Supplementary Material

Nitrogen-doped biochar nanosheets facilitate charge separation of Bi/Bi_2O_3 nanosphere with Mott-Schottky heterojunction for efficient photocatalytic reforming of biomass

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1. Experimental Section

1.1 Synthesis of sulfonated lignin

The method for synthesis of sulfonated lignin (SL) was according to the previous report with some modifications.[1] Typically, 5 g of IL was slowly added into 50 mL of NaOH (2 wt%) with stirring. After 30 min, 6.0 g of formaldehyde and 6.3 g of Na_2SO_3 were slowly added into it. The obtained system was then heated to 80 ^oC for 4 h. Subsequently, the obtained mixture was dialyzed for one week, and then evaporated and freeze-dried to give SL.

1.2 Preparation of flower-shaped BiOBr

Generally, 3 mmol of $Bi(NO_3)_3 \cdot 5H_2O$ was dissolved in 20 mL of ethylene glycol and stirred for 30 min (solution I). In another beaker, 1 mmol of KBr was added into 10 mL of deionized water to form solution II under the stirring. Subsequently, the solution I was added into solution II drop by drop in the case of stirring. After 30 min, the obtained reaction system was performed at 120 ^oC for 6 h. Afterwards, the cooled reaction system was treated with filtrating, washing and drying to give BiOBr.

1.3 Characterization

In this work, all the characterizations of the obtained photocatalysts were similar with our previous reports,[2-4] such as transmission electron microscopy (TEM), scanning electron microscopy (SEM), Fourier infrared (FT-IR) spectra, X-ray diffraction (XRD) patterns, N_2 adsorption-desorption isotherm, X-ray photoelectron spectroscopy (XPS), Electron spin-resonance (ESR) spectroscopy, Ultraviolet photoelectron spectroscopy (UPS) and photoelectrochemical measurements.

1.4 Stability and reusability test of Bi/Bi_2O_3@N-BC

To investigate the stability and reusability of Bi/Bi_2O_3@N-BC, a series of reaction was performed. Typically, a mixture of xylose (50 mg), Bi/Bi_2O_3@N-BC (5 mg) and KOH solution (5 mL, 2 M) was first performed at dark condition for 30 min, and then

irradiated by visible light for 45 min. At the end of each reaction, the catalyst is directly used in the next cycle after filtration, washing and drying. The conversion of xylose and the yield of lactic acid were detected by HPLC.[4]

1.5 1000-fold scale-up experiments

The scale-up application of a reaction system is an important parameter to evaluate the catalyst. Here, 1000-fold scale-up experiment was performed with 50 g of xylose and 5 g of Bi/Bi_2O_3@N-BC as well as 5 L KOH (2.0 M). The difference is that the light source was changed from visible light to sunlight, and the reaction temperature was changed from 60 ^oC to room temperature. The lactic acid yield was analyzed by HPLC.[4]

