Anchoring 0D $Cd_{0.5}Zn_{0.5}S$ nanoparticles on 3D porous N-doped $Ti_3C_2T_x$ MXene matrix for efficient photocatalytic hydrogen evolution

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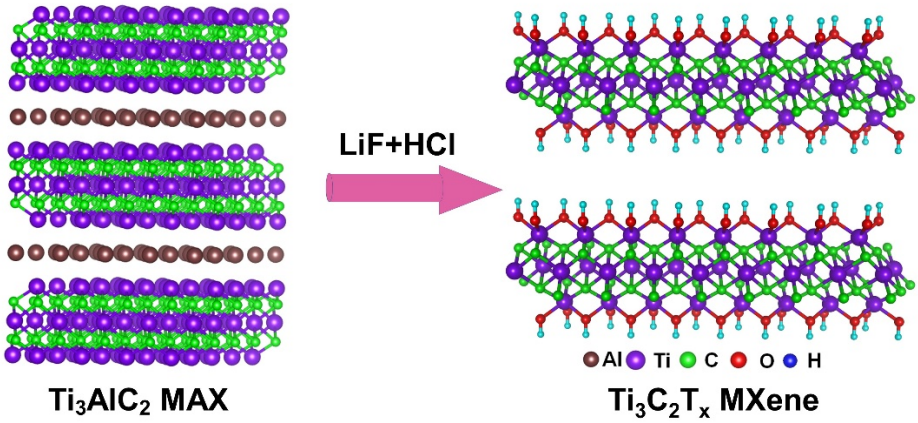

Fig. S1 Schematic illustration for the fabrication of $Ti_3C_2T_x$ MXene nanoflakes.

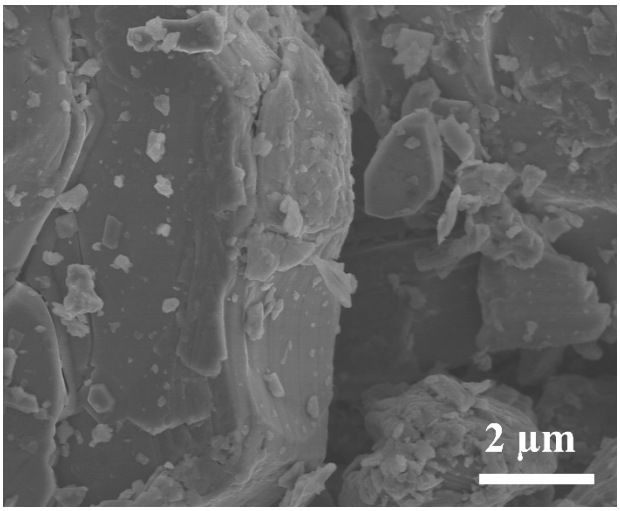

Fig. S2 SEM images of bulk Ti_3AlC_2 MAX.

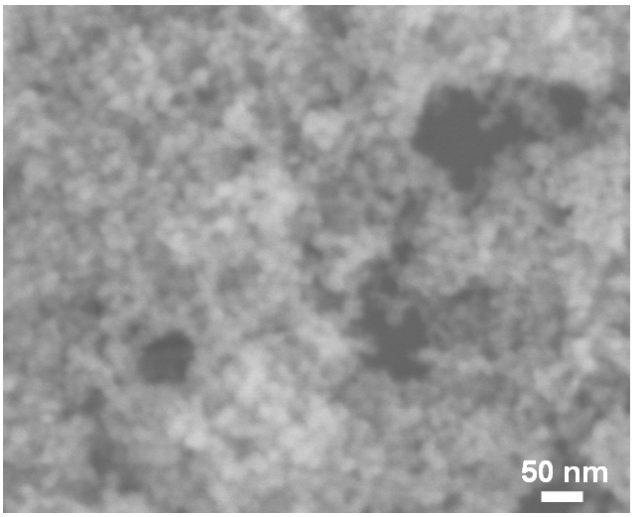

Fig. S3 SEM images of CZS nanoparticles.

