Sulfur vacancies and Ni_2P co-catalyst synergistically boosting $Zn_{0.5}Cd_{0.5}S$ photocatalytic H_2 evolution

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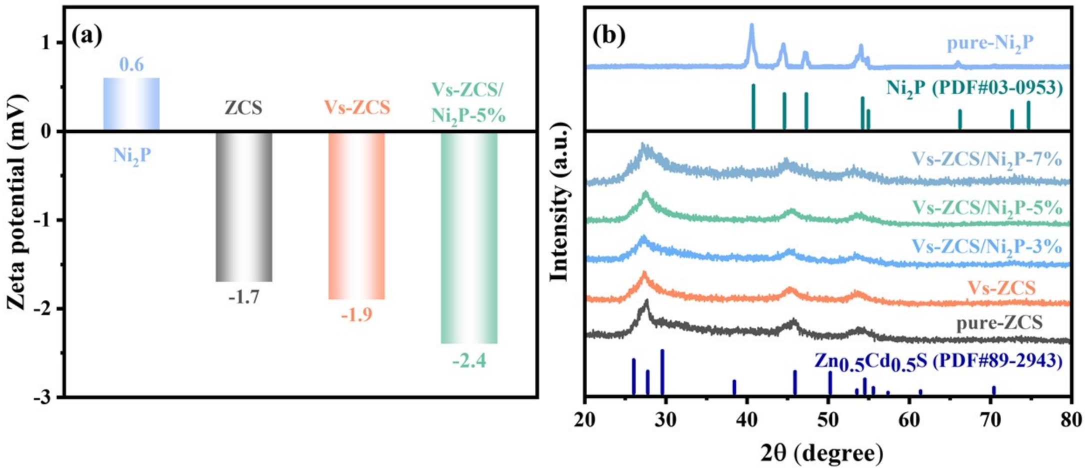

Fig. S1 (a) Zeta potentials of Ni_2P, ZCS, Vs-ZCS, Vs-ZCS/Ni_2P-5%; (b) XRD pattern of ZCS, Vs-ZCS, Vs-ZCS/Ni_2P-x%

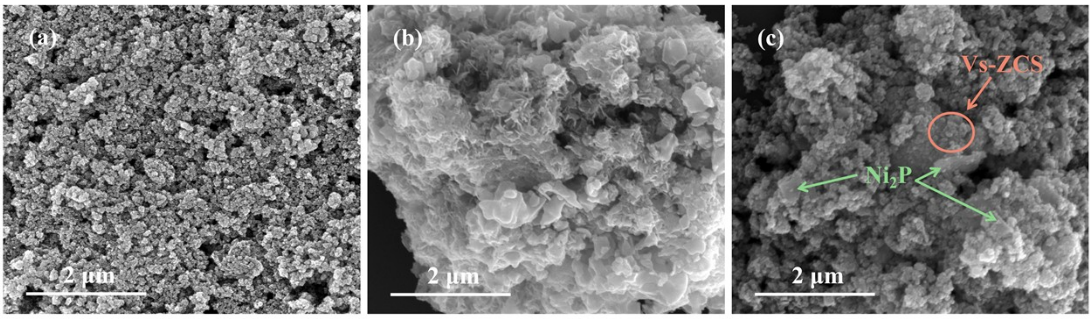

Fig. S2 SEM images of Vs-ZCS (a), Ni_2P (b), Vs-ZCS/Ni_2P-5% (c)