2. Results and discussion

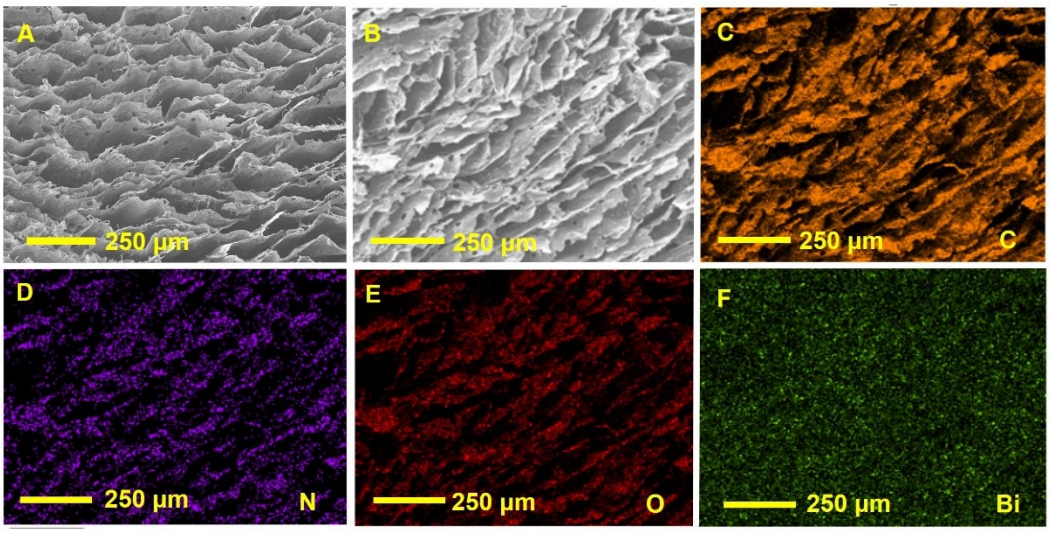

Fig. S1. SEM of Bi/Bi_2O_3@N-BC (A, B). Element mapping images of Bi/Bi_2O_3@N-BC: C element (C), N element (D), O element (E), Bi element (F).

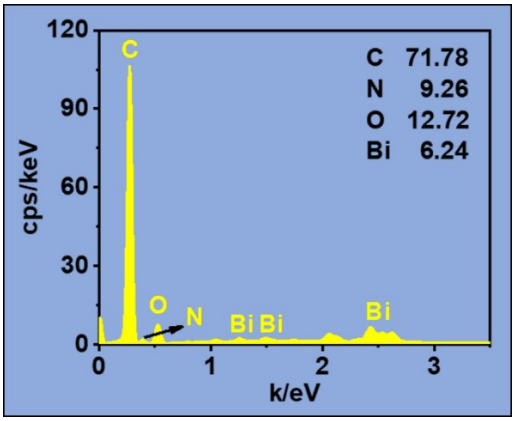

Fig. S2. EDS of Bi/Bi_2O_3@N-BC.

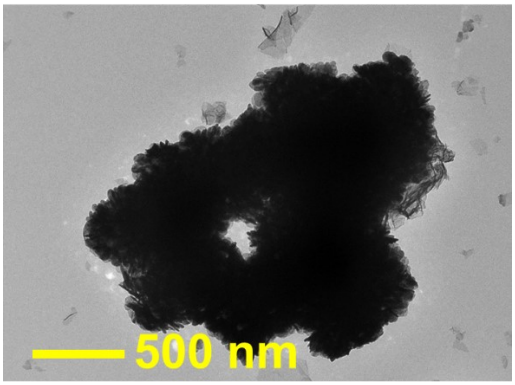

Fig. S3. TEM of BiOBr.

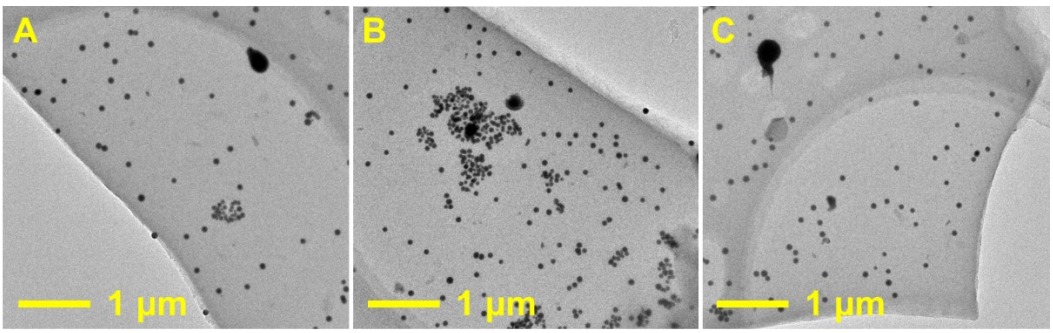

Fig. S4. TEM of Bi/Bi_2O_3@N-BC.

