

***In-situ* topotactic formation of 2D/2D direct Z-scheme $\text{Cu}_2\text{S}/\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$ in-plane intergrowth nanosheet heterojunctions for enhanced photocatalytic hydrogen production**

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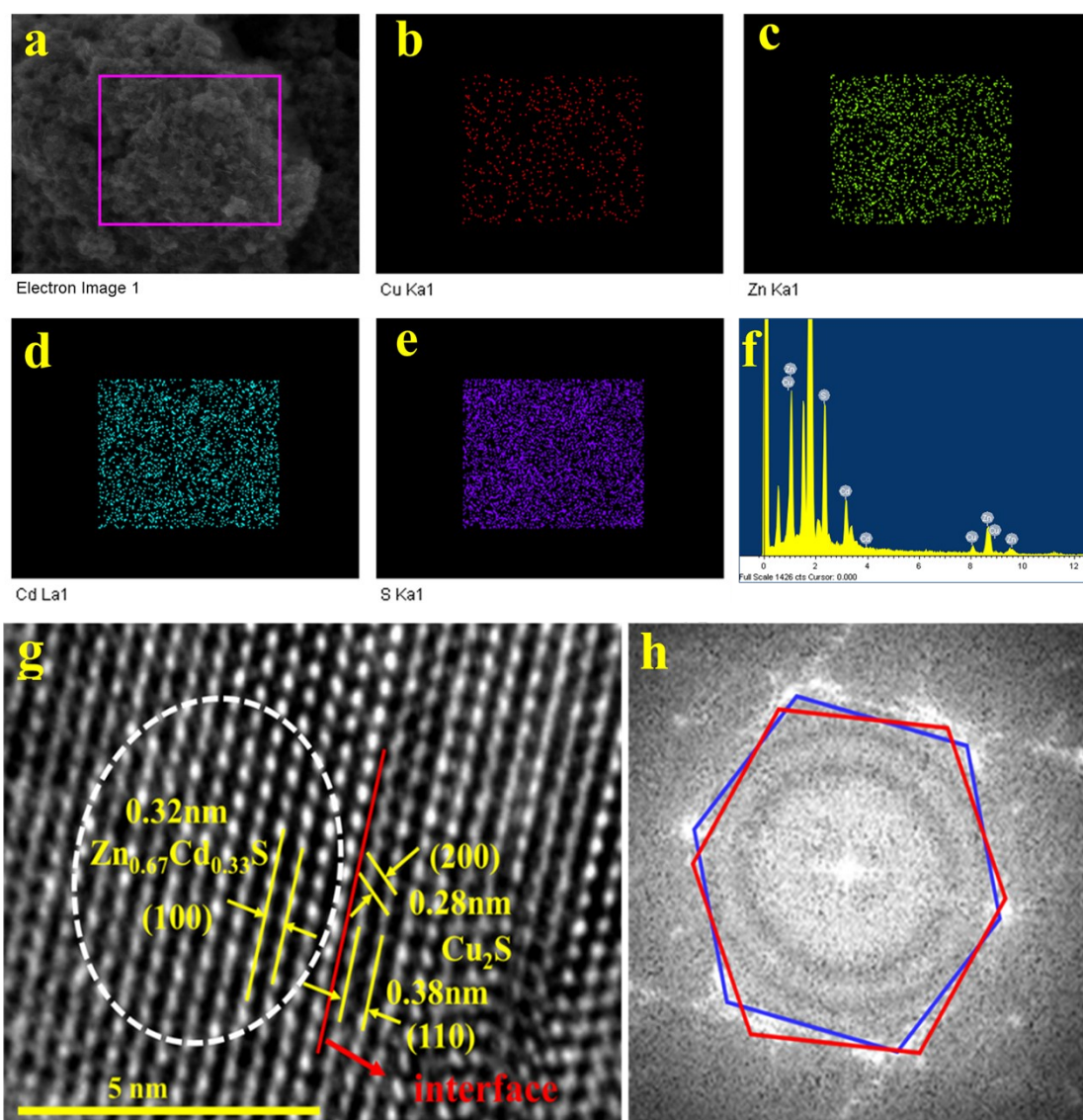


Figure S1. Corresponding element mapping of CZCS-20 in SEM image (b) Cu; (c) Zn; (c) Cd and (d) S element,(g-h) HRTEM images of CZCS-20.

