

Electronic Supplementary Information

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The construction of CoS/Cd_{0.5}Zn_{0.5}S Ohmic heterojunction for improved photocatalytic hydrogen production activity

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Table S1 ICP-OES characterization of the X%-CoS/Cd_{0.5}Zn_{0.5}S nanocomposites

X value	Element	CC (mg·kg ⁻¹)	Theoretical	Experimental
			mass ratio (Co:(Cd+Zn))	mass ratio (Co:(Cd+Zn))
10%	Co	43680.73		
	Cd	412063.78	6.41 wt%	6.70 wt%
	Zn	239887.47		
20%	Co	81045.48		
	Cd	380071.18	13.30 wt%	13.51 wt%
	Zn	219821.39		

	Co	111309.96		
30%	Cd	372148.49	19.99 wt%	18.95 wt%
	Zn	215239.15		
	Co	140067.44		
40%	Cd	350481.39	26.60 wt%	25.32 wt%
	Zn	202707.57		
	Co	168091.93		
50%	Cd	337871.92	33.26 wt%	31.52 wt%
	Zn	195414.65		

*X is the molar ratio of CoS and CdZnS in initial synthesis.

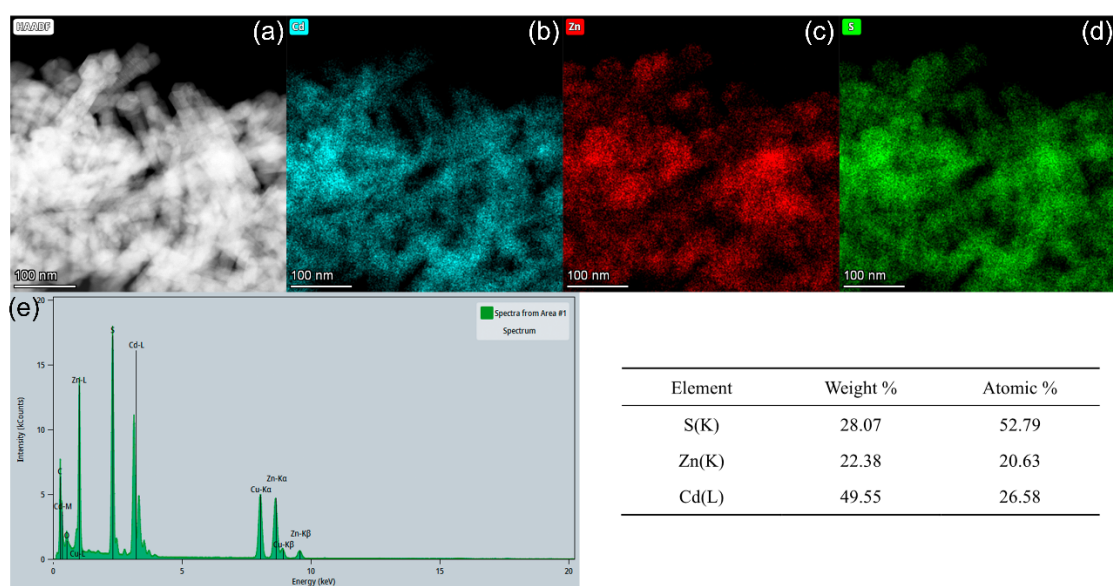


Fig. S1 High-angle annular dark field (HAADF)-STEM image of $\text{Cd}_{0.5}\text{Zn}_{0.5}\text{S}$ (a). Elemental mapping of Cd (b), Zn (c) and S (d) for $\text{Cd}_{0.5}\text{Zn}_{0.5}\text{S}$. (e) The EDX spectra.

