Supporting Information for

Lantern-like bismuth oxyiodides embedded typha-based carbon via in-situ selftemplate and ion exchange-recrystallization for high-performance photocatalysis

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- Fig. S1 Characterization of N-doped bamboo tube-like typha-based carbon (NTC).
- Table S1 The elements and chemicals analysis of BiOI, Bi₇O₉I₃, Bi₇O₉I₃/NTC and NTC.
- 3. Fig. S2 XPS spectra of Bi₇O₉I₃/NTC, high-resolution spectrum of C 1s and N 1s.
- Table S2 Porosity properties and distribution of pore volume of NTC, BiOI, Bi₇O₉I₃ and Bi₇O₉I₃/NTC.
- 5. **Fig. S3** The adsorption rate of MO (a) and RhB (b) for NTC, BiOI, Bi₇O₉I₃ and Bi₇O₉I₃/NTC until reaching to the absorption-desorption equilibrium.
- 6. **Fig. S4** Trapping experiment of active species for Bi₇O₉I₃/NTC during the photocatalytic oxidation of MO and RhB.
- 7. **Table S3** Comparison of the obtained specific surface area and photocatalysis performance results with literature data of the $Bi_xO_yI_z$ -based catalysts.
- 8. References.



Fig. S1 (a, b) TEM images of the typha grass; (c) SEM image of the N-doped bamboo tube-like typha-based carbon (NTC); (d) TEM image of the NTC; (e) Nitrogen adsorption-desorption isotherm and (f) corresponding pore size distribution of NTC; (g) XRD pattern of the NTC; (h) XPS survey spectra and (i) high-resolution spectrum of the N 1s peak of the NTC.

The interconnected laminar framework of typha grass with various macropore structures are as shown in Fig. S1a. The wide distribution of mesoporous inside typha grass is demonstrated in Fig. S1b, which may be attributed to natural pore structure biopolymers on the cell surface. After 750 °C carbonized process in ammonia gas, the obtained N-doped bamboo tube-like typha-based carbon (NTC) still retains the intrinsic framework of typha grass (Fig. S1c-d). The product demonstrates a unique distribution of interconnected bamboo tube-like pores from the hierarchical porous system network structure, which is obtained from the direct carbonized typha grass. As a result of the unique pore size and porous system network structure, it shows high specific surface area 454 m² g ⁻¹ and pore volume up to 0.27 cm³ g⁻¹ (Fig. S1e). The pore diameters are mainly presented as microporous, which may be due to the ammonia etching effect under high temperature. The numerous micro/mesoporous

hierarchical porous system obtained from the skeletal structure of the carbonized typha grass (Fig. S1f), which are consistent with the results of Fig. S1a-d. The X-ray diffraction (XRD) pattern of NTC can be seen in Fig. S1g. Two characteristic peaks of the sample are located at around $2\theta = 25^{\circ}$ corresponding to the (002) and 44° corresponding to the (101) plane. In addition, a high intensity enhancement in small-angle scattering is consistent with the existence of a high content of micropores. XPS measurements (Fig. S1h) show C, N, and O contents in NTC, which are 81.9, 11.8 and 6.3 wt %, respectively, and the results are consistent with the EDX elemental mapping (Fig. 4i). The high-resolution N 1s spectra (Fig. S1i) can be fitted by two peaks located at 400.1 eV due to a pyridone nitrogen and at 397.2 eV attributed to a pyridinic nitrogen. The N atom showing high content of 11.8% within the graphite layers could increase the electronic properties as metals and increase the Fermi level.

Table S1 The elements and chemicals analysis of BiOI, Bi₇O₉I₃, Bi₇O₉I₃/NTC and NTC.

Atomic percentage	Bi	0	I	С	N
BiOI	15.1	20.19	11.2 5	53.46	/
Bi ₇ O ₉ I ₃	17.09	38.61	5.24	39.05	/
Bi7O9I3/NTC	10.01	23.41	2.81	58.47	5.3
NTC	/	6.3	/	81.9	11. 8



Fig. S2 XPS spectra of as-synthesized Bi₇O₉I₃/NTC: (a) C 1s and (b) N 1s.

Table S2 Porosity properties and distribution of pore volume of NTC, BiOI, $Bi_7O_9I_3$ and $Bi_7O_9I_3/NTC$.

Samula	S _{BET}	Pore vol (cm ³ /g)			
Sample	(m²/g)	V _{S<2nm}	V _{2nm<s<50nm< sub=""></s<50nm<>}	V _{S>50nm}	
NTC	454	0.170	0.040	0.012	
BiOI	22	0.001	0.060	0.006	
Bi ₇ O ₉ I ₃	47	0.002	0.087	0.016	
Bi ₇ O ₉ I ₃ /NTC	40	0.001	0.083	0.026	



Fig. S3 The adsorption rate of MO (a) and RhB (b) for NTC, BiOI, $Bi_7O_9I_3$ and $Bi_7O_9I_3/NTC$ until reaching to the absorption-desorption equilibrium.



Fig. S4 Trapping experiment of active species for $Bi_7O_9I_3/NTC$ during the photocatalytic oxidation of MO (a) and RhB (b).

Materials	S _{BET} (m ² g ⁻¹)	Simulated pollutant	Degradation rate	Ref.	
Bi ₇ O ₉ I ₃ /NTC	39.5	10 mg L ⁻¹ MO	93.5% in 2 h	This	
		20 mg L ⁻¹ RhB	97.6% in 2h	work	
Bi ₄ O ₅ I ₂ -Bi ₅ O ₇ I	9.2	0.02 mM RhB	79% in 4 h	1	
		10 mg L ⁻¹ BPA	94% in 4 h		
CQDs/BiOI	29.22	10 mg L ⁻¹ RhB	94.9% in 2 h	2	
GR-BiOI	-	3×10 ⁻⁵ mol L ⁻¹ RhB	80% in 4 h	3	
BN/BiOI	69.49	10 mg L ⁻¹ RhB	93% in 100 min	4	
BiOI@rGO	-	5 mg L ⁻¹ RhB	85.0% in 3 h		
		5 mg L ⁻¹ MO	70.1% in 3 h	5	
		5 mg L ⁻¹ phenol	65.9% in 4 h		
BiOBr-BiOI	-	10 mg L ⁻¹ phenol	75% in 10 h	6	
BiVO ₄ /BiOI		0.02 mM RhB	97% in 5 h	-	
	-	0.11 mM phenol	63.9% in 16 h		
BiOI/Bi ₅ O ₇ I		10.0 mg L ⁻¹ MO	93% in 40 min	8	
BiOI–GO	4.5	100 mg/L phenol	54% in 150 min	9	
BiOI/BiOCl	4.2	20 mg L ⁻¹ MO	95% in 3 h	10	

Table S3 Comparison of the obtained specific surface area and photocatalysisperformance results with literature data of the $Bi_xO_yI_z$ -based catalysts.

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