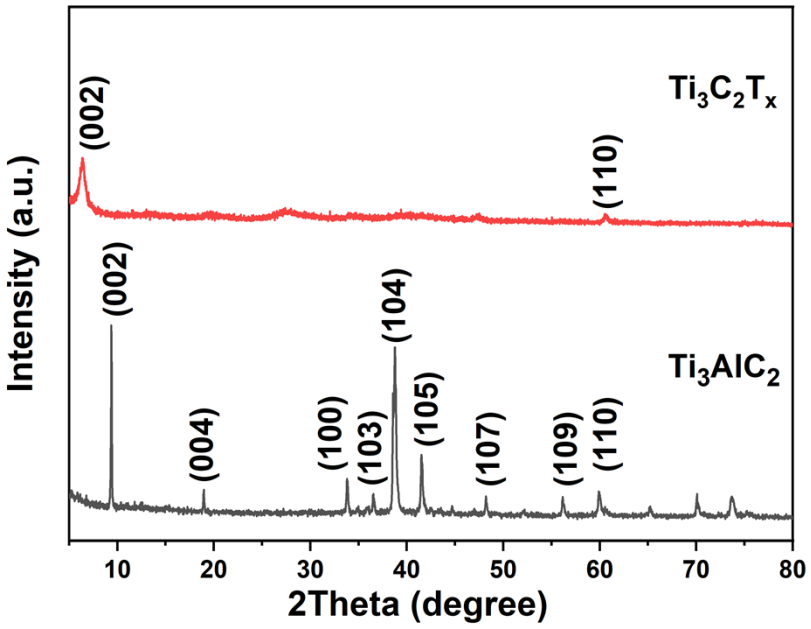

Fig. S4 XRD patterns of the Ti_3AlC_2 MAX and the fabrication of $Ti_3C_2T_x$ MXene.

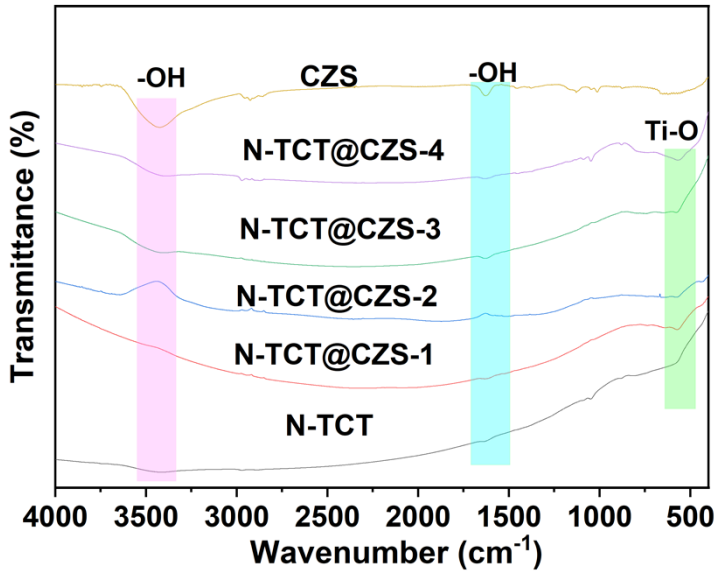

Fig. S5. FT-IR spectra of CZS, N-TCT@CZS composites, and N-TCT.

