Supporting Information

Visible-light driven H_2 evolution coupled with furfuryl alcohol selective oxidation over Ru atom decorated $Zn_{0.5}Cd_{0.5}S$ nanorods

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Figures

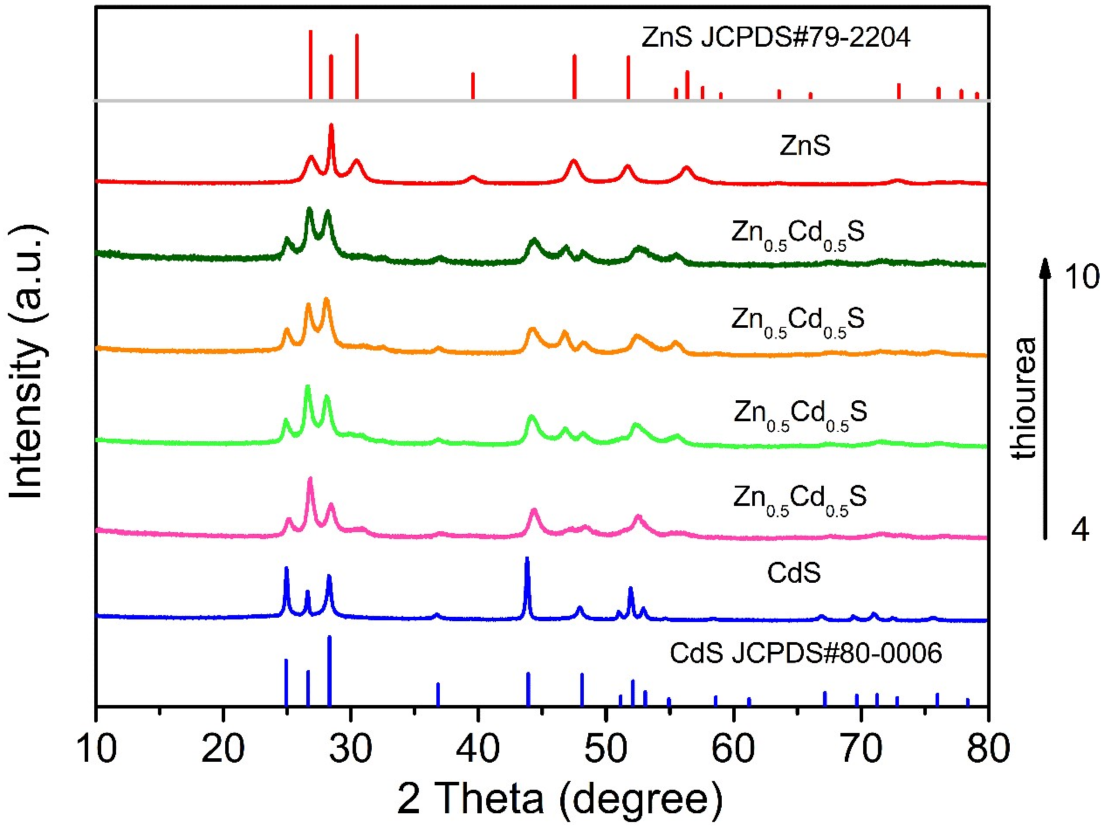

Fig. S1. XRD patterns of ZnS, CdS, and $Zn_{0.5}Cd_{0.5}S$ synthesized using different dosages of thiourea.

