Supplementary Information

Spatially ordered NiOOH-ZnS/CdS heterostructures with efficient photo-carriers transmission channel for markedly-improved H_2 production

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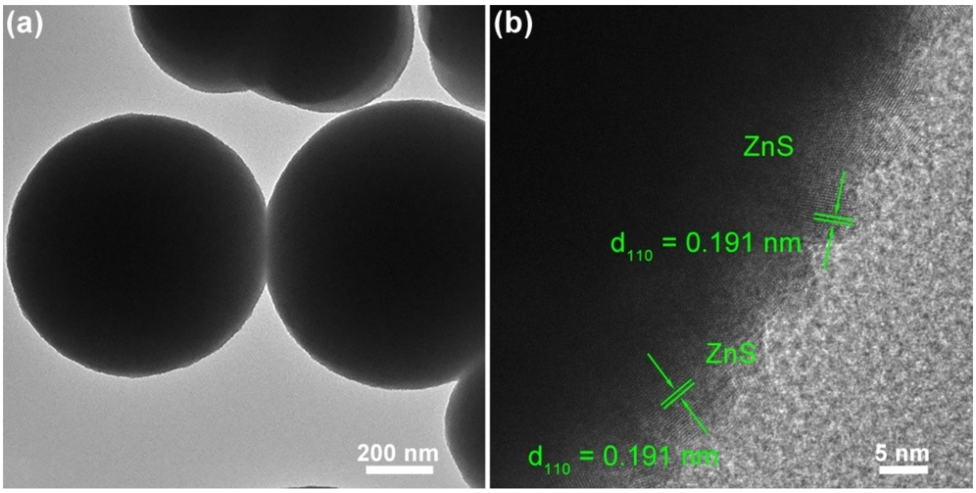

Fig. S1. (a) TEM and (b) HRTEM images of ZnS sample.

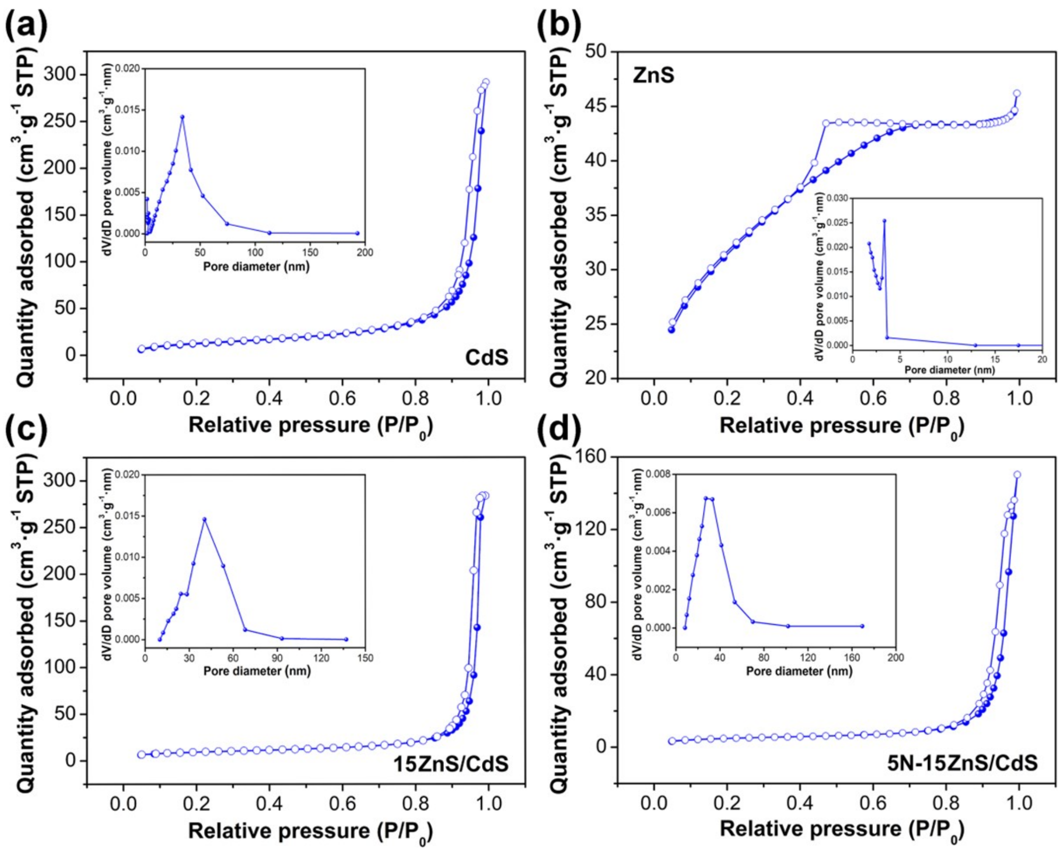

Fig. S2. N_2 adsorption-desorption isotherms and pore-size distributions of (a) CdS, (b) ZnS, (c) 15ZnS/CdS, and (d) 5N-15ZnS/CdS.