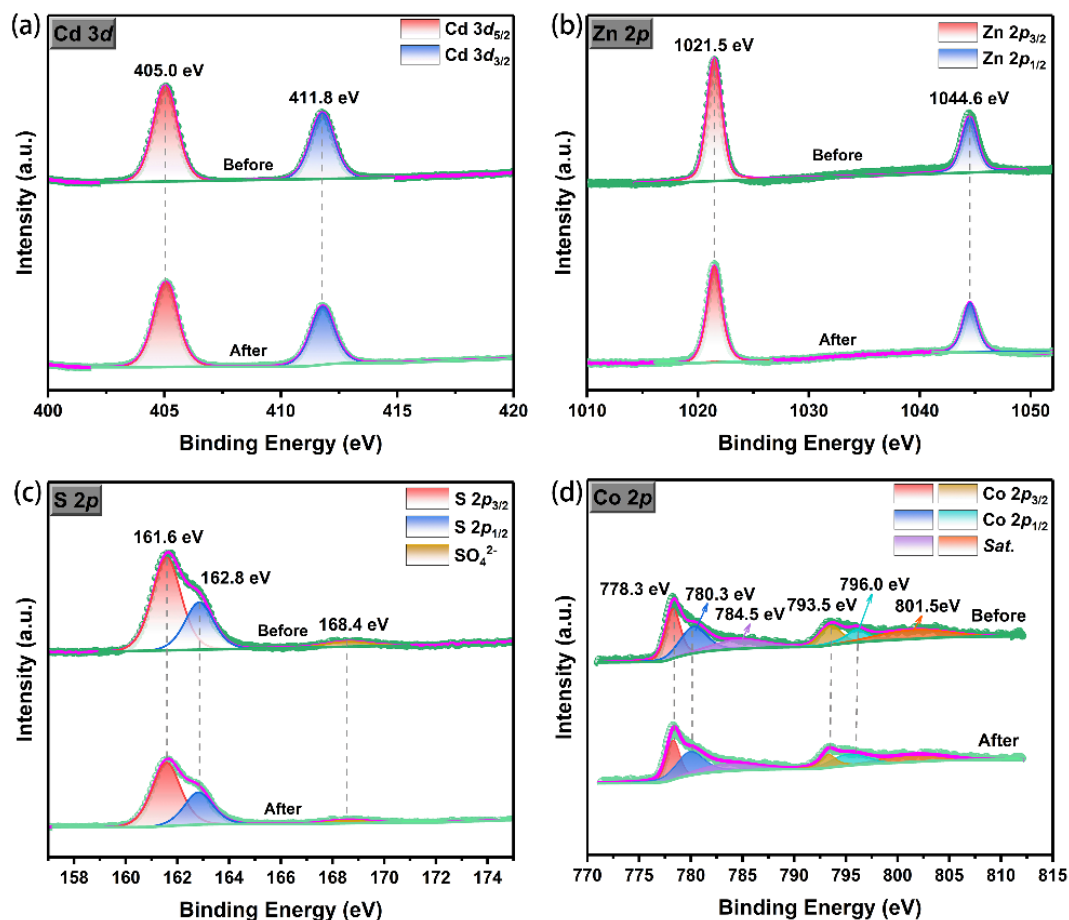


Fig. S2 XPS results of (a) Cd 3d; (b) Zn 2p; (c) S 2p; (d) Co 2p of 30% CoS/Cd_{0.5}Zn_{0.5}S nanocomposite before and after cycle photocatalysis.

Table S2 Comparison of the H₂ revolution rates with other photocatalysts.

Catalyst	Light source	Sacrificial reagent	H ₂ yield (mmol·g ⁻¹ ·h ⁻¹)	Reaction time (h)	Ref.
30%-CoS/Cd _{0.5} Zn _{0.5} S	λ>400 nm 300 W Xe	3 vol.% lactic acid	6.917	3	This work
2%-Cu ₂ S/CZS	LED lamp 5 W	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	5.904	5	[1]
In ₂ O ₃ /CdZnS (FICZ-2.5)	λ>420 nm 300 W Xe	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	1.11	5	[2]
CNTs (Cu)-1.0 wt.%	λ>420 nm 300 W Xe	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	2.995	5	[3]

