

## Supporting Information

### **Enhanced pollutant photodegradation activity of graphitic carbon nitride on via bismuth oxyhalide graphene hybridization and the mechanism study**

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### Transient photocurrent test

Photocatalytic activity is closely related to the transfer and separation rate of photogenerated electron-hole pairs; therefore, the carrier separation behavior is often investigated through the transient photocurrent measurement. To explore the photocurrents of the four samples, the electrochemical measurements were performed with an electrochemical workstation using a four-electrode system at room temperature under simulated sunlight glowed from a 500 W Xe lamp.

### Band scheme confirmation

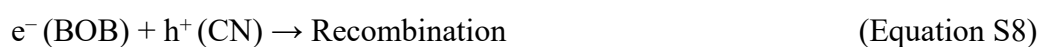
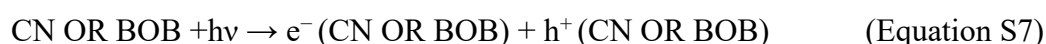
band gap energies ( $E_g$ ) about pure CN and BOB were calculated according to the following Kubelka- Munk formula:

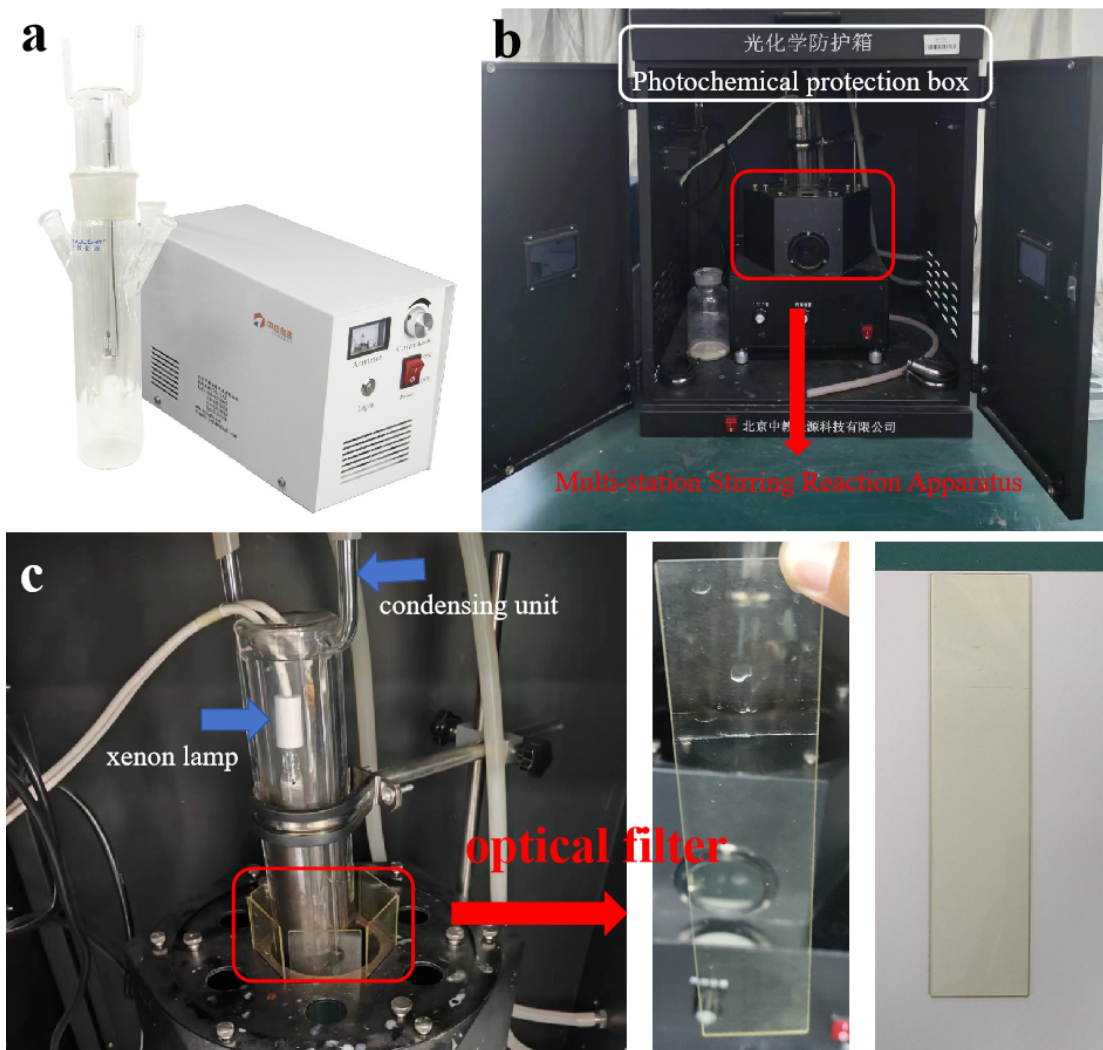
$$\alpha h\nu = A(h\nu - E_g)^{1/2}$$

(Equation S1)

where  $a$ ,  $h$ ,  $\nu$  and  $A$  are the absorption coefficient, Planck's constant, the optical coefficient frequency and the proportionality constant<sup>1-3</sup>.