Table S1. Specific surface areas of different samples.

Sample	CdS	ZnS	15ZnS/CdS	5N-15ZnS/CdS
S_{BET} ($m^2 \cdot g^{-1}$)	48.3	106.0	32.3	17.1

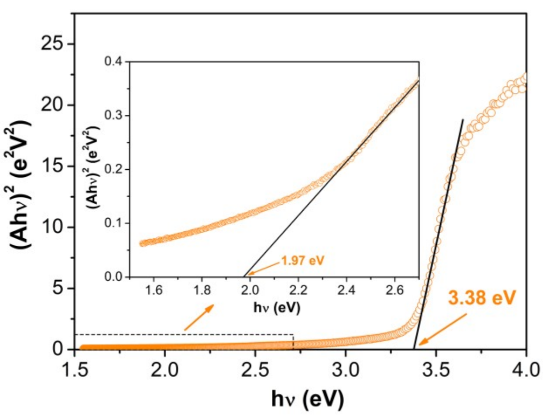

Fig. S3. Tauc plot of ZnS. Inset displays the bandgap relevant to zinc vacancies.

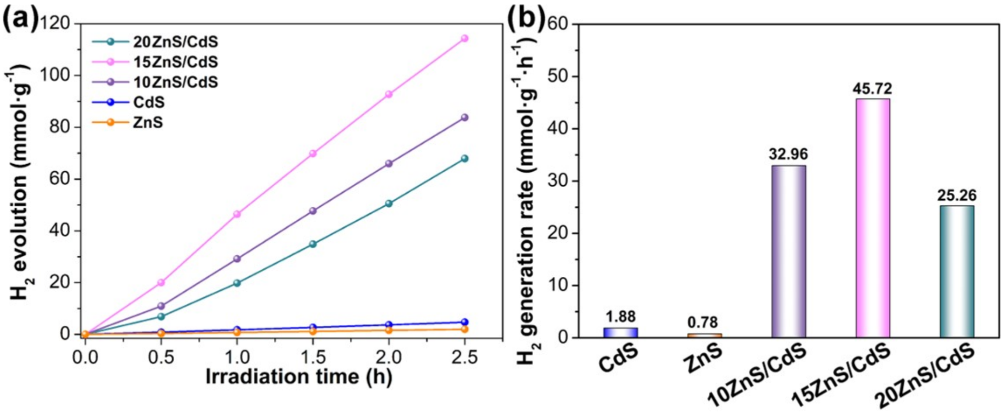

Fig. S4. (a) Photocatalytic H_2 generation activities and (b) average rates of different samples.

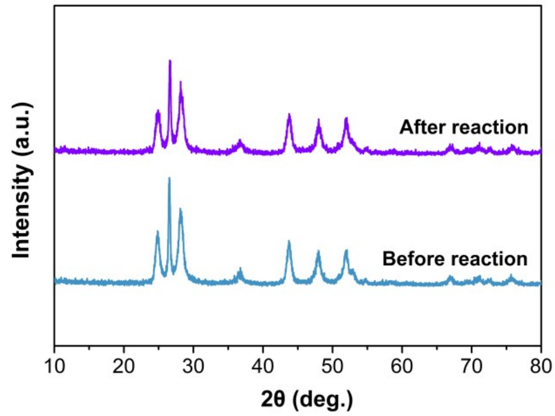

Fig. S5. XRD patterns of 5N-15ZnS/CdS before and after cyclic HER test.

