

Supplementary Materials

Pt-Loaded Z-Scheme g-C₃N₄/Bi₄Ti₃O₁₂ Heterostructure for Enhanced Photocatalytic H₂ Evolution

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Table S1. Mass% and weight% of g-C₃N₄ content in CN/BTO heterojunctions.

Samples	Obtained Mass (m _c) (g)	Mass% (m _c – 0.5)/m _c	Weight% (TGA Analysis)
0.5-CN/BTO	0.66	24.2	24.3
1.5-CN/BTO	1.22	59.0	62.2
2.5-CN/BTO	1.78	71.9	73.8
3.0-CN/BTO	2.23	77.6	79.7
CN	-	-	100.0

Mass% calculated by (m_c – 0.5)/m_c formula, where m_c represents the mass of X-CN/BTO composites in g and 0.5 g is the fixed mass for BTO.

Table S2. XPS binding energies of Bi4f, Ti2p, O1s, C1s, and N1s for BTO, 2.5-CN/BTO and CN.

		BTO (eV)	2.5-CN/BTO (eV)	CN (eV)
Bi 4f	4f _{7/2}	158.7	159.1	-
	4f _{5/2}	164.0	164.5	-
Ti 2p	2p _{3/2}	457.6	457.9	-
	2p _{1/2}	463.1	463.3	-
O 1s	1s Lattice (Bi-O)	529.5	530.4	-
	1s Lattice (Ti-O)	530.9	530.4	-
	1s-OH	-	532.0	532.9
C 1s	(C-C)	-	284.8	284.8
	((N) ₂ -C=N)	-	287.7	287.9
N 1s	(C-N=C)	-	398.5	398.4
	(N-(C) ₃)	-	400.4	400.2
	(π-excitation)	-	403.8	404.1

Table S3. Absorption edge and estimated optical transition energies of BTO, CN, and CN/BTO heterostructures.

Samples	Absorption Edge (nm)	Band Gap (eV)
BTO	385	3.15
0.5-CN/BTO	425	2.72
1.5-CN/BTO	442	2.73
2.5-CN/BTO	450	2.71
3.0-CN/BTO	444	2.76
CN	445	2.70



Table S4. Surface area, total pore volume, and mean pore size (pore diameter) of BTO, CN, and CN/BTO heterojunctions.

Samples	S_{BET} [$\text{m}^2 \text{g}^{-1}$]	V_{pore} [$\text{cm}^3 \text{g}^{-1}$]	Mean Pore Diameter [nm]
BTO	1	0.0026	17.1
0.5-CN/BTO	4	0.020	45.5
1.5-CN/BTO	7	0.038	44.8
2.5-CN/BTO	9	0.055	48.2
3.0-CN/BTO	6	0.042	46.1
CN	6	0.044	29.03

Table S5. Equivalent circuit fitting parameters of EIS data of BTO, CN, and CN/BTO heterojunctions.

Compounds	R_s (Ω)	R_{ct} (Ω)
BTO	38.4	363.3
0.5-CN/BTO	39.3	48.0
1.5-CN /BTO	38.8	50.0
2.5-CN /BTO	39.9	38.0
3.0-CN/BTO	30.6	70.0
CN	42.0	75.0

Table S6. Summary of the photoluminescence decay time (τ) and their pre-exponential factor (B) of BTO, CN, and CN/BTO heterojunctions.

Samples	Decay Time (ns)		Pre-Exponential Factor (%)		τ_{ave} (ns)
	τ_1	τ_2	B_1	B_2	
BTO	1.50000	18.00000	0.11206	0.01526	11.73509
0.5-CN/BTO	2.58161	12.50182	0.08911	0.01551	7.11839
1.5-CN /BTO	2.58973	12.26714	0.09382	0.0155	6.83771
2.5-CN /BTO	1.93651	9.460570	0.10699	0.0129	4.72542
3.0-CN/BTO	2.36535	9.775690	0.09388	0.01627	5.45833
CN	2.64946	12.06134	0.0905	0.01248	6.27933

Table S7. Comparison of the photocatalytic H_2 -evolution performance of representative $\text{g-C}_3\text{N}_4$ - and $\text{Bi}_4\text{Ti}_3\text{O}_{12}$ -based photocatalysts with and without Pt cocatalysts.