### The proposed reaction pathway for CN-BOB.





**Fig. S1** (a) a is the CEL-LAX500 long arc xenon lamp, (b) the photocatalytic reaction device, and (c) a partial enlargement of the photocatalytic reaction dark box & visible light filter.

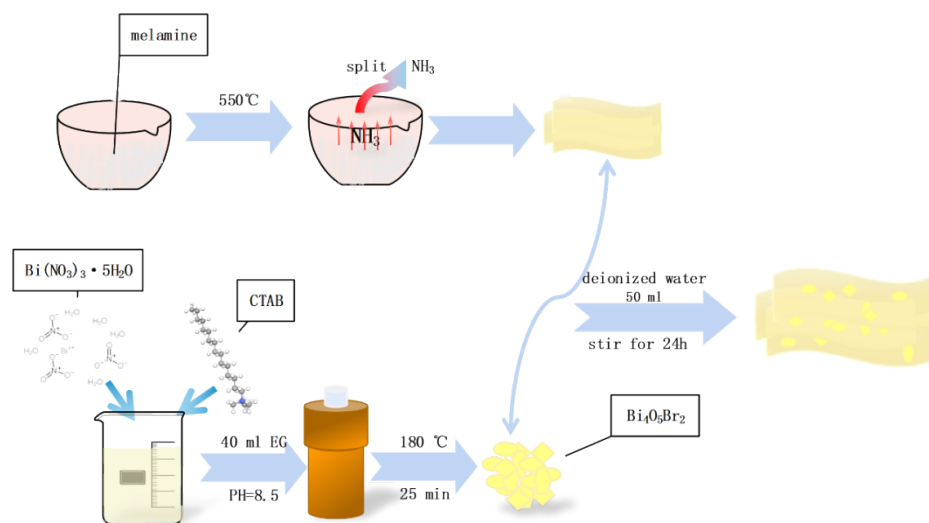


Fig. S2. synthesis procedure of  $g\text{-C}_3\text{N}_4/\text{Bi}_4\text{O}_5\text{Br}_2$ .

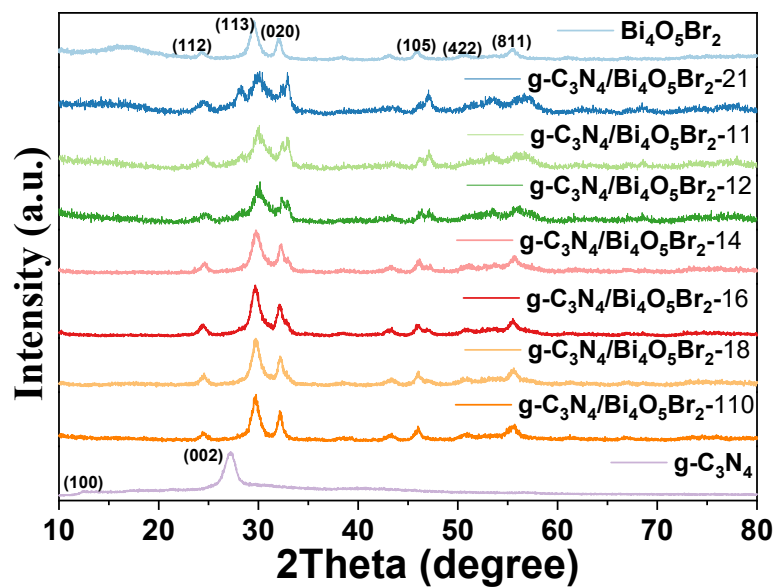
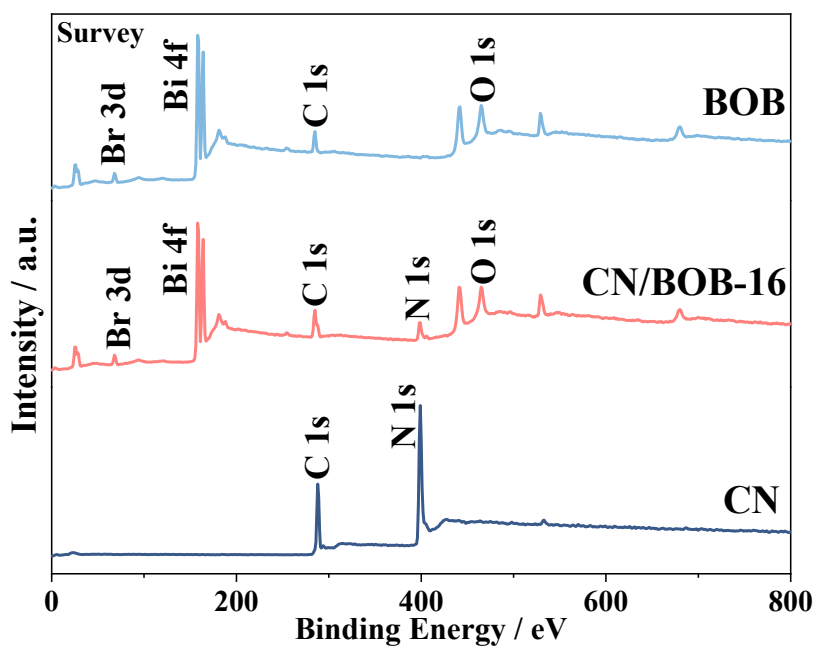
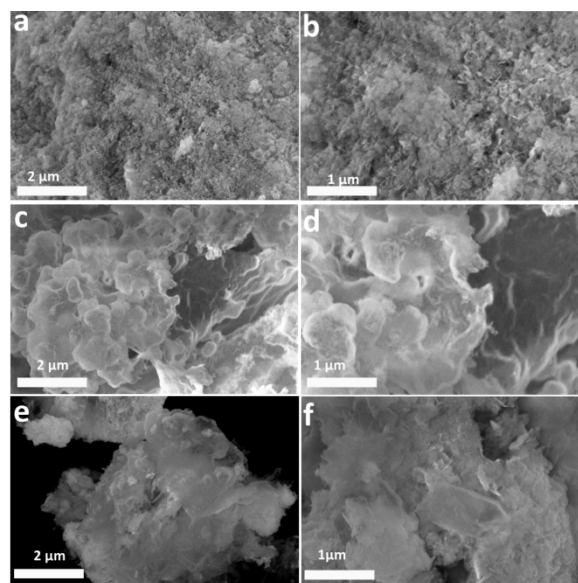