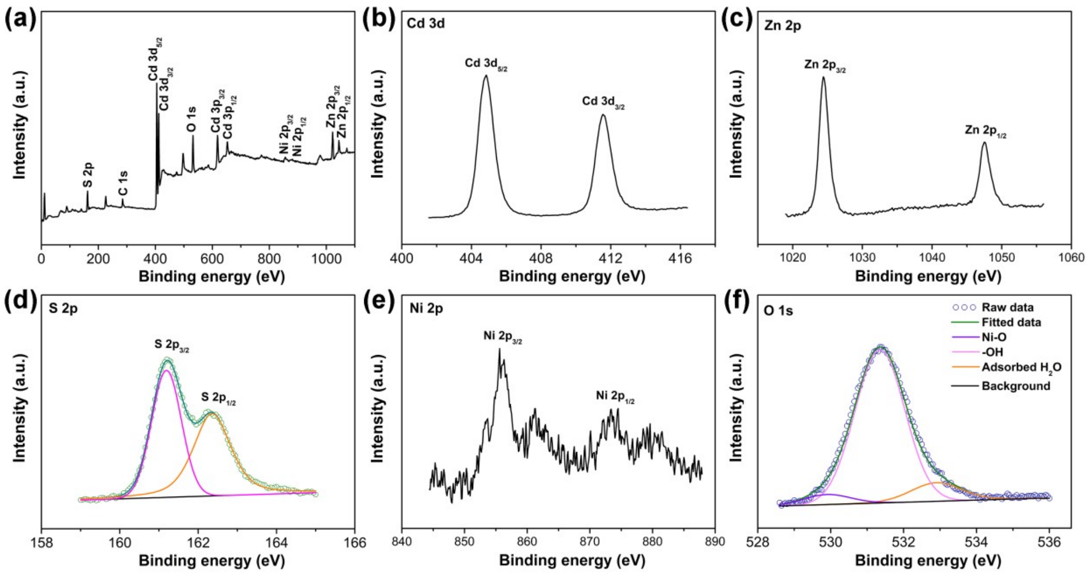

Fig. S6. (a) XPS survey and high-resolution (b) Cd 3d, (c) Zn 2p, (d) S 2p, (e) Ni 2p, and (f) O 1s XPS spectra of 5N-15ZnS/CdS after cyclic photocatalytic reaction.

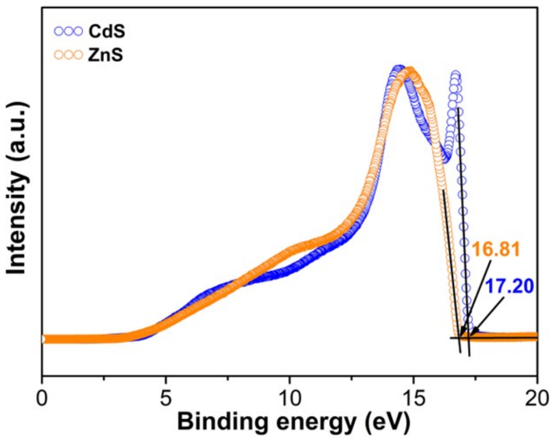

Fig. S7. UPS spectra of CdS and ZnS.

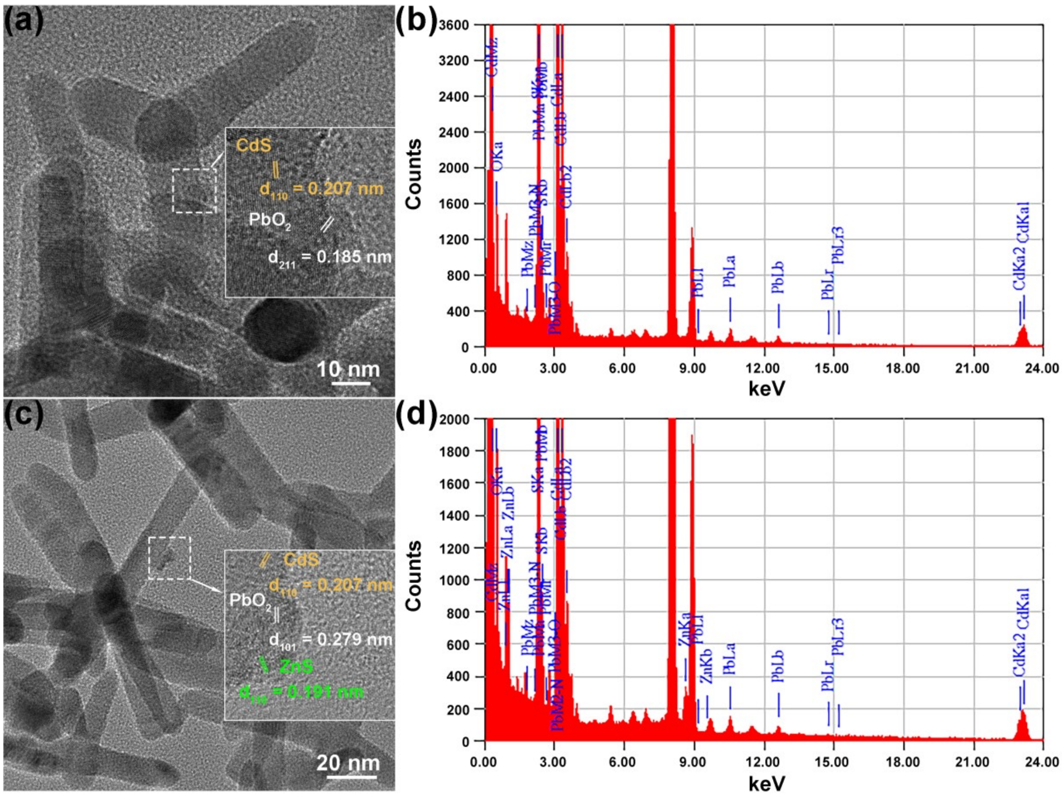

Fig. S8. (a, c) TEM, HRTEM (insets) and (b, d) EDX results of (a, b) CdS and (c, d) 15ZnS/CdS.