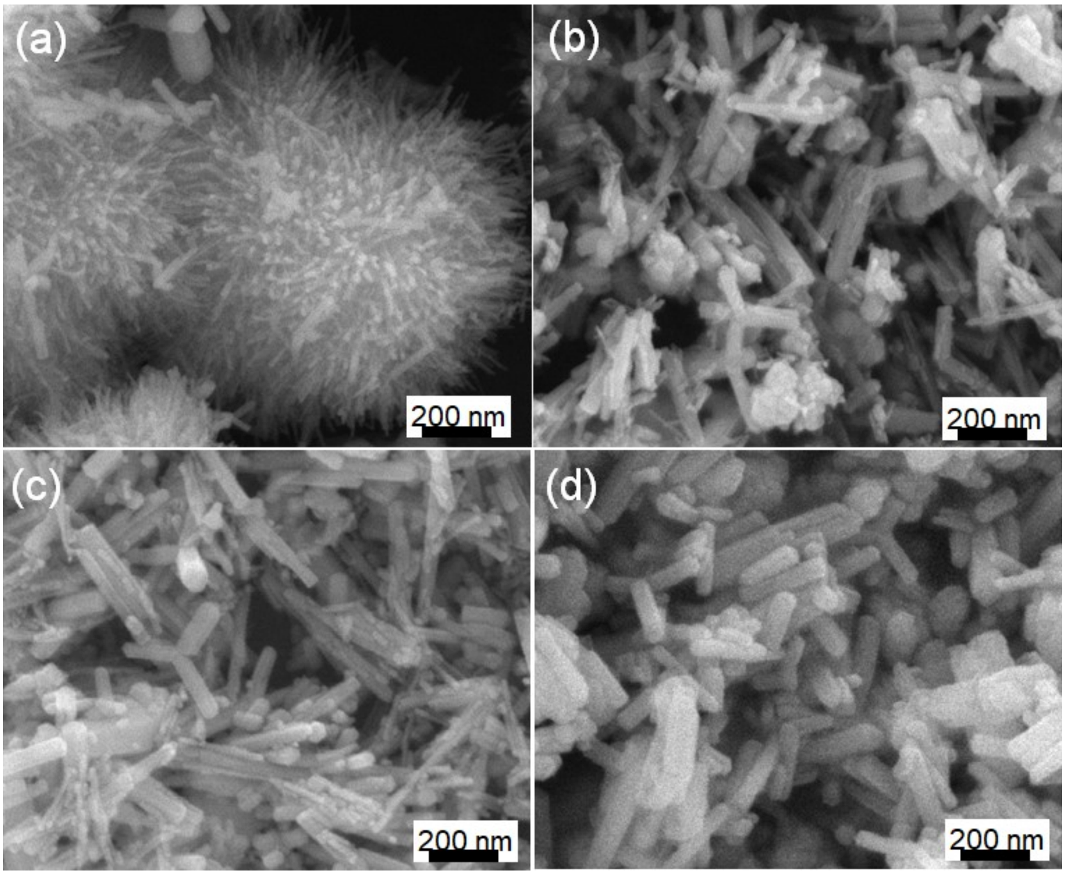

Fig. S2. (a-d) SEM images of $Zn_{0.5}Cd_{0.5}S$ synthesized using 4 (a), 6 (b), 8 (c), and 10 (d) mmol thiourea.