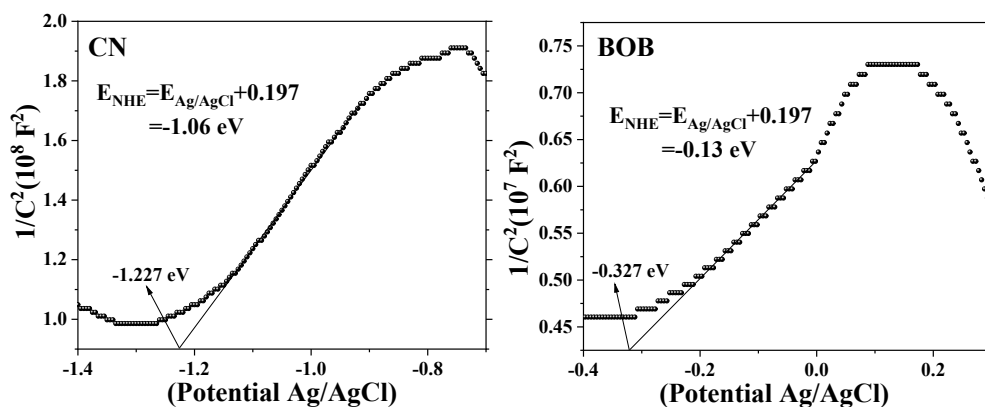
Fig. S3. XRD patterns for  $g\text{-C}_3\text{N}_4$ ,  $\text{Bi}_4\text{O}_5\text{Br}_2$ , and various  $g\text{-C}_3\text{N}_4/\text{Bi}_4\text{O}_5\text{Br}_2\text{-XY}$ .



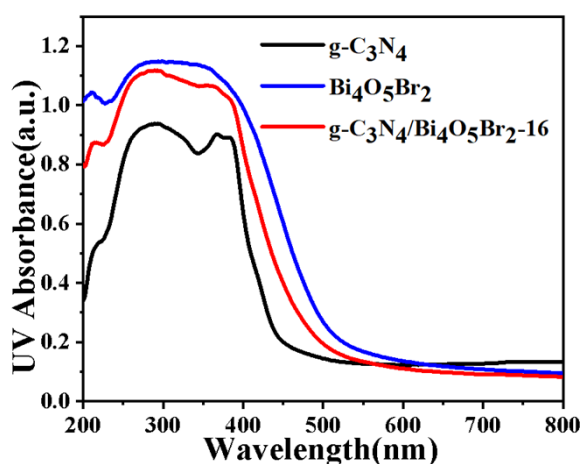
**Fig. S4.** XPS spectra survey.