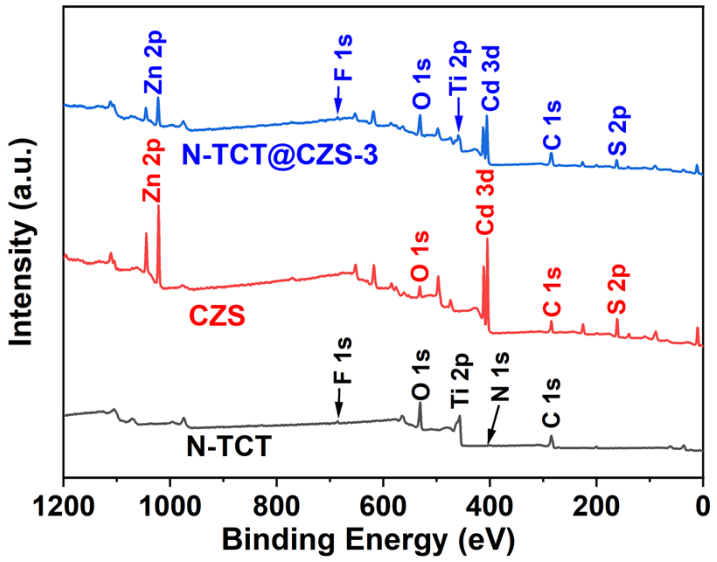

Fig. S6 XPS survey spectra of CZS, N-TCT MXene and N-TCT@CZS-3.

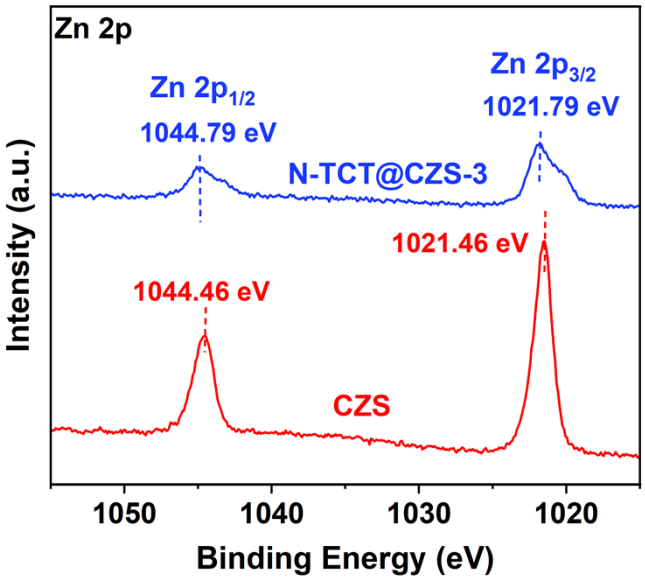

Fig. S7 High-resolution XPS spectra of Zn 2p.

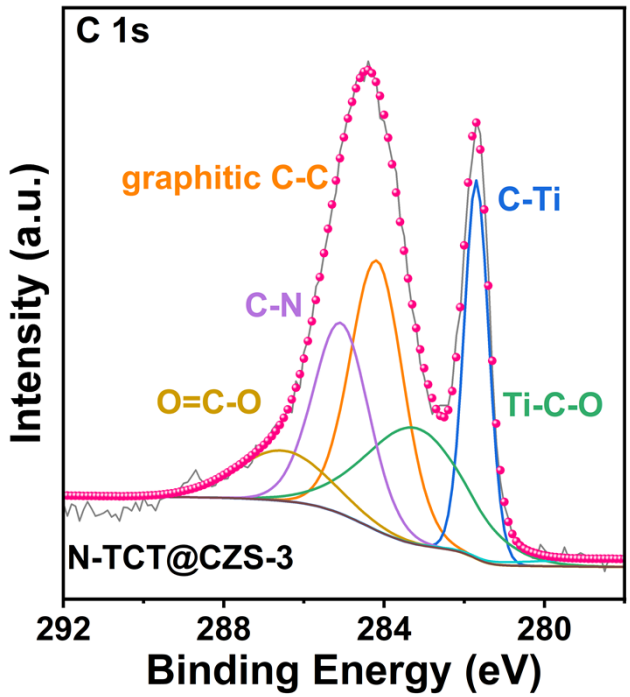

Fig. S8 High-resolution XPS spectra of C 1s.