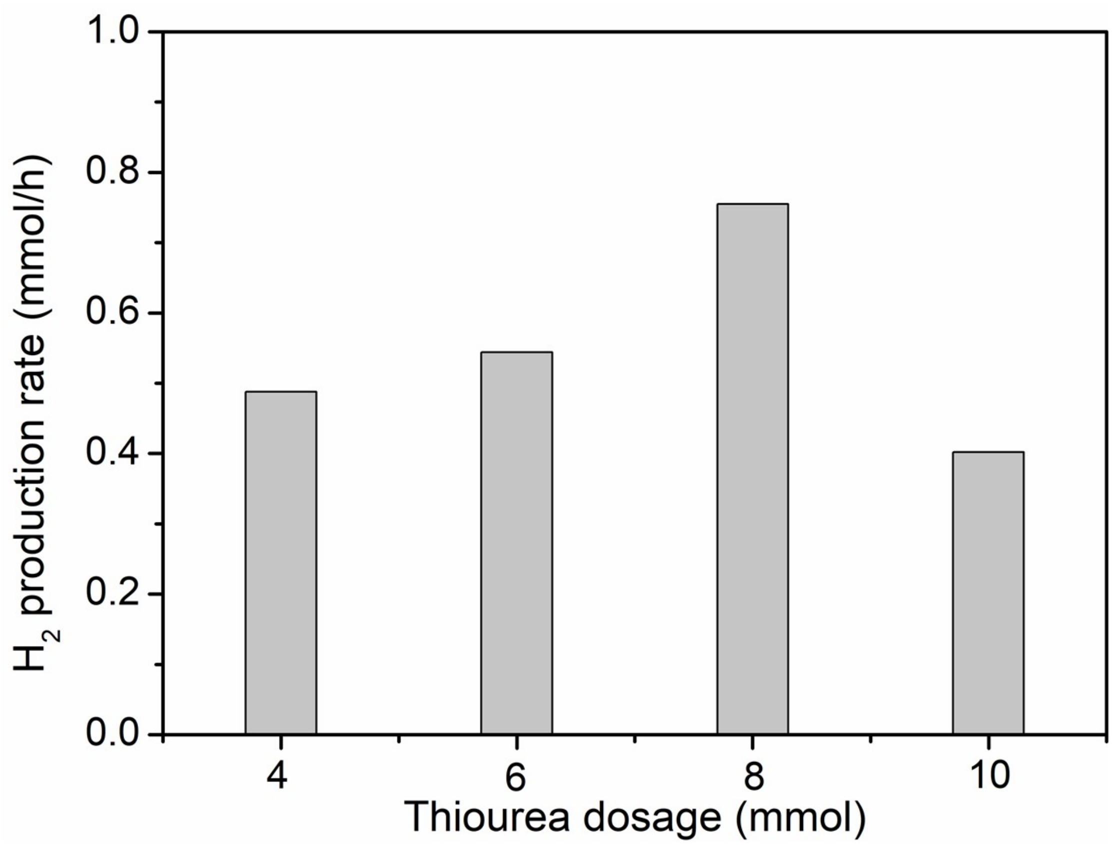

Fig. S3. Photocatalytic H_2 evolution performance of $Zn_{0.5}Cd_{0.5}S$ synthesized using 4, 6, 8, and 10 mmol thiourea. Light source: 300 W Xeon lamp equipped with a UV cutoff filter; reaction solution: 60 mL of Na_2S/Na_2SO_3 solution (0.25 M/0.35 M), 20 mg catalyst.