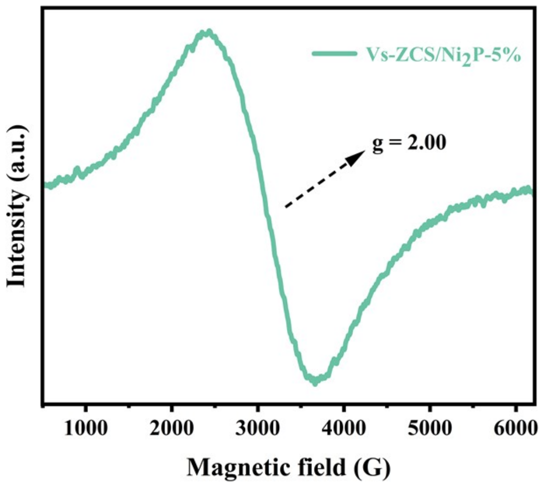

Fig. S3 EPR spectra of Vs-ZCS/Ni_2P-5%

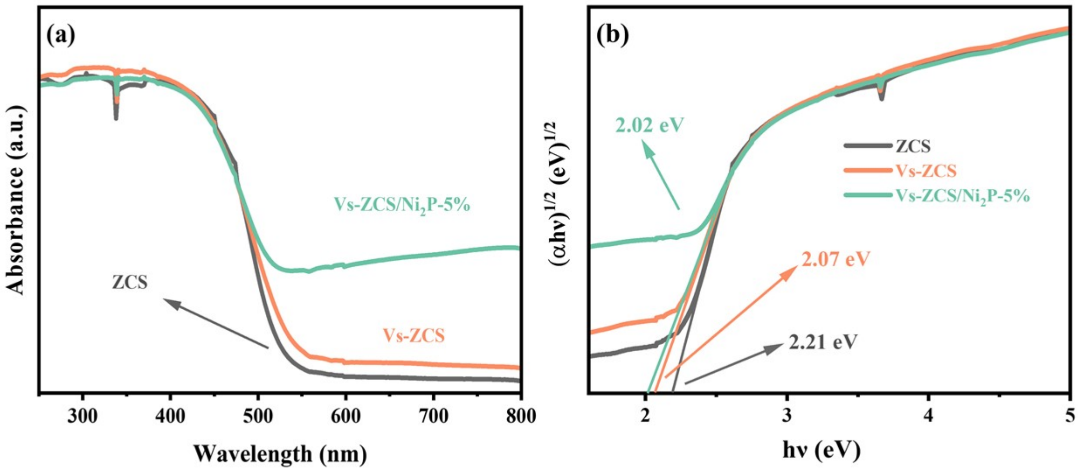

Fig. S4 UV-vis DRS spectra (a) and band gap spectra (b) of ZCS, Vs-ZCS and Vs-ZCS/Ni_2P-5%

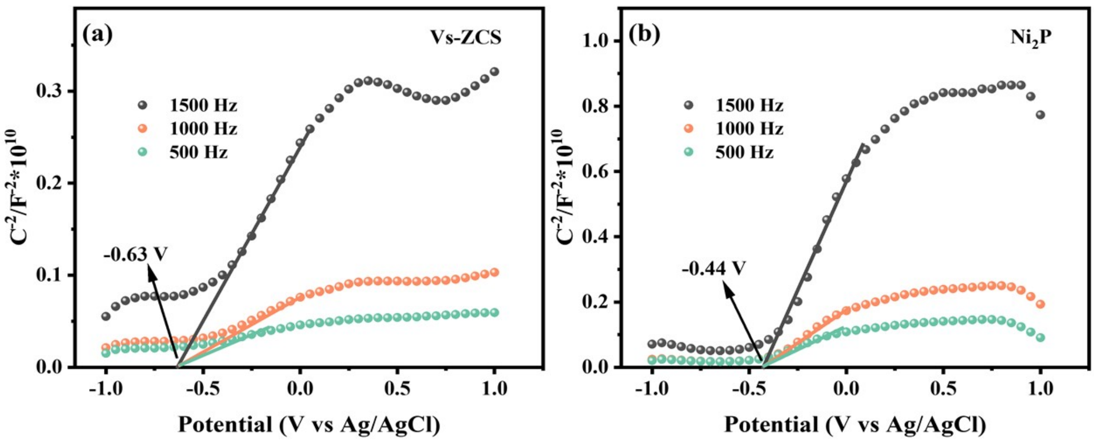

Fig. S5 Mott-Schottky plots of Vs-ZCS (a) and Ni_2P(b)

Table S1 Surface area and pore volume of Vs-ZCS, Ni_2P, and Vs-ZCS/Ni_2P-5%

Samples	S_{BET} (m^2/g)	Pore volume (cm^3/g)
Vs-ZCS	30.1790	0.184686
Ni_2P	67.5146	0.275776
Vs-ZCS/Ni_2P-5%	45.6236	0.267017