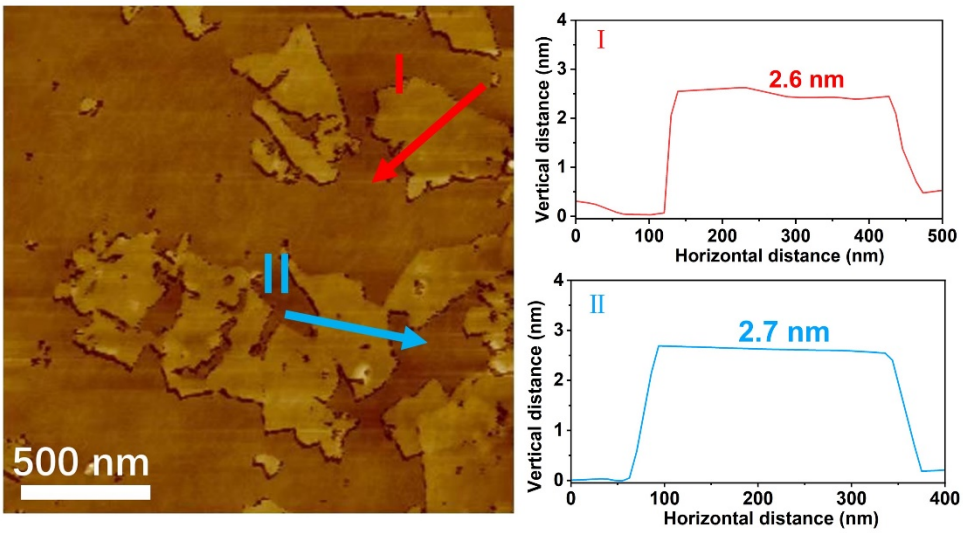

Fig. S9 AFM images of TCT MXene nanoflakes.

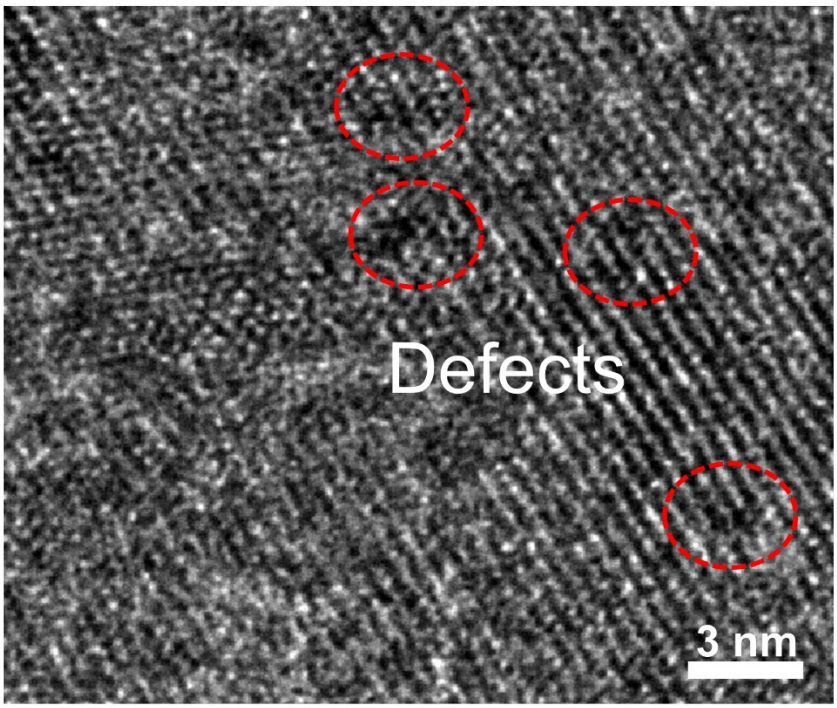

Fig. S10 the local magnification of HRTEM images of TCT MXene nanoflakes.

