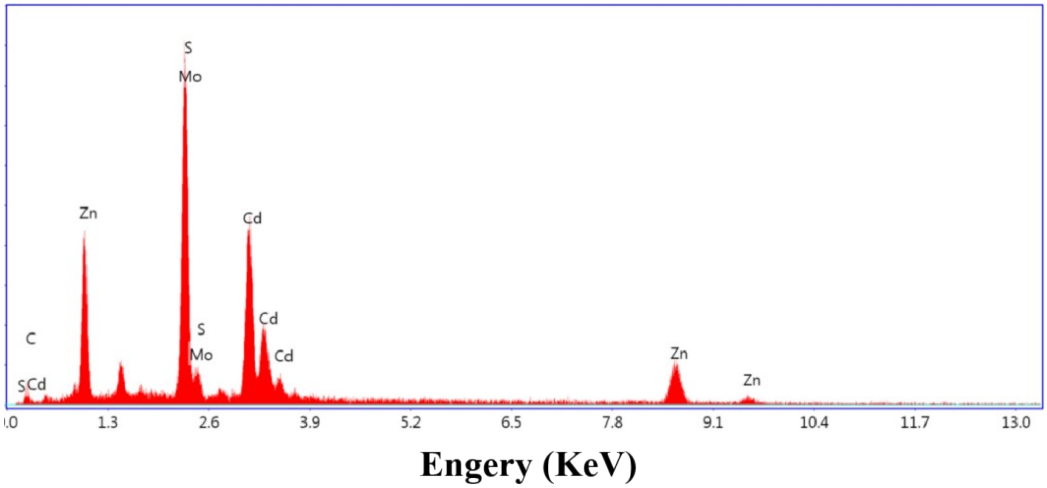

Fig. S3 EDS spectra of 2-MMC/ZCS sample

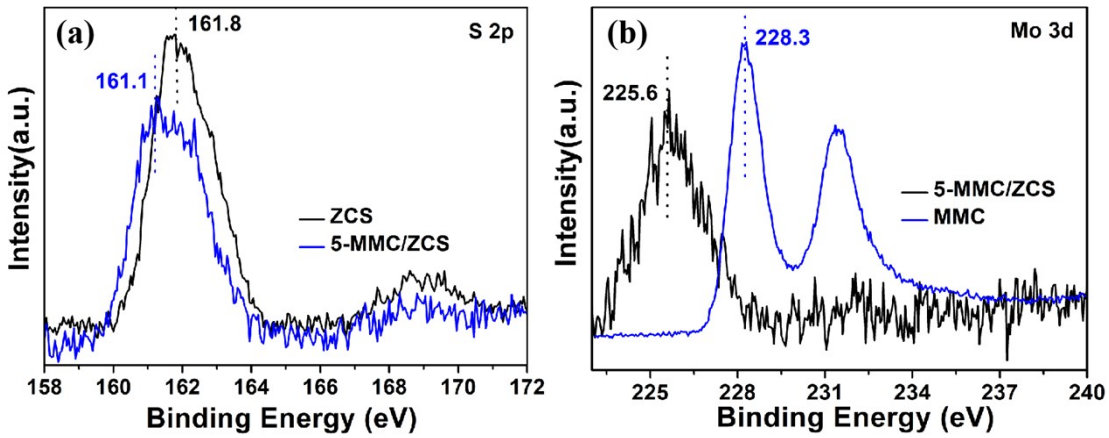

Fig. S4 (a) S 2p in the prepared ZCS and 5-MMC/ZCS sample, (b) Mo 3d in the prepared MMC and 5-MMC/ZCS sample.

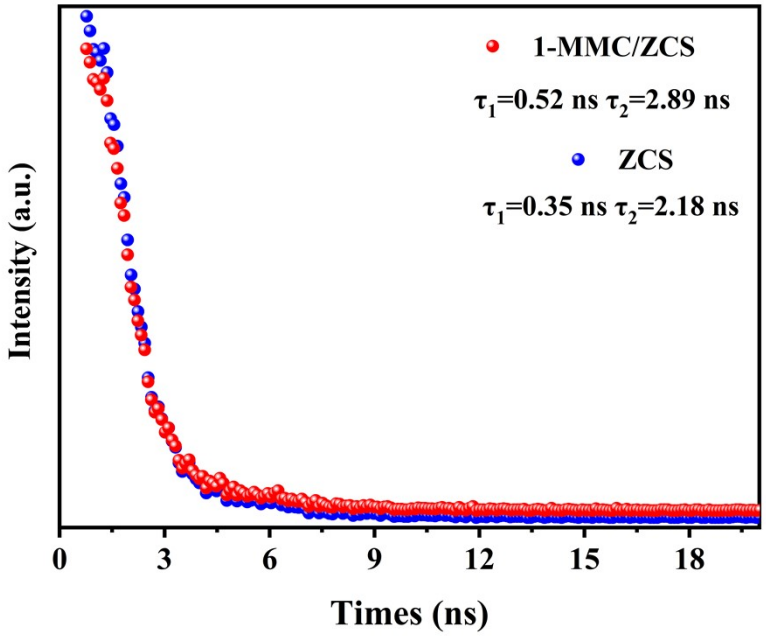

Fig. S5 Time-resolved fluorescence decay spectra.