Table S2. Comparison on the HER activities of CdS-based photocatalysts.

Photocatalyst	Hole scavenger (aqueous solution)	Light source (Xe lamp)	Maximum rate ($mmol \cdot h^{-1} \cdot g^{-1}$)	AQY (420 nm)	Reference
5N-15ZnS/CdS	Na_2S/Na_2SO_3	λ > 420 nm	152.20	40.9% 32.2% (400 nm)	This work
CdS/MoS$_2$/Mo	Na_2S/Na_2SO_3	λ > 420 nm	4.54	11.03%	1
Ag$_2$S@CdS/ZnS	Na_2S/Na_2SO_3	λ > 420 nm	3.76	6.83% (365 nm)	2
Co$_3$O$_4$/CdS	TEOA	λ > 420 nm	16.32	32.21%	3

$MoSe_2$/CdS-CdSe	Lactic acid	$\lambda > 420$ nm	24.34	28.5% (500 nm)	4
$ZnIn_2S_4$/CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	7.4	12.6%	5
TpTAP/CdS	Ascorbic acid	$\lambda > 420$ nm	47.6	25.23%	6
CdS/Nb_2C	Na_2S/Na_2SO_3	$\lambda > 420$ nm	2.53	3.69%	7
CdS@NiB	TEOA	$\lambda > 420$ nm	28.11	16.45%	8
CdS/PT	Lactic acid	$\lambda > 420$ nm	9.28	24.3%	9
NiO/CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	15.6	16%	10
WN/CdS	Lactic acid	$\lambda > 420$ nm	24.13	18.59%	11
$MoSe_2$/CdS	Lactic acid	$\lambda > 420$ nm	4.7	15.6% (450 nm)	12
CdS/Cu_7S_4/g-C_3N_4	Na_2S/Na_2SO_3	$\lambda > 420$ nm	3.57	4.4%	13
$CeO_{2-x}S_x$@CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	1.15	-	14
CdS/MoO_2/MoS_2	Lactic acid	400–800 nm	1.25	11.3%	15
CdS@Au/MXene	Lactic acid	$\lambda > 420$ nm	5.37	16.7%	16
B-g-C_3N_x/Bi_2S_3/CdS	Methanol	$\lambda > 420$ nm	4.78	-	17
CdS@TPPA	Sodium ascorbate	$\lambda > 420$ nm	24.3	4.29%	18
CdS–NiFeS	Na_2S/Na_2SO_3	320–780 nm	62.67	22.1% (380 nm)	19
MOF/CdS	Benzyl alcohol	$\lambda > 350$ nm	0.63	1.45%	20
SAO/CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	1.21	30.1%	21
CdS/VC	Lactic acid	$\lambda > 420$ nm	14.2	8.7%	22
CdS-CTF-1	Lactic acid	$\lambda > 420$ nm	11.43	16.3%	23
CdS/MoC	Lactic acid	$\lambda > 420$ nm	56.13	7.6%	24
Zr-MOF/CdS	Lactic acid	$\lambda > 420$ nm	1.86	-	25
Ca-modified CoP_x@CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	24.42	35.4%	26
P-CdS/Ni-MOL	Lactic acid	$\lambda > 420$ nm	29.81	4.78% (450 nm)	27
CdS/Cu_7S_4	Na_2S/Na_2SO_3	$\lambda > 420$ nm	27.8	14.7%	28
MnO_2@CdS	Na_2S/Na_2SO_3	$\lambda > 420$ nm	3.94	16.9% (450 nm)	29
CdS/ZnS	Na_2S/Na_2SO_3	$\lambda > 400$ nm	14.02	2.76% (400 nm)	30

Table S3. Fitting parameters for the TRPL spectra of different samples.

Sample	τ_1 (ns)	Ref_1 (%)	τ_2 (ns)	Ref_2 (%)	τ_{avg} (ns)
CdS	0.63	37.3	4.19	62.7	1.92
ZnS	4.18	38.4	9.33	61.6	7.35

15ZnS/CdS	0.38	46.5	2.25	53.5	1.08
5N-15ZnS/CdS	0.29	52.8	1.50	47.2	0.86

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