Photocatalyst	Co-Catalyst	Light Source	Reaction Conditions	Activity	Ref.
$\text{g-C}_3\text{N}_4/\text{Bi}_4\text{Ti}_3\text{O}_{12}$	-	250 W MP Hg Lamp	100 mg catalyst, 200 mL H_2O , 50 mL MeOH,	$37.2 \mu\text{mol g}^{-1} \text{h}^{-1}$	This work
$\text{g-C}_3\text{N}_4/\text{Bi}_4\text{Ti}_3\text{O}_{12}$	Pt (0.5 wt% nominal precursor dosage)	250 W MP Hg Lamp	100 mg catalyst, 200 mL H_2O , 50 mL MeOH, H_2PtCl_6 solution	$67.4 \mu\text{mol g}^{-1} \text{h}^{-1}$	This work
$\text{g-C}_3\text{N}_4$	-	AM 1.5 G	10 mg catalyst, 30 mL H_2O , 10 vol% TEOA	$6 \mu\text{mol g}^{-1} \text{h}^{-1}$	[1]
Pt-NPs/ $\text{g-C}_3\text{N}_4$	0.8 wt.% Pt	AM 1.5 G	10 mg catalyst, 30 mL H_2O , 10 vol% TEOA	$1726 \mu\text{mol g}^{-1} \text{h}^{-1}$	[1]
Pt single-atom/ $\text{g-C}_3\text{N}_4$	0.8 wt.% Pt	AM 1.5 G	10 mg catalyst, 30 mL H_2O , 10 vol% TEOA	$3460 \mu\text{mol g}^{-1} \text{h}^{-1}$	[1]
Few-layer $\text{g-C}_3\text{N}_4$	-	300 W Xe Lamp	50 mg catalyst, 80 mL H_2O , 20 mL TEOA	$44 \mu\text{mol g}^{-1} \text{h}^{-1}$	[2]
Pt single-atom/ $\text{g-C}_3\text{N}_4$	Pt SA	300 W Xe Lamp	50 mg catalyst, 80 mL H_2O , 20 mL TEOA	$6400 \mu\text{mol g}^{-1} \text{h}^{-1}$	[2]
$\text{g-C}_3\text{N}_4$	-	300 W Xe Lamp	50 mg catalyst, 85 mL H_2O , 15 mL TEOA	$2.6 \mu\text{mol g}^{-1} \text{h}^{-1}$	[3]
Pt/ $\text{g-C}_3\text{N}_4$	1.0 wt.% Pt	300 W Xe Lamp	50 mg catalyst, 85 mL H_2O , 15 mL TEOA	$130.4 \mu\text{mol g}^{-1} \text{h}^{-1}$	[3]
$\text{Bi}_4\text{Ti}_3\text{O}_{12}$ platelets	-	AM 1.5 G	20 mg catalyst, $\text{H}_2\text{O}/\text{CH}_3\text{OH} = 75/25$	$7.5 \mu\text{mol g}^{-1} \text{h}^{-1}$	[4]
$\text{Bi}_4\text{Ti}_3\text{O}_{12}$	1.0 wt.% Pt	450 W HP Hg Lamp	1 g catalyst, 350 mL H_2O , 20 mL MeOH, H_2PtCl_6 solution	$0.6 \mu\text{mol g}^{-1} \text{h}^{-1}$	[5]
$\text{Bi}_4\text{Ti}_3\text{O}_{12}$ nanosheets	-	300 W Xe Lamp	0.25 g catalyst, 200 mL H_2O , 20 mL MeOH,	$38.0 \mu\text{mol g}^{-1} \text{h}^{-1}$	[6]



Figure S1. Optical images showing the physical appearance of (a) BTO; (b) 0.5-CN/BTO; (c) 1.5-CN/BTO; (d) 2.5-CN/BTO; (e) 3.0-CN/BTO; and (f) CN.