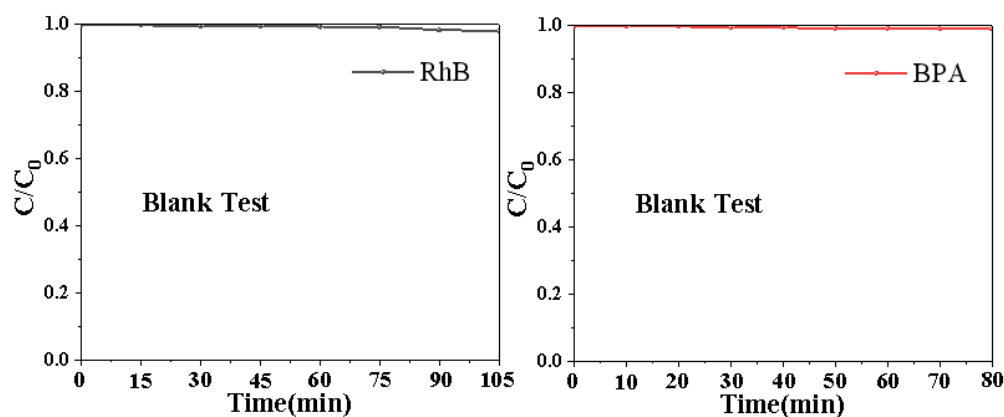
**Fig. S5.** SEM images. (a, b)  $\text{Bi}_4\text{O}_5\text{Br}_2$ , (c, d)  $\text{g-C}_3\text{N}_4$ , (e, f) CN/BOB-16 heterojunction.



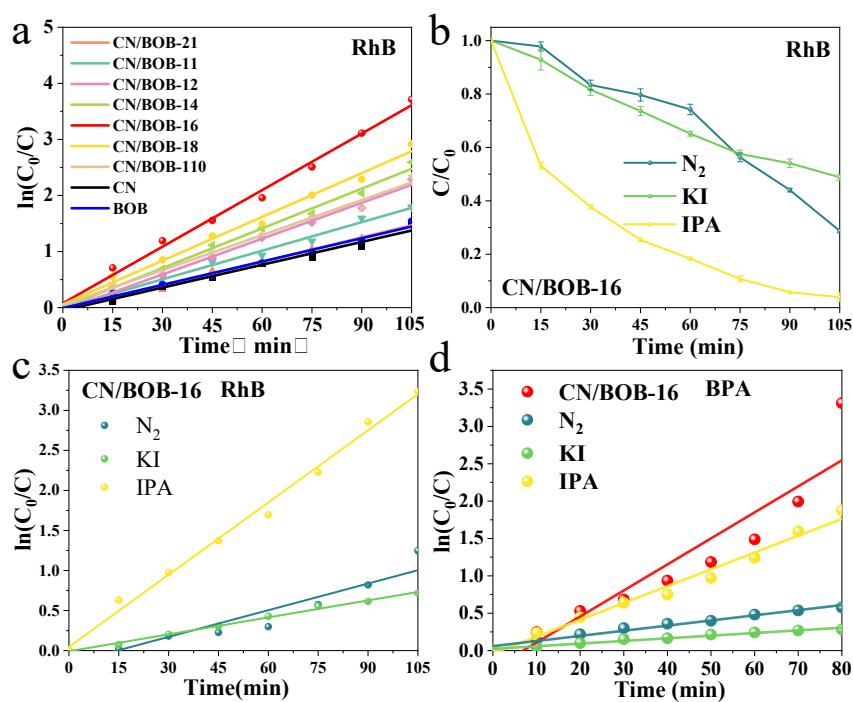
**Fig. S6.** Mott-Schottky curves of CN and BOB. Electrolyte properties:  $\text{Na}_2\text{SO}_4$ . The working electrode was prepared by dip-coating a photocatalyst slurry on an ITO glass electrode ( $2.0 \times 4.0 \text{ cm}^2$ ). Mott-Schottky plots were collected at a scan rate of  $5 \text{ mV s}^{-1}$ . The counter electrode was an Ag/AgCl electrode, and the results and calculated equations after converting it to NHE are shown in Figure.



**Fig. S7.** UV-Vis DRS spectra.



**Fig. S8.** The blank test with the light only.



**Fig. S9.** (a) Pseudo-first-order kinetic curve of CN, BOB, CN/BOB-21, CN/BOB-11, CN/BOB-12, CN/BOB-14, CN/BOB-16, CN/BOB-18 and CN/BOB-110. (b) Assessment of active species through free radical scavenging degradation experiments. (c) Pseudo-primary kinetic profile of RhB degradation by CN/BOB-16. (d) Pseudo-primary kinetic profile of BPA degradation by CN/BOB-16.