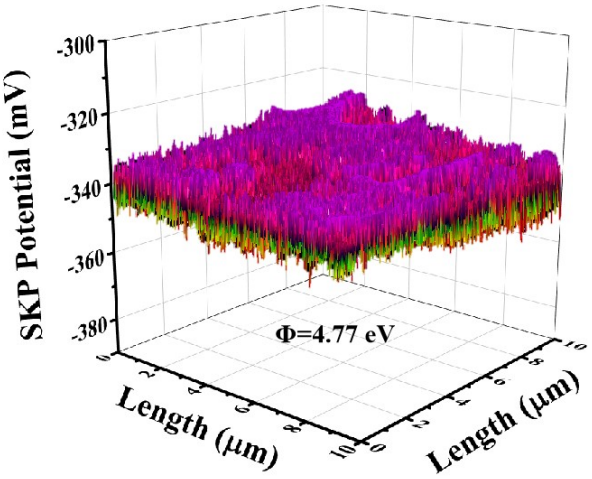

Fig. S6 Relative work function images of MMC.

Table S1. Based on the $Cd_xZn_{1-x}S$ system for photocatalytic hydrogen evolution.

Cocatalysts	Light harvesting	Light source	Weight(mg)/ Solution (mL), sacrificial agent	Activity (mmol g^{-1} h^{-1})	A.Q.Y. (%)	Ref.
1-MMC	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a	25/200, 6.3 g Na_2SO_3 and 16.8	68.7	32.9%	This work

		420 nm cut-off	g Na_2S			
Au/g-C_3N_4	$Cd_xZn_{1-x}S$	300 W Xe lamp with a 420 nm cut-off filter	50/100，0.1 mol L^{-1} glucose	0.123	--	1
NiS	$Cd_xZn_{1-x}S$	300 W Xe lamp with a 420 nm cut-off filter	100/100,0.1 M Na_2SO_3 and Na_2S	0.512	--	2
rGO	$Cd_xZn_{1-x}S$	300 W Xe lamp with a 420 nm cut-off filter	--/--, 0.25 M Na_2SO_3 and 0.35M Na_2S	--	19.4	3
MoS_2	$Cd_xZn_{1-x}S$	300 W Xe lamp with a 420 nm cut-off filter	10/100,0.25 M Na_2SO_3 and 0.35 M Na_2S	69.25	55.2	4
--	$Cd_xZn_{1-x}S$	300 W Xe lamp with a 420 nm cut-off filter	--/100, 0.25 M Na_2SO_3 and 0.35M Na_2S	717 μmol h^{-1}	28.69	5
Cd-Zn-Fe PBA	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	50/250, 0.25 M Na_2SO_3 and 0.35 M Na_2S	4.34	4.5	6
Pt/PdS	$Cd_{0.5}Zn_{0.5}S$-P	300 W Xe lamp with a 420 nm cut-off filter	10/100, 0.1 M Na_2S-Na_2SO_3	--	80	7
Ni_2P	SiO_2/rGO/$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	30/50, 0.5 M Na_2SO_3 and 0.7M Na_2S	11.65	15.6	8
--	Mo_3S_4/$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	30/60,0.3 M Na_2S-Na_2SO_3	72.1	9.6	9
NiSe	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	10/100, 0.25 M Na_2SO_3 and 0.35M Na_2S	78.1	46	10
Ni_3N/Ni_4N	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a	1/200, 0.25 M Na_2SO_3 and 0.35	241.3	43.8	11

		420 nm cut-off filter	M Na_2S			
Cu_3P	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	25/100, 0.25 M Na_2SO_3 and 0.35 M Na_2S	12.84	17.5	12
Potassium-doped-C_3N_4	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	50/50, triethanolamine aqueous solution	1.83	--	13
β-$NaYF_4$:Yb^{3+},Tm^{3+},Er^{3+}	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	10/250, 0.25 M Na_2SO_3 and 0.35 M Na_2S	159.3	24.2	14
$Ni_xCo_{1-x}P$	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	--/100, 0.25 M Na_2SO_3 and 0.35 M Na_2S	976 μmol · h^{-1}	19.7	15
MoS_2	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	20/80, lactic acid	40.2	33.4	16
$Co_xMo_{1-x}S$	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	50/300, 0.25 M Na_2SO_3 and 0.35 M Na_2S	3.77	16.72	17
Co_3N	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	1/200, 0.25 M Na_2SO_3 and 0.35 M Na_2S	160.7	30.2	18
Ni_2P	$Cd_{0.5}Zn_{0.5}S$	LED lamps with a 420 nm cut-off filter	5/105, 0.25 M Na_2SO_3 and 0.35 M Na_2S	21.19	21.16	19
Ni_2P	$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 400 nm cut-off filter	100/100, 0.25 M Na_2SO_3 and 0.35 M Na_2S	9.12	37.5	20
NiS	$Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	50/100, 0.25 M Na_2SO_3 and 0.35 M Na_2S	16.78	--	21
C_3N_4	rGO-	300 W Xe lamp with a	30/100, 0.25 M Na_2SO_3 and 0.35	39.24	37.88	22

	$Cd_{0.5}Zn_{0.5}S$	420 nm cut-off filter	M Na_2S			
Ni_2P	$Zn_{0.5}Cd_{0.5}S$-P	300 W Xe lamp with a 420 nm cut-off filter	50/100, 0.25 M Na_2SO_3 and 0.35 M Na_2S	1.3	29	23
CoP	$Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	50/100, lactic acid (10% Vol)	14.68	--	24
--	Cu/Ni-Codoped $Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp with a 420 nm cut-off filter	6/60, 0.25 M Na_2SO_3 and 0.35 M Na_2S	58.33	11.9	25
--	2-NTC/ZCS	300 W Xe lamp with a 420 nm cut-off filter	50/200, 6.3 g Na_2SO_3 and 16.8 g Na_2S	36.6	51.2	26

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