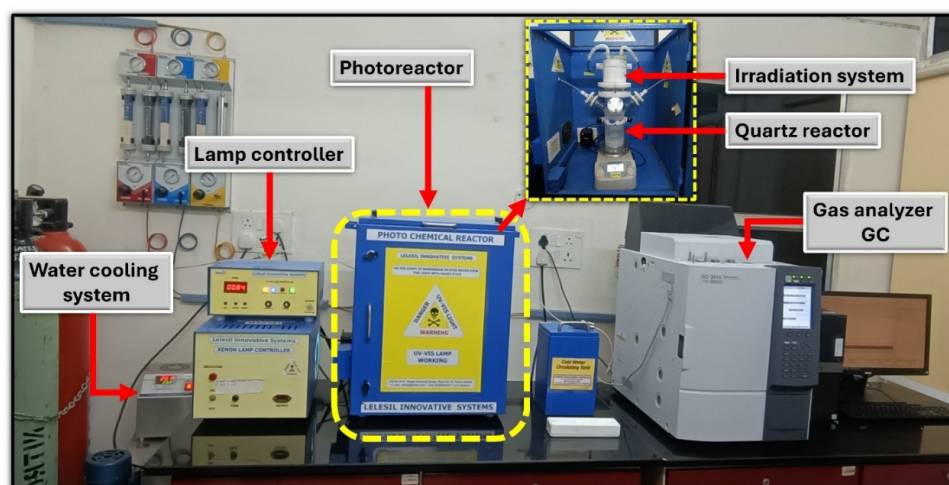


Figure S2. Experimental set-up used for the photocatalytic H₂-evolution tests.

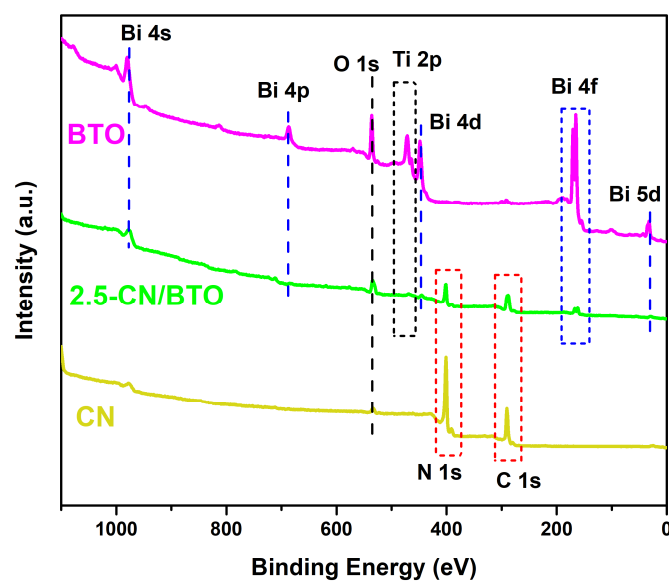


Figure S3. Survey XPS of BTO, CN, and 2.5-CN/BTO heterojunction.