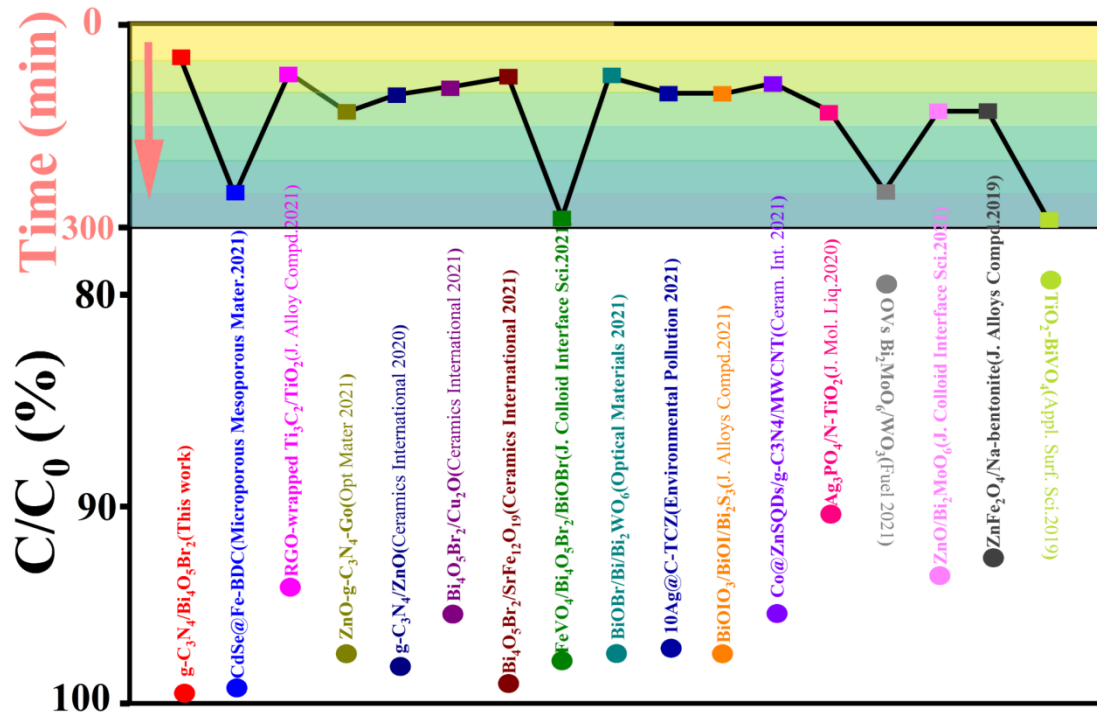


Fig. S10. Comparison of photocatalytic degradation performance using the literature images.