UIO-66(Ce)/Zn	300 W Xe	1.0 M Na ₂ S·9H ₂ O and 1.0 M Na ₂ SO ₃	3.959	/	[4]
ZnCdS/NiAl hydrotalcite	λ>420 nm 5 W LED light	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	1.512	5	[5]
ZnCdS QDs (Zn: Cd=3:1)	λ>420 nm 300 W Xe	0.75 M Na ₂ S and 1.05 M Na ₂ SO ₃	3.752	5	[6]
ZnCdS/ Co@CoO	λ>420 nm 300 W Xe	Na ₂ S and Na ₂ SO ₃	5.445	5	[7]
CN/ZCS-2/Pt	λ>420 nm 300 W Xe	0.25 M Na ₂ S and 0.25 M Na ₂ SO ₃	3.245	3	[8]
BiVO ₄ -ZnCdS	λ>420 nm 300 W Xe	0.25 M Na ₂ S and 0.35 M Na ₂ SO ₃	0.152	5	[9]
NiS/rGO/C _{0.3} Z _{0.7} S	λ>420 nm 300 W Xe	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	1.058	4	[10]
CZS:Yb(15)	λ>420 nm 300 W Xe	20 vol.% CH ₃ OH	0.422	5	[11]
Zn _{1/2} Cd _{1/2} In ₂ S ₄ /MoS ₂	λ>400 nm 300 W Xe	0.35 M Na ₂ S and 0.25 M Na ₂ SO ₃	2.255	5	[12]

*Xe, xenon lamp.

Notes and references

- [1] G. Wang, Y. Quan, K. Yang and Z. Jin, *J. Mater. Sci. Technol.*, 2022, **121**, 28-39.
- [2] H. Yang, J. Tang, Y. Luo, X. Zhan, Z. Liang, L. Jiang, H. Hou and W. Yang, *Small*, 2021, **17**(36), 2102307.
- [3] B. Gong, Y. Lu, P. Wu, Z. Huang, Y. Zhu, Z. Dang, N. Zhu, G. Lu and J. Huang, *Appl. Surf. Sci.*, 2016, **365**, 280-290.
- [4] Y. Wang, H. Jin, Y. Li, J. Fang and C. Chen, *Int. J. Hydrogen Energ.*, 2022, **47**(2), 962-970.
- [5] C. Zheng, G. Jiang and Z. Jin, *Int. J. Hydrogen Energ.*, 2022, **47**(1), 292-304.

- [6] S. Qi, Y. Miao, J. Chen, H. Chu, B. Tian, B. Wu, Y. Li and B. Xin, *Nanomaterials*, 2021, **11**(6), 1357.
- [7] Y. Zou, C. Guo, X. Cao, T. Chen, Y. Kou, L. Zhang, T. Wang, N. Akram and J. Wang, *Int. J. Hydrogen Energ.*, 2022, **47**(60), 25289-25299.
- [8] T. Bai, X. Shi, M. Liu, H. Huang, J. Zhang and X.H. Bu, *RSC Adv.*, 2021, **11**(60), 38120-38125.
- [9] M. Imran, A.B. Yousaf, M. Farooq and P. Kasak, *Int. J. Hydrogen Energ.*, 2022, **47**(13), 8327-8337.
- [10] X. Wang, L. Li, H. Gu, H. Zhang, J. Zhang, Q. Zhang and W.L. Dai, *Appl. Surf. Sci.*, 2022, **574**, 151553.
- [11] P. Mu, M. Zhou, K. Yang, C. Zhou, Y. Mi, Z. Yu, K. Lu, Z. Li, S. Ouyang, W. Huang and C. Yu, *Sustain. Energ. Fuels*, 2021, **5**(22), 5814-5824.
- [12] Y. Hao, Z. Min, H. Guo, P. Shi, Y. Min, J. Fan and Q. Xu, *Appl. Surf. Sci.*, 2021, **546**, 149137.