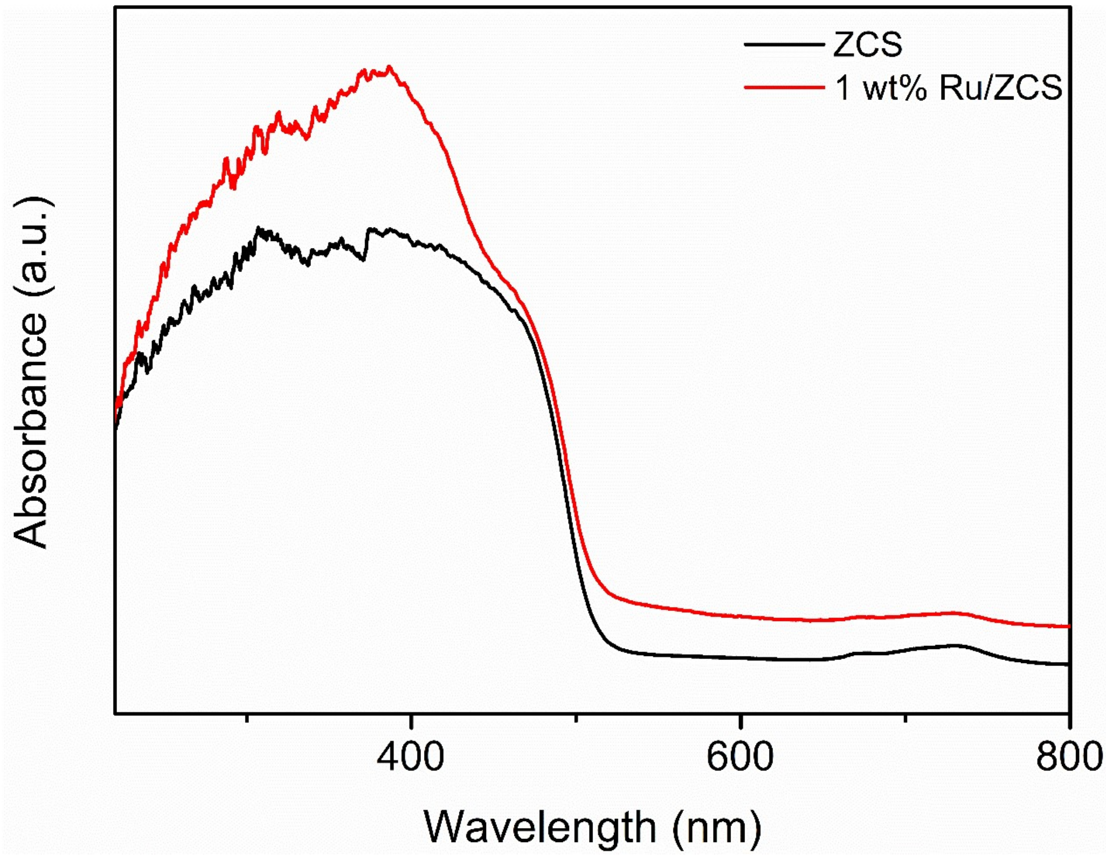

Fig. S4. UV-vis absorption spectra of ZCS and 1 wt% Ru/ZCS.