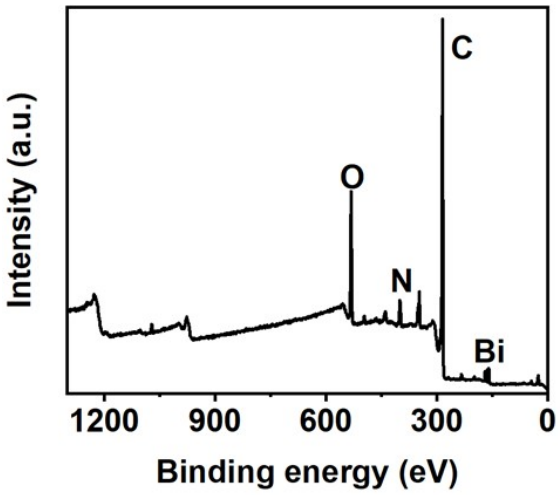

Fig. S5. XPS survey spectrum of Bi/Bi_2O_3@N-BC.

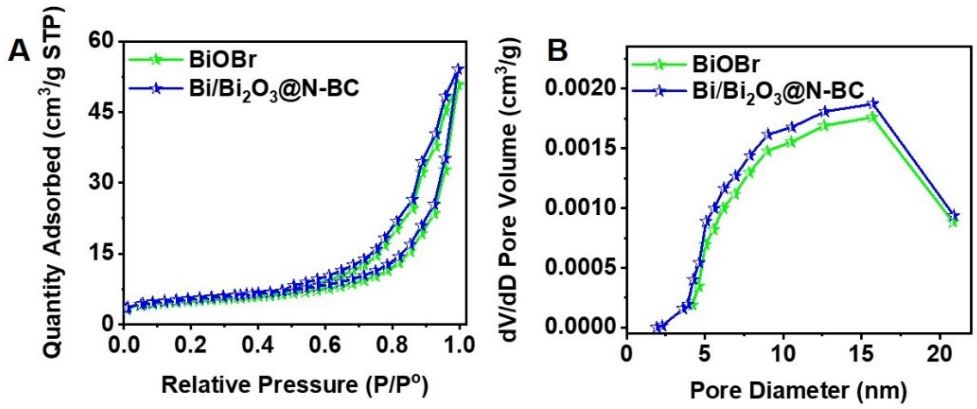

Fig. S6. N_2 adsorption-desorption isotherm (A) and the pore size distribution (B) of BiOBr and Bi/Bi_2O_3@N-BC.

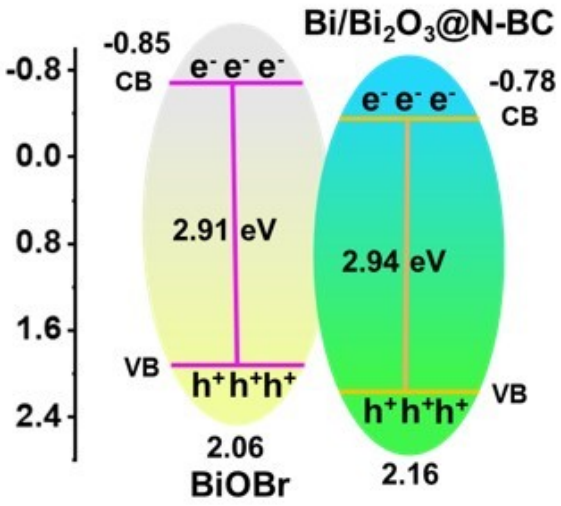

Fig. S7. Relative band alignment of BiOBr and Bi/Bi_2O_3@N-BC.