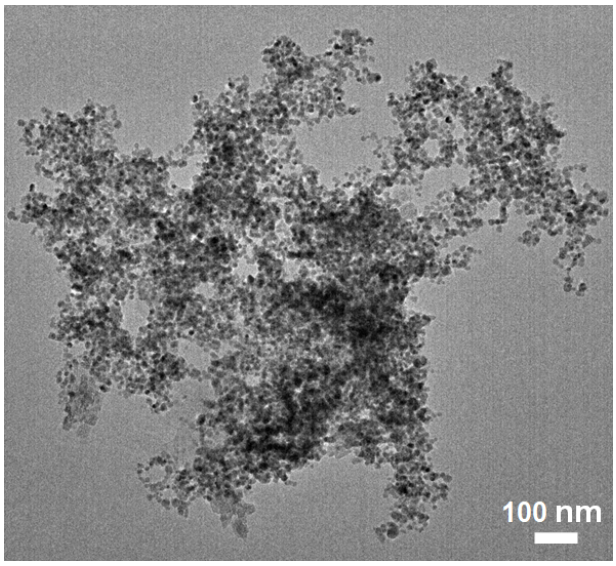

Fig. S11 TEM images of CZS nanoparticles.

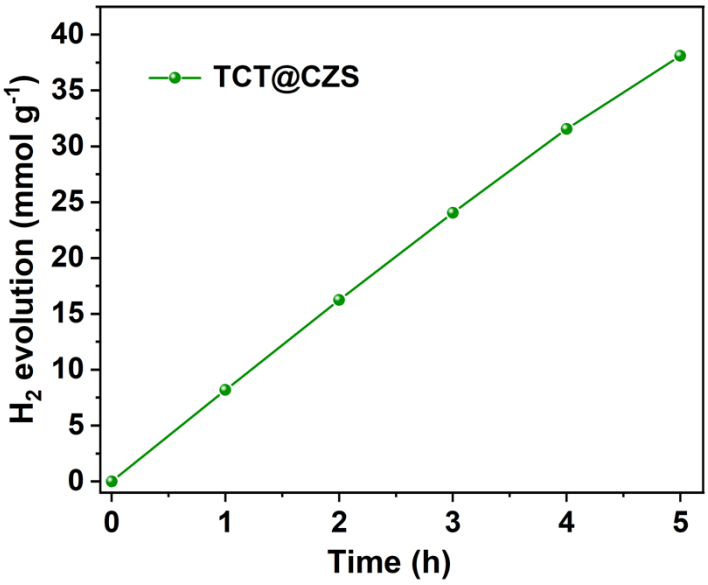

Fig. S12 The photocatalytic hydrogen evolution rate of TCT@CZS

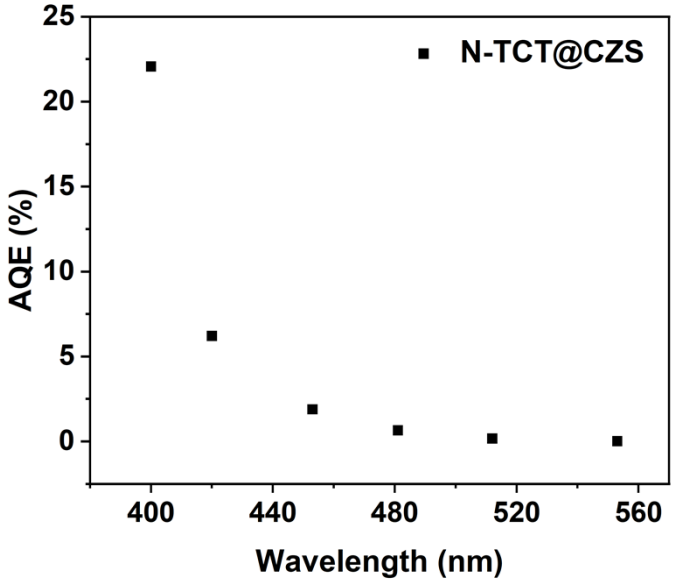

Fig. S13 The AQE values of N-TCT@CZS at different wavelength.