Table S2 Comparison of Vs-ZCS/Ni_2P-5% photocatalytic hydrogen production performance with other photocatalytic materials

Photocatalysts	Light Source Scavenger	Performance ($mmol \cdot h^{-1} \cdot g^{-1}$)	Reference
$Co_9S_8/Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp (λ>400 nm) Na_2S/Na_2SO_3	10.90	S1
$PtPd/Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp (λ>400 nm) Na_2S/Na_2SO_3	9.69	S2
$Ni(OH)_2/Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp (λ>400 nm) Na_2S/Na_2SO_3	6.87	S3
$Cu_3P/Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp (λ>420 nm) Na_2S/Na_2SO_3	2.70	S4
$Ni/Zn_{0.5}Cd_{0.5}S$	300 W Xe lamp (λ>420 nm) Na_2S/Na_2SO_3	5.93	S5
$Ni_2P/Zn_{0.9}Cd_{0.1}S$	300 W Xe lamp (λ>400 nm) Na_2S/Na_2SO_3	1.88	S6
$Ni_2P/Zn_xCd_{1-x}Se$	300 W Xe lamp (λ>420 nm) Na_2S/Na_2SO_3	4.34	S7
Fe-$Ni_2P/ZnIn_2S_4$-Vs	300 W Xe lamp (λ>420 nm) TEOA	4.55	S8
Vs-ZCS/Ni_2P-5%	**300 W Xe lamp (λ>380 nm)** **Na_2S/Na_2SO_3**	**40.81**	**This work**

Table S3 The AQY of all samples at 380 nm

Samples	ZCS	Vs-ZCS	Vs-ZCS/ Ni_2P-3%	Vs-ZCS/ Ni_2P-4%
AQY (%)	2.74	7.01	15.18	16.83
Samples	Vs-ZCS/ Ni_2P-5%	Vs-ZCS/ Ni_2P-6%	Vs-ZCS/ Ni_2P-7%	ZCS/ Ni_2P-5%
AQY (%)	21.60	18.96	16.20	5.76

References

S1. X. L. Li, R. B. He, Y. J. Dai, S. S. Li, N. Xiao, A. X. Wang, Y. Q. Gao, N. Li, J. F. Gao, L. H. Zhang and L. Ge, *Chem. Eng. J.*, 2020, **400**, 125474.

S2. L. H. Zhang, F. D. Zhang, H. Q. Xue, J. F. Gao, Y. Peng, W. Y. Song and L. Ge, *Chin. J. Catal.*, 2021, **42**, 1677-1688.

S3. X. Y. Gao, D. Q. Zeng, J. R. Yang, W. J. Ong, T. Fujita, X. L. He, J. Q. Liu and Y. Z. Wei, *Chin. J. Catal.*, 2021, **42**, 1137-1146.

S4. G. Y. Ge, S. T. Yuan, Q. Z. Liu, D. F. Yang, J. S. Shi, X. F. Lan and K. F. Xiao, *Appl. Surf. Sci.*, 2022, **597**, 153660.

S5. X. Y. Gao, J. R. Yang, D. Q. Zeng, G. He, C. Dai, Y. N. Bao and Y. Z. Wei, *J. Alloys Compd.*, 2021, **871**, 159460.

S6. Z. W. Shao, X. Meng, H. Lai, D. F. Zhang, X. P. Pu, C. H. Su, H. Li, X. Z. Ren and Y. L. Geng, *Chin. J. Catal.*, 2021, **42**, 439-449.

S7. L. Wei, D. Q. Zeng, J. Q. Liu, H. F. Zheng, T. Fujita, M. Y. Liao, C. Y. Li and Y. Z. Wei, *J. Colloid Interface Sci.*, 2022, **608**, 3087-3097.

S8. G. Q. Li, H. O. Liang, X. Y. Fan, X. L. Lv, X. W. Sun, H. G. Wang and J. Bai, *J. Mater. Chem. A.*, 2023, **11**, 14809-14818.