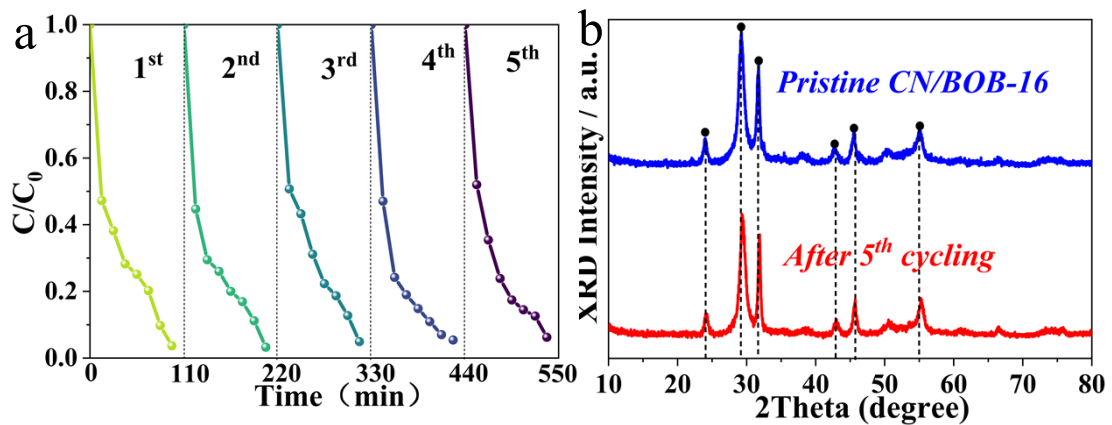
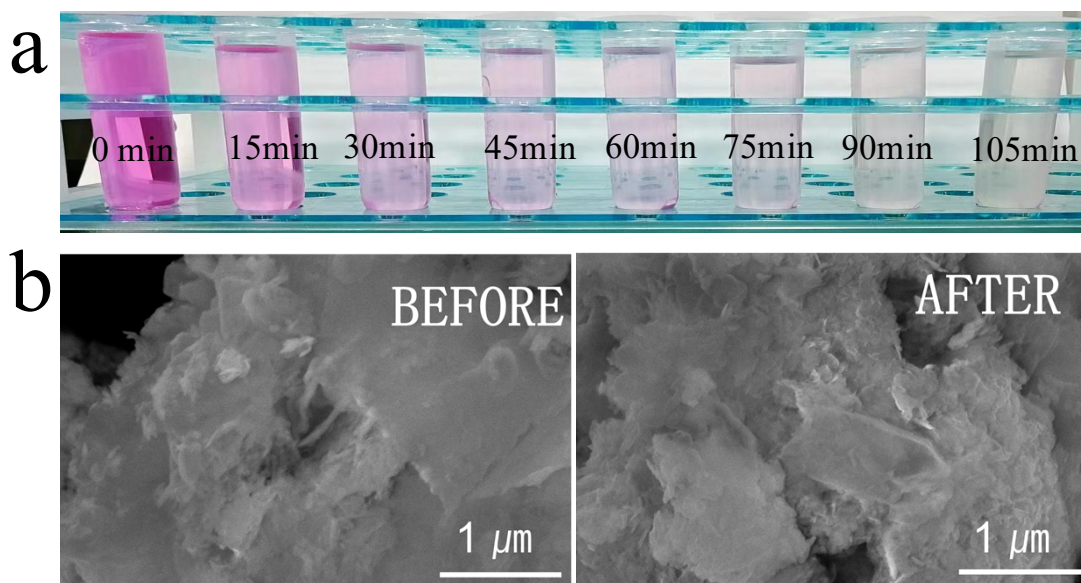
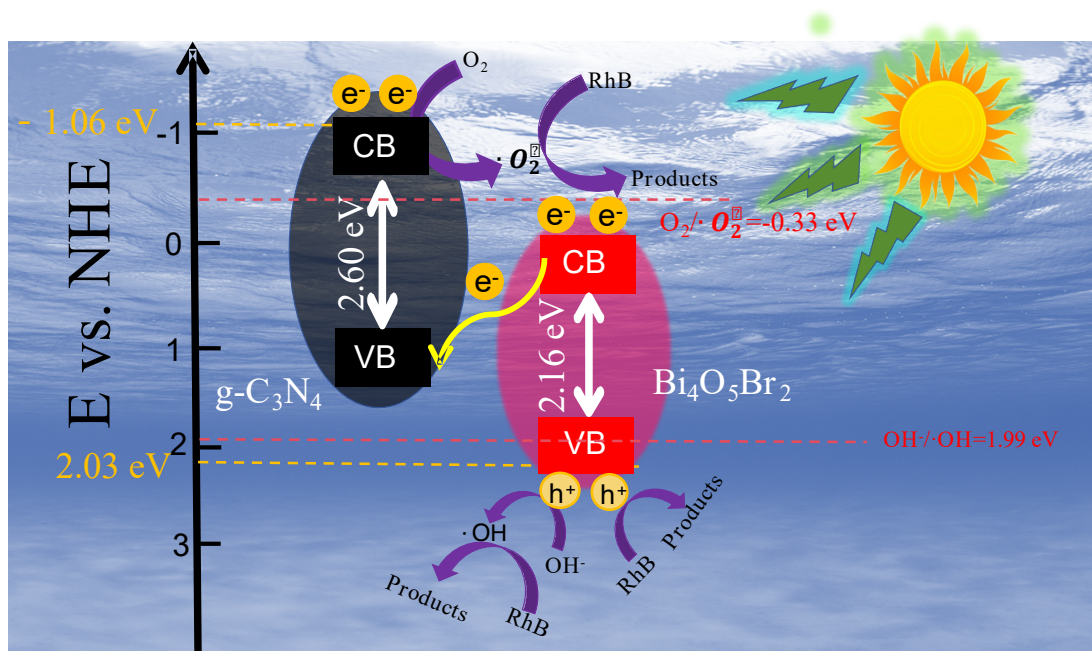


Fig. S11. (a) Recycling ability evaluation for five cycles. (b) XRD patterns of the CN/BOB-16 before and after the photocatalytic degradation experiment.