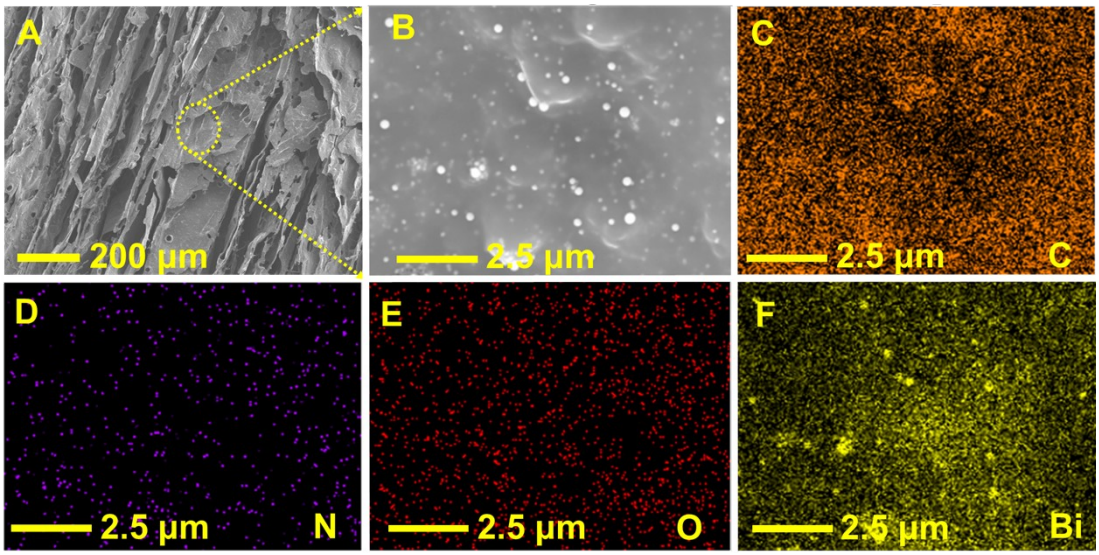

Fig. S8. SEM of Bi/Bi_2O_3@N-BC (A, B). Element mapping images of Bi/Bi_2O_3@N-BC: C element (C), N element (D), O element (E), Bi element (F).

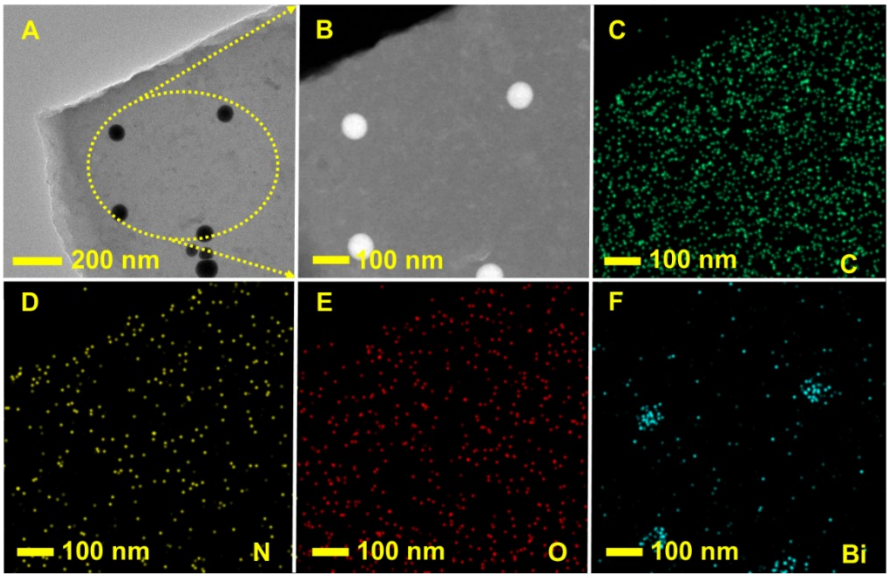

Fig. S9. TEM of Bi/Bi_2O_3@N-BC (A). HAADF-STEM of Bi/Bi_2O_3@N-BC (B). Element mapping images of Bi/Bi_2O_3@N-BC: C element (C), N element (D), O element (E), Bi element (F).