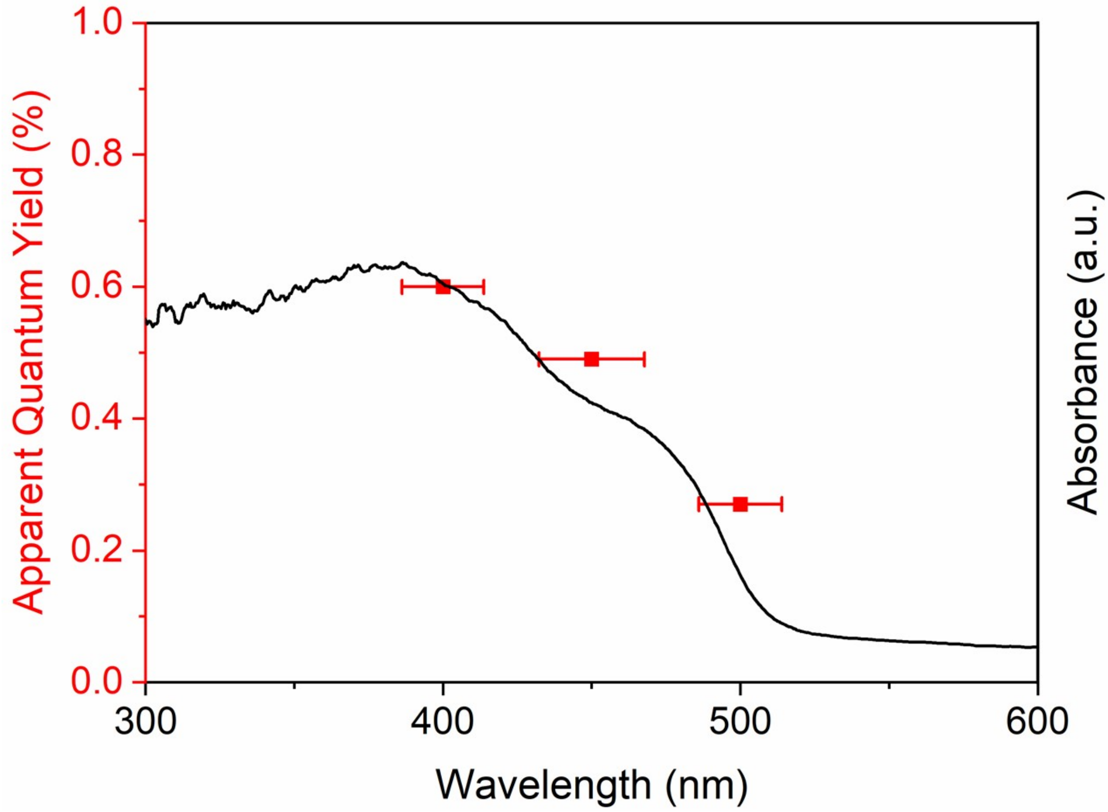

Fig. S5. Wavelength dependent AQY of photocatalytic H_2 production over 1 wt% Ru/ZCS.