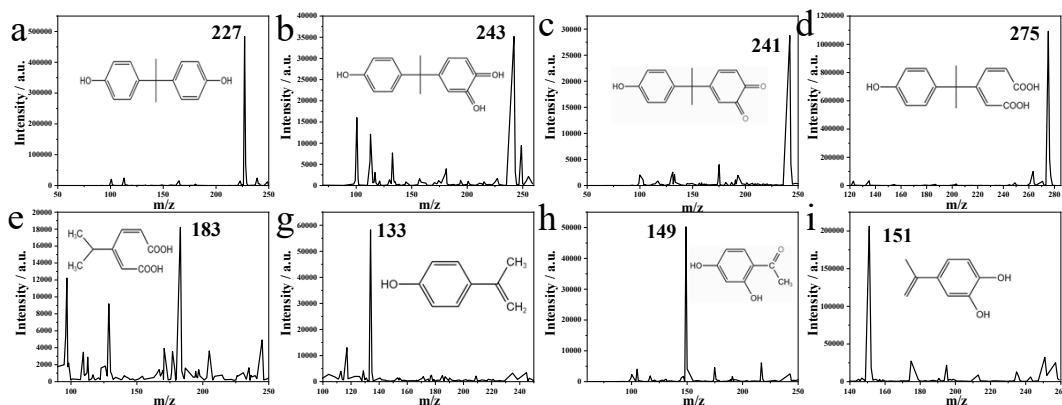




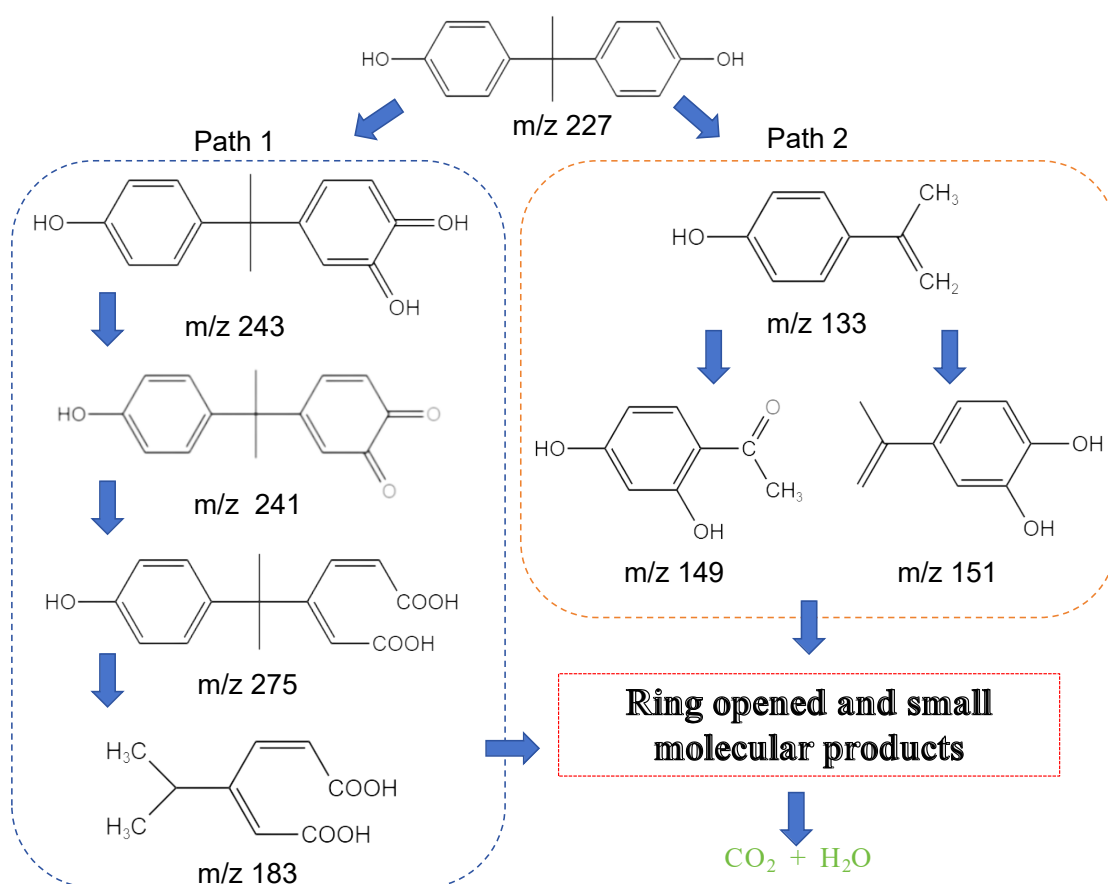
**Fig. S12.** (a) Photograph of the dye solvents for the 5<sup>th</sup> cycle. (b) SEM images of the CN/BOB-16 before and after the photocatalytic degradation experiment.



**Fig. S13. Mechanism analysis of photocatalytic degradation:** Proposed mechanism for the  $g\text{-C}_3\text{N}_4/\text{Bi}_4\text{O}_5\text{Br}_2$  heterojunction.

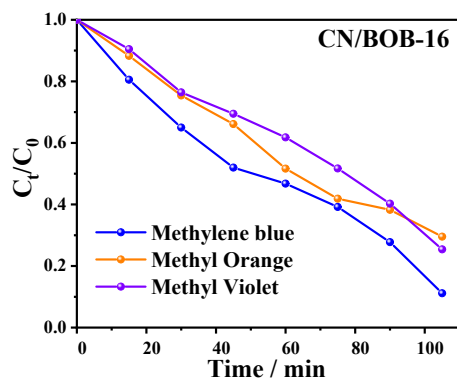


**Fig. S14.** HPLC-MS analysis conditions of the organic contaminants. (BPA)



**Fig. S15.** Possible degradation pathways of BPA. In **Path 1**, hydroxylation was the first step of BPA photoconversion<sup>6, 7</sup>, and the aromatic ring was then attacked by  $\cdot\text{O}_2^-$  to form mono-hydroxylated BPA  $m/z = 243$ . Undergone the subsequent dehydration and ring-opening reactions, the corresponding quinone and carboxylic acid compounds  $m/z = 241$  and  $m/z = 275$  were produced<sup>8</sup>. Due to the instability of hydroxylated BPA, ring-opening reactions may occur on  $m/z = 243$  and  $m/z = 241$  under the attack of the active substance to form the product  $m/z = 183$ <sup>9</sup>. In **Path 2**, two phenolic hydroxyl groups in BPA as electron donors increase the electron density of the aromatic ring, which makes the electron-rich CAC connecting the two aromatic rings vulnerable to

the attack of the active species, leading to the form products  $m/z = 133$ , and  $m/z = 133$  further becomes  $m/z = 149$  and  $m/z = 151^{10}$ . In the late stage of the reaction, the above-mentioned products are subjected to ring-opening reaction under the continuous attack of the free radicals to generate small molecular products, which are finally converted into  $\text{CO}_2$  and  $\text{H}_2\text{O}$ .