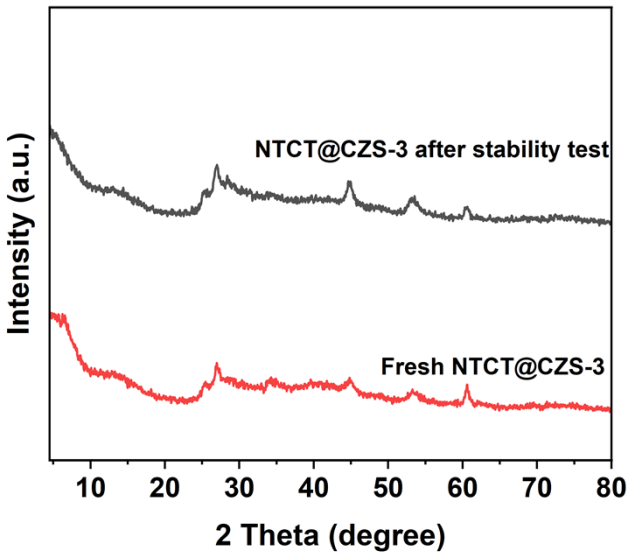

Fig. 14 XRD patterns of N-TCT@CZS-3 before and after stability test.

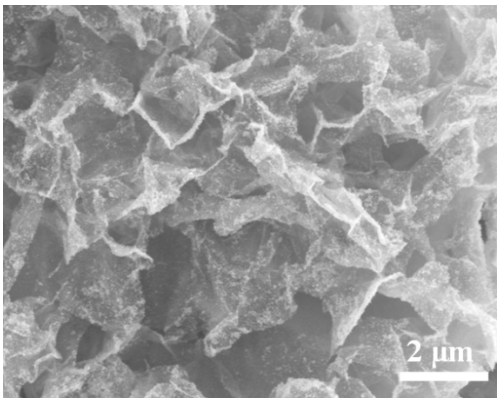

Fig. 15 SEM of N-TCT@CZS-3 after stability test.

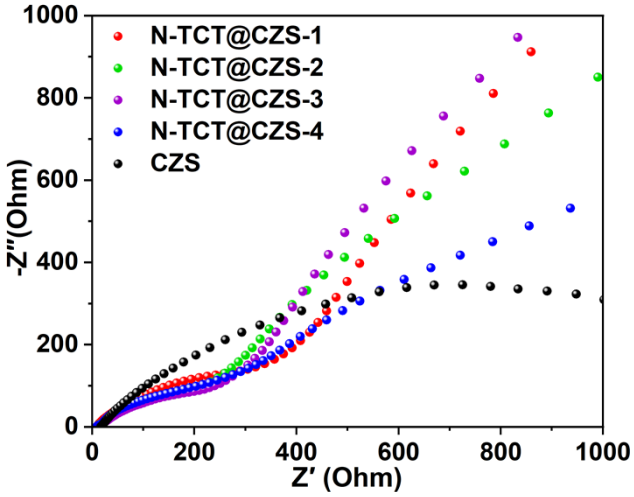

Fig. 16 SEM of N-TCT@CZS-3 after stability test.