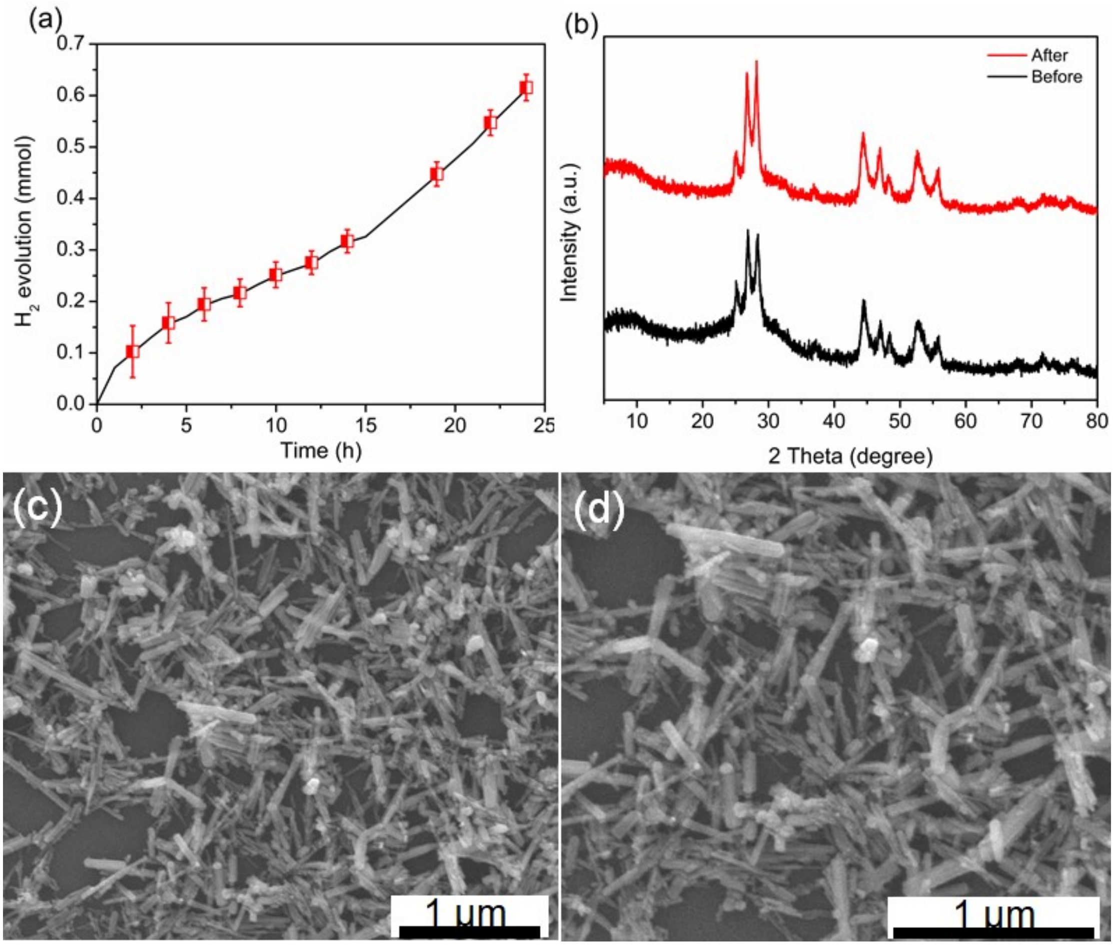

Fig. S6. (a) Time course of H_2 evolution over 24 h irradiation, (b) XRD pattern, (c, d) SEM images of 1 wt% Ru/$Zn_{0.5}Cd_{0.5}S$ after the photocatalytic reaction.

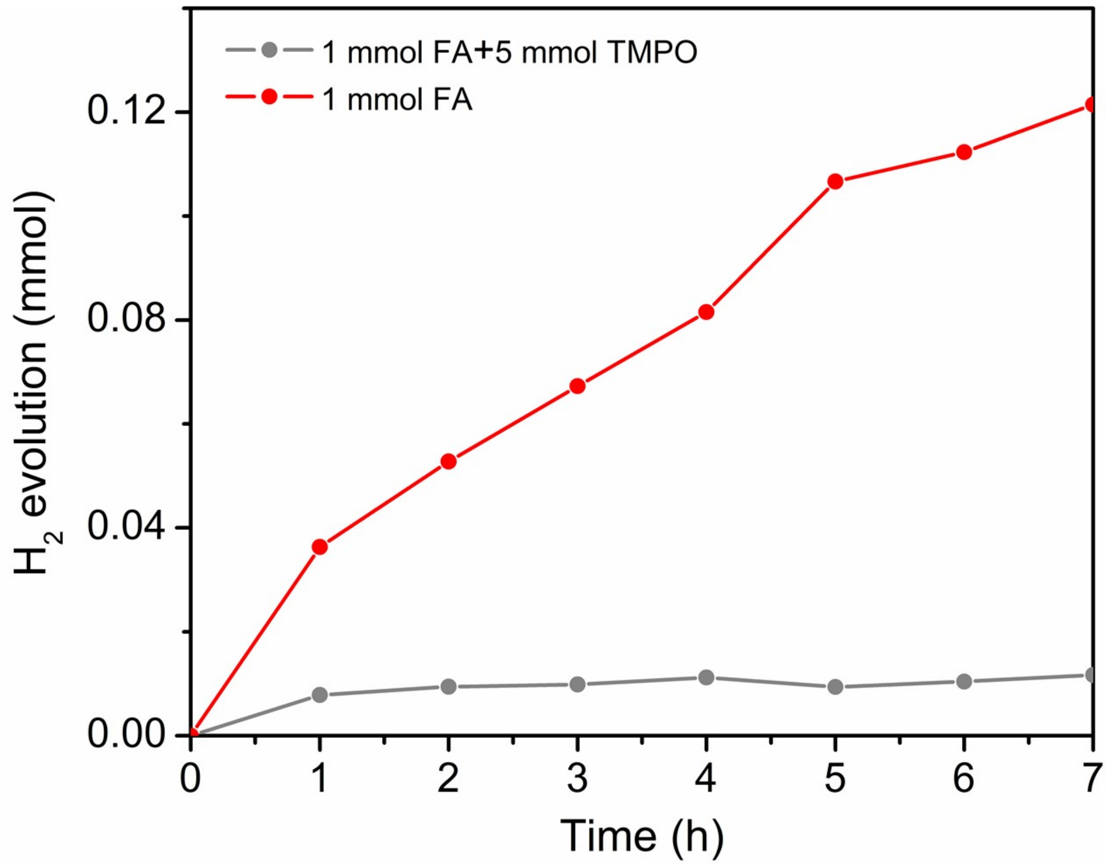

Fig. S7. Time course of photocatalytic H_2 evolution over 1 wt% Ru/$Zn_{0.5}Cd_{0.5}S$ in the presence of furfuryl alcohol and TMPO.