**Fig. S16.** Degradation properties for the other three dyes: methyl blue (90%), methyl orange (71%), and methyl violet (75%).

**Table S1.** The fitting parameter for the pseudo-first-order kinetic curve. (RhB)

Sampl es	CN/BO B-21	CN/BO B-11	CN/BO B-21	CN/BO B-14	CN/BO B-16	CN/BOB -18	CN/BO B-110	CN	BOB
Slopes	0.043±	0.050±	0.063±	0.070±	0.101±	0.078±	0.062±	0.040	0.041
	0.001	0.001	0.001	0.002	0.003	0.003	0.002	±	±
r <sup>2</sup>	0.993	0.989	0.993	0.992	0.992	0.988	0.989	0.980	0.987

**Table S2.** Fitting parameters for the proposed first-order kinetic curve for free radical trapping.

Sampl es	CN/BO B-16	N <sub>2</sub>	KI	IPA	RhB	N <sub>2</sub>	KI	IPA
Slopes	BPA 0.034± 0.004	0.022	0.006	0.003	RhB	0.011	0.007	0.030
		±0.00	±0.00	±0.00		±0.00	±0.00	±0.00
r <sup>2</sup>	0.879	0.983	0.976	0.973	0.941	0.997	0.996	

**Table S3.** (BPA and RhB) Total organic carbon removal rate of CN/BOB-16.

Sample(Time)	TOC (mg L <sup>-1</sup> )	Removal Rate
BPA (0)	16.5	-
BPA (80)	3.5	78.8%
RhB (0)	17.8	-

**Table S4.** Comparisons of RhB photocatalytic degradation between the prepared composite and some previous reported photocatalysts.

Samples	Light source	RhB Conc(mg/ L)	Time(min )	Removal efficiency (%)	Ref
<b><i>g-C<sub>3</sub>N<sub>4</sub>/Bi<sub>4</sub>O<sub>5</sub>Br<sub>2</sub></i></b>	<b><i>500 W Xenon lamp</i></b>	<b><i>10</i></b>	<b><i>35</i></b>	<b><i>100</i></b>	<b><i>This work</i></b>
CdSe QDs@ Fe-based metal organic framework	250 W Sodium lamp	50	240	99.8	11
RGO-wrapped Ti <sub>3</sub> C <sub>2</sub> /TiO <sub>2</sub>	300 W Xenon lamp	10	60	94.6	12
ZnO-g-C <sub>3</sub> N <sub>4</sub> -GO	350 W Xenon lamp	10	120	98	13
g-C <sub>3</sub> N <sub>4</sub> /ZnO	300 W Xenon lamp	10	90	98.5	14
Bi <sub>4</sub> O <sub>5</sub> Br <sub>2</sub> /Cu <sub>2</sub> O	300 W Xenon lamp	10	80	96	15
Bi <sub>4</sub> O <sub>5</sub> Br <sub>2</sub> /SrFe <sub>12</sub> O <sub>19</sub>	300 W Xenon lamp	10	60	99.3	16
FeVO <sub>4</sub> /Bi <sub>4</sub> O <sub>5</sub> Br <sub>2</sub> /BiOBr	50 W LED lamp	10	360	98.2	17
BiOBr/Bi/Bi <sub>2</sub> WO <sub>6</sub>	350 W Xe lamp	10	60	98	18
Ag NPs decorated C- TiO <sub>2</sub> /Cd <sub>0.5</sub> Zn <sub>0.5</sub> S	500 W Xe lamp	7	90	97.6	19
BiOIO <sub>3</sub> /BiOI/Bi <sub>2</sub> S <sub>3</sub>	500 W Xe lamp	10	90	98	20
Co@ZnSQDs/g-C <sub>3</sub> N <sub>4</sub> /MWCNT	halogen lamp 500 W	10	75	96	21
Ag <sub>3</sub> PO <sub>4</sub> /N-TiO <sub>2</sub>	150W Xe lamp	10	120	91	22
OVs Bi <sub>2</sub> MoO <sub>6</sub> /WO <sub>3</sub>	300 W Xe lamp	10	240	80	23
ZnO/Bi <sub>2</sub> MoO <sub>6</sub>	15 W Panasonic cool daylight lamp	10	120	94	24
ZnFe <sub>2</sub> O <sub>4</sub> /Na-bentonite	350 W Xenon lamp	10	120	93	25

TiO <sub>2</sub> -BiVO <sub>4</sub>	300 Xe lamp	10	300	79.3	26
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