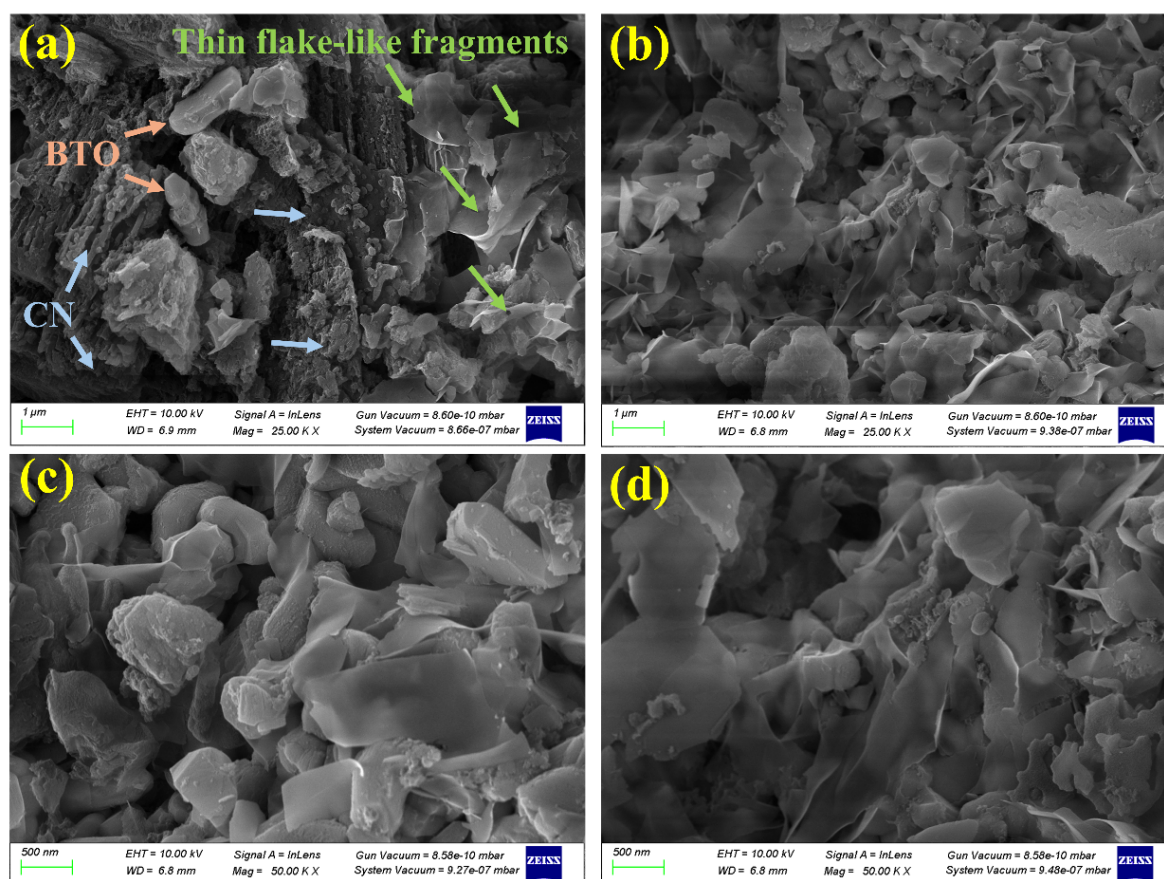


Figure S4. (a–d) FE-SEM images of the spent 0.5-Pt/2.5-CN/BTO heterojunction after four cycles of sacrificial-agent-assisted photocatalytic H₂ evolution.

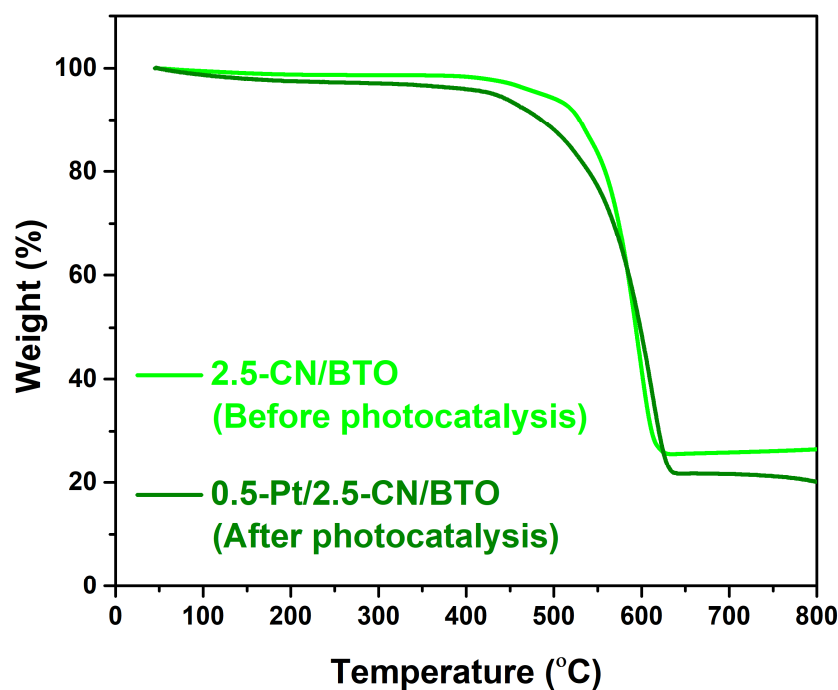


Figure S5. TGA of fresh 2.5-CN/BTO and spent 0.5-Pt/2.5-CN/BTO heterojunction catalyst.