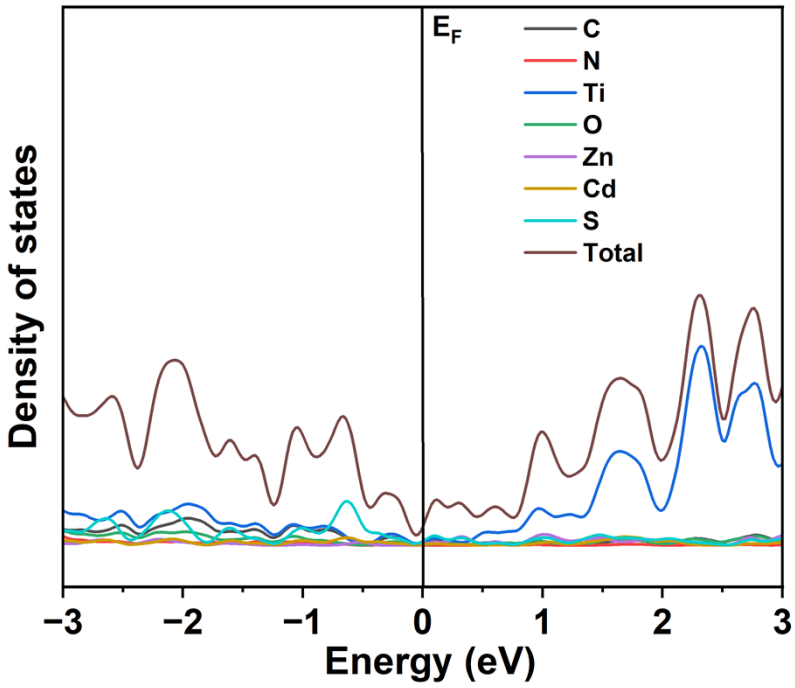

Fig. S17. The density of states of the N-TCT@CZS.

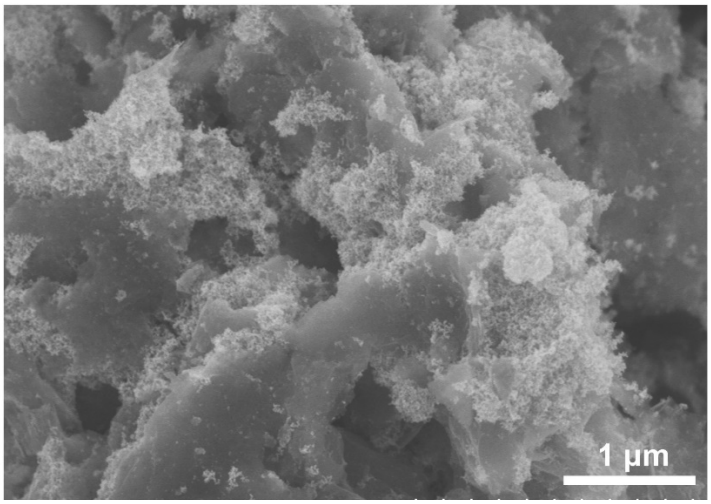

Fig. S18. The SEM of the TCT@CZS (TCT: CZS= 4: 1).

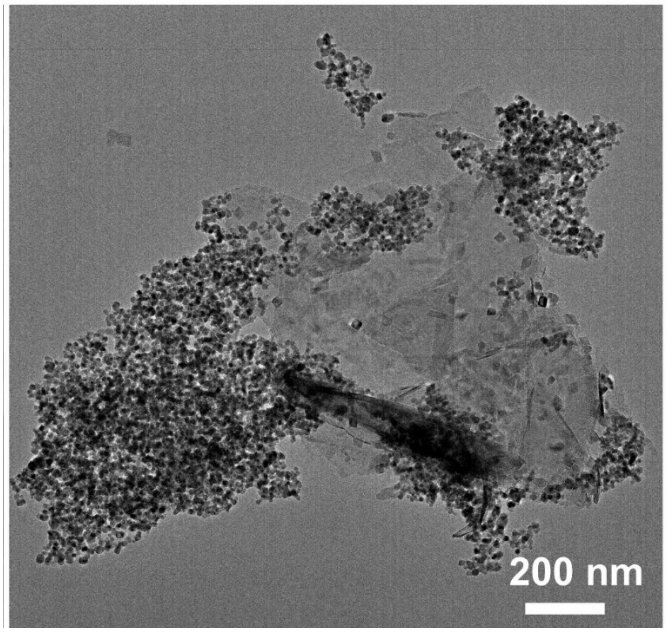

Fig. S19. The TEM of the TCT@CZS (TCT: CZS=4:1).

Table S1. Comparison of the photocatalytic H_2 evolution activity for some previous reports MXene-based photocatalysts