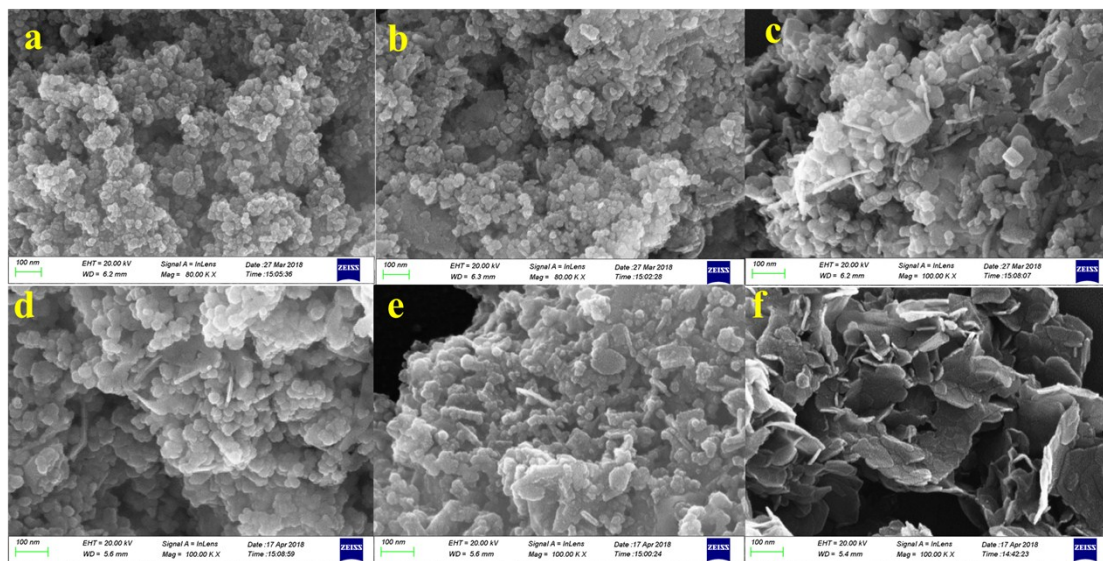


Figure S2. SEM images of (a) CZCS-1, (b) CZCS-2, (c) CZCS-4, (d) CZCS-8, (e) CZCS-20, (f) CZCS-40.

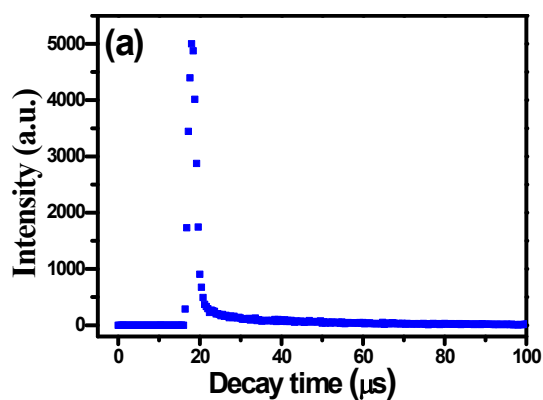


Figure S3. Transient fluorescence spectra of the (a) $\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$