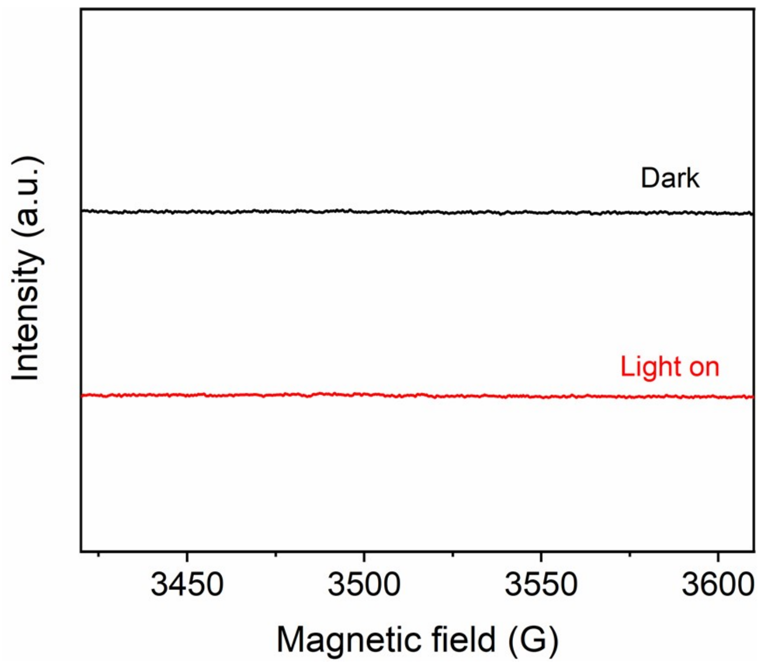

Fig. S8. EPR spectra of 1 wt% Ru/$Zn_{0.5}Cd_{0.5}S$ using DMPO as the spin-trapping agent.

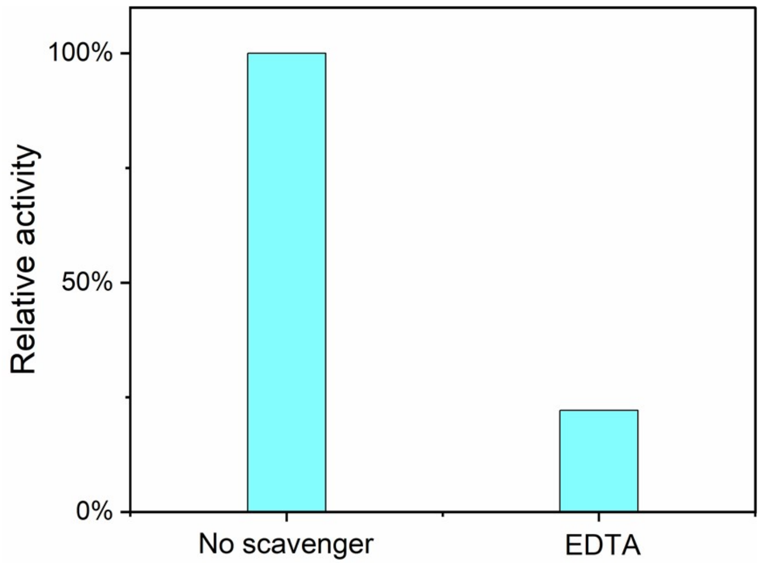

Fig. S9. Relative performance of the oxidation of furfuryl alcohol to furfural over 1 wt% Ru/$Zn_{0.5}Cd_{0.5}S$ with and without EDTA as a hole scavenger.

Table S1 Comparison of photocatalytic activity of H_2 production coupled with alcohol oxidation from literatures.