Photocatalyst	Light source	sacrificial agent	H_2 evolution rate (mmol $h^{-1}g^{-1}$)	H_2 production AQE（%）	Ref.
MXene/$ZnIn_2S_4$	300 W Xe lamp (λ≥400 nm)	triethanolamine	3.475	11.14 (λ=420 nm)	[1]
MXene/CdS	300 W Xe lamp (λ≥420 nm)	benzylamine	0.220	None	[2]
MXene/CdS/Au	300 W Xe lamp (λ≥400 nm)	lactic acid	5.371	16.70 (λ=420 nm)	[3]
MXene/Ru/g-C_3N_4	300 W Xe lamp (λ≥380 nm)	TEOA	3.21	30.9 (λ=380 nm)	[4]
MXene/TiO_2	300 W Xe lamp (λ≥380 nm)	TEOA	4.672	27.11 (λ=380 nm)	[5]
MXene/UiO-66-NH_2 (Zr/Ti)	300 W Xe lamp (λ≥400 nm)	TEOA	2.187	None	[6]
MXene/CdS/C	300 W Xe lamp	TEOA	5.64	45.70 (λ=450 nm)	[7]
MXene/$ZnIn_2S_4$	300 W Xe lamp (λ≥400 nm)	Na_2S/Na_2SO_3	3.058	17.68 (λ=420 nm)	[8]
MXene@TiO_2/$ZnIn_2S_4$	350 W Xe lamp (λ≥420 nm).	Na_2S/Na_2SO_3	1.18	None	[9]
MXene/TiO_2/Ru	300 W Xe lamp (λ≥350 nm).	TEOA	0.235	14.33 (λ=350 nm)	[10]
MXene@TiO_2@MoS_2	300 W Xe lamp (λ≥400 nm)	TEOA	6.425	4.61 (λ=400 nm)	[11]
MXene@TiO_2@WS_2	300 W Xe lamp	TEOA	3.409	2.464	[12]

				(λ=400nm)	
MXene/g-C_3N_4	300 W Xe lamp (λ≥400 nm)	TEOA	5.111	3.654 (λ=400nm)	[13]
MXene/TiO_2/PtO	300 W Xe lamp (λ≥420 nm)	methanol	2.54	4.2 (λ=365nm)	[14]
MXene/CdS	300 W Xe lamp (λ≥400 nm)	methanol	4.235	2.28 (λ=400nm)	[15]
MXene/CdSe	300 W Xe lamp (λ≥400 nm)	Na_2S/Na_2SO_3	0.763	1.30 (λ=400nm)	[16]
MXene/$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp （λ≥400 nm)	Na_2S/Na_2SO_3	10.90	22.07 (λ=400nm)	This work

Table S2. Comparison of the photocatalytic H_2 evolution activity for some previous reports CdZnS-based photocatalysts

Photocatalyst	Light source	sacrificial agent	H_2 evolution rate (mmol $h^{-1}g^{-1}$)	H_2 production AQE（%）	Ref.
$Cd_{0.5}Zn_{0.5}S$/CoPPi-M	300 W Xe lamp (λ≥400 nm)	Na_2S/Na_2SO_3	6.87	20.7 (λ=420 nm)	[17]
PtSA-$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp (λ≥420 nm)	Na_2S/Na_2SO_3	0.279	None	[18]
$Cd_{0.5}Zn_{0.5}S/Bi_2Fe_4O_9$	300 W Xe lamp (λ≥420 nm)	Na_2S/Na_2SO_3	0.811	None	[19]
In_2O_3/CdZnS	300 W Xe lamp (λ≥380 nm)	Na_2S/Na_2SO_3	1.11	30.9 (λ=380 nm)	[20]
Cu_2S/CdZnS	300 W Xe lamp (λ≥420 nm)	Na_2S/Na_2SO_3	5.904	2.13 (λ=400 nm)	[21]
Cu-MOF/$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp (λ≥400 nm)	Na_2S/Na_2SO_3	5.301	None	[22]
$Cd_{0.5}Zn_{0.5}S/CuInS_2$	300 W Xe lamp	Na_2S/Na_2SO_3	7.73	0.61 (λ=420 nm)	[23]
Ni/NiS/$Zn_{0.2}Cd_{0.8}S$	350 W Xe lamp (λ≥420 nm).	lactic acid	4.151	None	[24]
MXene/$Cd_{0.5}Zn_{0.5}S$	300 W Xe lamp （λ≥400 nm)	Na_2S/Na_2SO_3	10.90	22.07 (λ=400nm)	This work

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