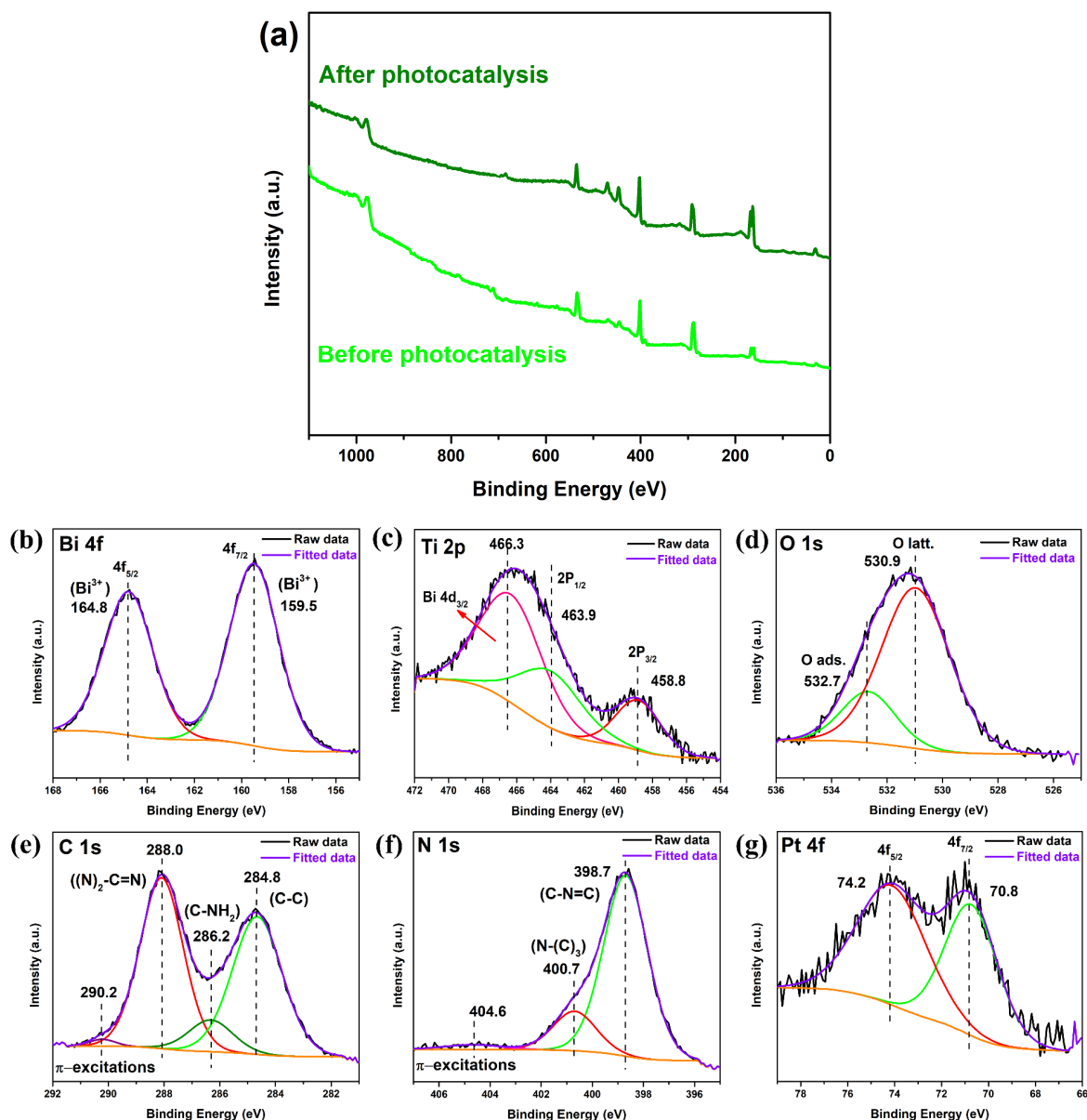


Figure S6. (a) XPS Survey scan and High-resolution XPS of (b) Bi 4f; (c) Ti 2p; (d) O 1s; (e) C 1s; (f) N 1s; and (g) Pt 4f for spent 0.5-Pt/2.5-CN/BTO heterojunction catalyst after four consecutive cycles of photocatalytic H₂-evolution.

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