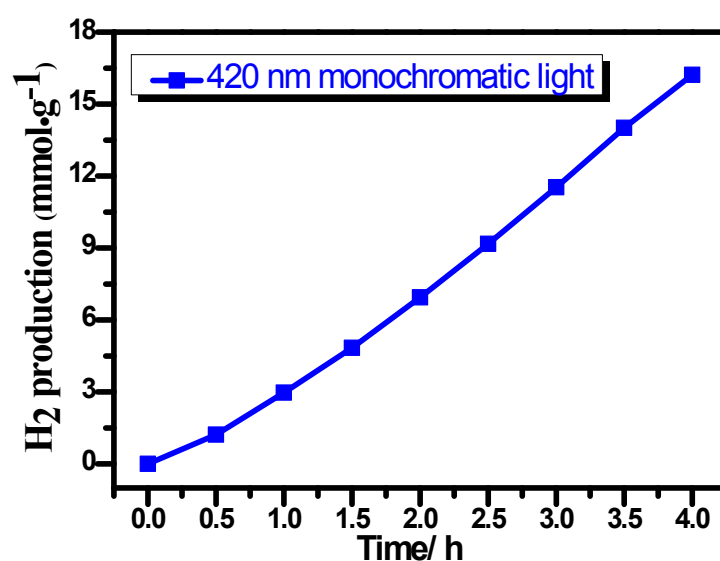
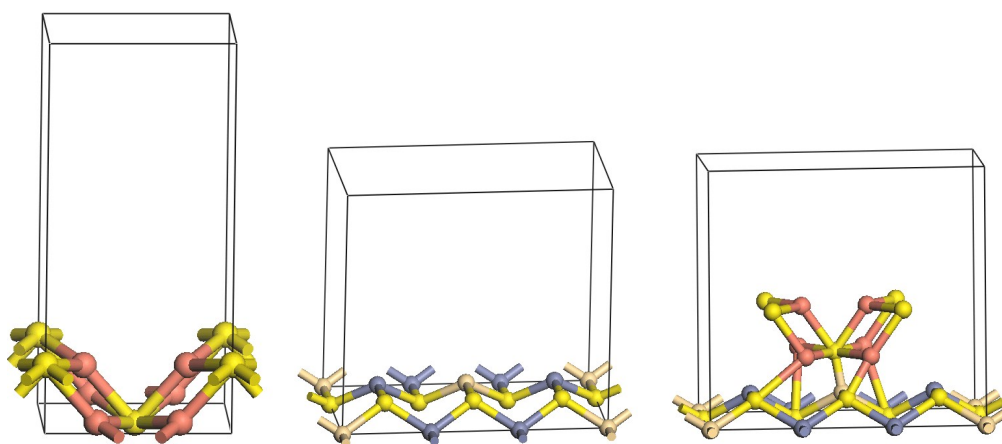
Table S1. Zn/Cu molar ratio was measured by ICP measurement.

Sample	Zn/Cu molar ratio
CZCS-1	0.95
CZCS-2	1.91
CZCS-4	3.89
CZCS-8	8.11
CZCS-20	19.81
CZCS-40	41.93

Table S2. Transient fluorescence lifetimes of the $\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$ and CZCS-20.

Sample	Emission peak	$\langle\tau_i\rangle$ (s)	$A_i(\%)$	$\langle\tau\rangle$	χ^2
$\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$	521 nm	5.169E-007	82.89	5.3 μs	1.431
		2.839E-005	17.11		
CZCS-20	529 nm	5.534E-010	89.60	0.89 ns	1.075
		3.877E-009	10.40		

τ_i ($i=1, 2$) is the fitted fluorescence lifetime, A_i is the percentage of τ_i in the double-exponential case, χ^2 is goodness of fit.

**Figure S4.** The Photocatalytic H_2 production of CZCS-20 composite photocatalysts under 420 nm monochromatic light irradiation.**Figure S5.** The optimized geometry of Cu_2S (left), $\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$ (middle) and CZCS (right) by DFT simulation

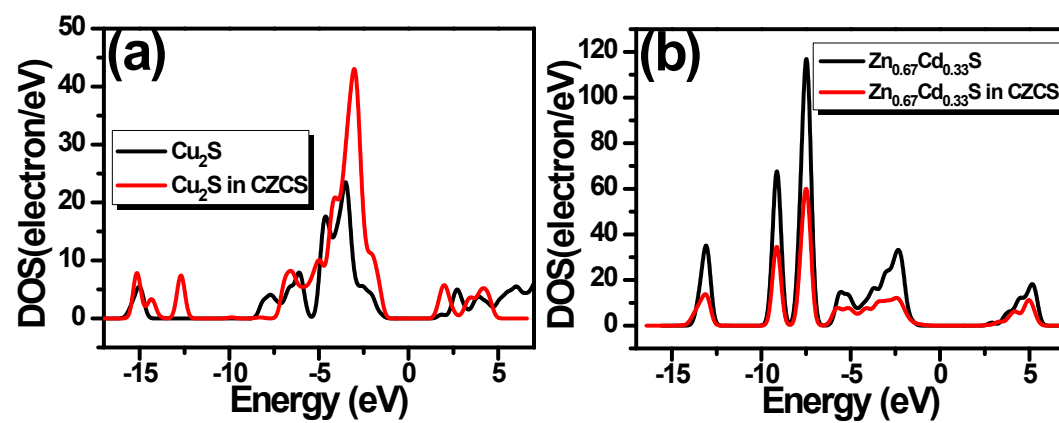


Figure S6. The density of states for (a) Cu_2S and (b) $\text{Zn}_{0.67}\text{Cd}_{0.33}\text{S}$