Photocatalyst	Reactant weight	Alcohol	Light source	Activity (μmol h^{-1})	Oxidation product and selectivity	Ref.
$Ti_3C_2T_x$/CdS	10 mg	Furfuryl alcohol	300 W Xe lamp	1.9	Furfural 93%	[S1]
$Ti_3C_2T_x$/CdS	10 mg	Furfuryl alcohol	3 W blue LED	6.1	Furfural N/A	[S2]
$MoS_2/ZnIn_2S_4$	5 mg	Furfuryl alcohol	300 W Xe lamp	14.7	Furfural N/A	[S3]
$NiS/ZnIn_2S_4$	5 mg	Furfuryl alcohol	300 W Xe lamp	12.5	Furfural N/A	[S3]
$WS_2/ZnIn_2S_4$	5 mg	Furfuryl alcohol	300 W Xe lamp	13.0	Furfural N/A	[S3]
Ni/CdS	10 mg	Furfuryl alcohol	450 nm LED lamp	20.3	Furfural >99%	[S4]
$Zn_{0.5}Cd_{0.5}S$-P	1 mg	5-hydroxymethylfurfural	White LED light	0.8	2,5-diformylfuran 65%	[S5]
Co_9S_8/CdS	1 mg	Benzyl-alcohol	450 nm LED Lamp	4.3	Benzaldehyde >99%	[S6]
Co_9S_8/CdS	1 mg	Benzyl-alcohol	300 W Xe lamp	10.3	Benzaldehyde >99%	[S6]
CdS/MIL-53(Fe)	5 mg	Benzyl-alcohol	300 W Xe lamp	11.67	Benzaldehyde 99%	[S7]
Pt/g-C_3N_4	10 mg	Benzyl-alcohol	300 W Xe lamp	2.55	Benzaldehyde 90%	[S8]
Ru/ $Zn_{0.5}Cd_{0.5}S$	20 mg	Furfuryl alcohol	300 W Xe lamp	17.4	Furfural >99%	this work

Table S2. Kinetic analysis of emission decay of ZCS, 1 wt% Au/ZCS, 1 wt% Pt/ZCS, 1 wt% Pd/ZCS, and 1 wt% Ru/ZCS.

Samples	Decay life time (ns)			Fractional contribution			Average lifetime (ns)
	τ_1	τ_2	τ_3	f_1	f_2	f_3	
ZCS	0.416	2.0	18.0	2.0	9.7	88.3	4.50
1 wt% Au/ZCS	0.414	1.90	12.0	2.8	13.2	84.0	2.20
1 wt% Pt/ZCS	0.334	1.20	6.60	4.2	14.7	81.1	1.90
1 wt% Pd/ZCS	0.388	1.50	6.70	4.5	17.5	78.0	1.59
1 wt% Ru/ZCS	0.322	0.83	4.50	5.7	14.7	79.6	1.35

Supplementary References

[S1] Y.-H. Li, F. Zhang, Y. Chen, J.-Y. Li, Y.-J. Xu, Photoredox-catalyzed biomass intermediate conversion integrated with H_2 production over $Ti_3C_2T_x$/CdS composites, Green Chem., 2020, 22: 163-169.

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[S3] C.-L. Tan, M.-Y. Qi, Z.-R. Tang, Y.-J. Xu, Cocatalyst decorated $ZnIn_2S_4$ composites for cooperative alcohol conversion and H_2 evolution, Appl. Catal., B, 2021, 298: 120541.

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[S5] H.-F. Ye, R. Shi, X. Yang, W.-F. Fu, Y. Chen, P-doped $Zn_xCd_{1-x}S$ solid solutions as photocatalysts for hydrogen evolution from water splitting coupled with photocatalytic oxidation of 5-hydroxymethylfurfural, Appl. Catal., B, 2018, 233: 70-79.

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[S7] P. Li, X. Yan, S. Gao, R. Cao, Boosting photocatalytic hydrogen production coupled with benzyl alcohol oxidation over CdS/metal–organic framework composites, Chem. Eng. J., 2021, 421: 129870.

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