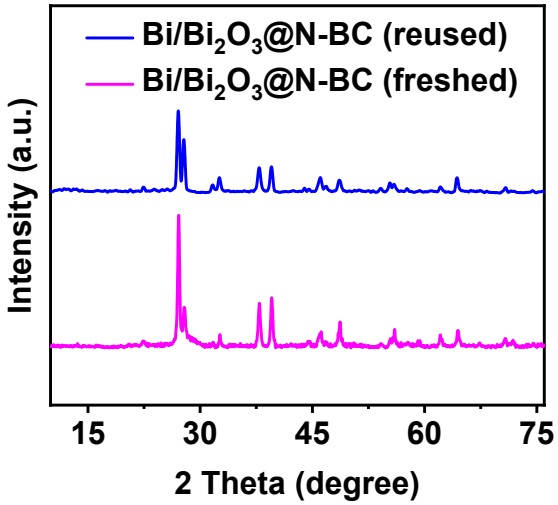

Fig. S10. XRD patterns of Bi/Bi_2O_3@N-BC for reused and freshed.

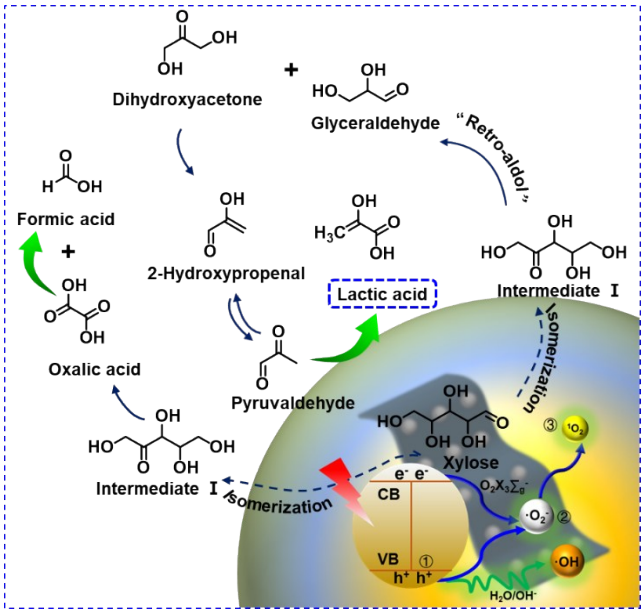

Fig. S11. Possible reaction pathway for the conversion of xylose photocatalyzed by Bi/Bi_2O_3@N-BC under visible-light irradiation.

Table S1. The effects of different catalysts on the synthesis of lactic acid.

Entry	Samples	Photocatalysis	Light sources	Yield (%)
1	Xylose	Bi/Bi_2O_3@N-BC	Visible light	28.52
2		BiOBr	Visible light	7.19
3		None	Visible light	Trace
4			Dark	Trace

Reaction conditions: 5 mL of KOH solution (1 M), 5 mg photocatalyst, 30.0 °C, 45.0 min.

References

[1] Y. Y. Ge, Z. L. Li, Y. Kong, Q. P. Song and K. Q. Wang, *J. Ind. Eng. Chem.,* 2014, **20**, 4429-4436.

[2] Y. C. Li, J. L. Ma, D. N. Jin, G. J. Jiao, X. P. Yang, K. N. Liu, J. H. Zhou and R. C. Sun, *Appl. Catal. B-Environ.,* 2021, **291**, 120123.

[3] J. L. Ma, Y. C. Li, D. N. Jin, Z. Ali, G. J. Jiao, J. Q. Zhang, S. Wang and R. C. Sun, *Green Chem.,* 2020, **22**, 6384-6392.

[4] J. L. Ma, D. N. Jin, Y. C. Li, D. Q. Xiao, G. J. Jiao, Q. Liu, Y. Z. Guo, L. P. Xiao, X. H. Chen, X. Z. Li, J. H. Zhou and R. C. Sun, *Appl. Catal. B-Environ.,* 2021, **283**, 119520.