

Supporting information

Iron doped BiOBr loaded on carbon spheres for improved visible-light-driven detoxification of 2-chloroethyl sulfide

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The preparation of porous PANI carbon, porous phenolic resin carbon and hollow polydopamine carbon

The porous PANI carbon was synthesized through the following procedures. Firstly, the SiO₂@PANI nanoparticles were prepared by putting 1.00 mL silica colloid (40.0%), 5.00 mL 1 mol/L HCl, 15.0 mL ultra-pure water (18.2 MΩ·cm) and 400 μL aniline successively into a 30.0 mL glass bottle in ice (solution A). Solution A was constantly mixed for 20.0 min using a magnetic bar. Secondly, the 1.00 g ammonium persulfate and 2.00 mL 1.00 mol/L HCl were added into a test tube in ice bath (solution B). Then, add solution B drop by drop to solution A and rapid agitation for 24.0 h. After the reaction, the solution was collected and washed three times with ultra-pure water/ethanol successively. After drying for 24.0 h, the SiO₂@PANI product was obtained. The obtained SiO₂@PANI was put into a tubular furnace and calcined at 900 °C under nitrogen atmosphere for 160 min. The SiO₂ template was etched with 0.5 mol/L NaOH solution for 12.0 h. The nitrogen-doped mesoporous carbon nanospheres were obtained after collecting and washing the etching products.

The porous phenolic resin carbon was synthesized through the following procedures

Solution composed of 70.0 mL of ethanol, 10.0 mL of water, 3.00 mL of ammonia

solution (25.0 wt%) and 3.46 mL of disodium EDTA was vigorously stirred at room temperature. 15 min later, 0.400 g of resorcinol and 0.56 mL of formaldehyde (37.0 wt%) were added to the above solution and the system was vigorously stirred at room temperature for 24.0 h. The precipitate was separated by centrifugation and washed with deionized water and ethanol several times. The precipitate was then dried at 60.0 °C overnight. The precipitate was then calcined at 700 °C for 5 h under N₂ atmosphere to obtain C/SiO₂ spheres. Finally, SiO₂ was etched by using 2.00 M NaOH for 8.00 h to obtain phenolic resin carbon spheres.

The hollow polydopamine carbon was synthesized through the following procedures

2.00 g PS pellets were dispersed in 200 mL Tris-HCl (10.0 mM, pH = 8.50) in a 250 mL flask, then 0.200 g DA was added and mechanically stirred for 24.0 h. PDA was deposited on the PS surface to obtain PS@PDA, which was centrifuged, rinsed three times with water and ethanol, and then dried under vacuum at 45°C. The PS@PDA was then calcined at 800 °C for 120 min to obtain the hollow polydopamine carbon.

The data of ¹H NMR (600MHz,CDCl₃) of the [C₁₆imC_n]Br (n = 1, 2, 4, 8, 12, 16):

- 1) [C₁₆mim]Br: δ (ppm) 10.79(s, H), 7.23(d, 2H), 4.32(t, 2H), 4.13(s, 3H), 1.92(m, 2H), 1.31(m, 26H), 0.88(t, 3H).
- 2) [C₁₆imC₂]Br: δ (ppm) 10.88(s, H), 7.27(s, 2H), 3.73 (m, 4H), 1.63 (d, 4H), 1.25 (m, 24H), 0.89 (t, 6H).
- 3) [C₁₆imC₄]Br: δ (ppm) 10.57 (s, H), 7.47 (s, H), 7.42 (s, 1H), 4.36 (m, 4H), 1.92 (d, 4H), 1.25 (m, 28H), 0.912 (t, 3H), 0.87 (t, 3H).
- 4) [C₁₆imC₈]Br: δ (ppm) 10.53 (s, H), 7.52 (s, 2H), 4.39 (s, 4H), 1.93 (s, 4H), 1.25 (m, 36H), 0.87 (t, 6H).
- 5) [C₁₆imC₁₂]Br: δ (ppm) 10.47 (s, H), 7.47 (s, H), 7.46 (s, 1H), 4.39 (s, 4H), 1.91 (s, 4H), 1.24 (m, 44H), 0.86 (t, 6H).
- 6) [C₁₆imC₁₆]Br: δ (ppm) 10.514 (s, H), 7.399 (s, 2H), 4.36 (t, 4H), 1.92 (s, 4H), 1.25 (m, 52H), 0.86 (t, 6H).

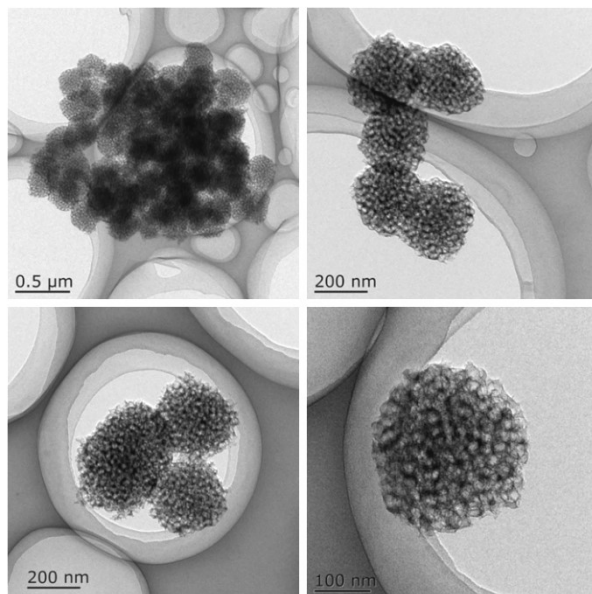


Fig. S1 TEM images of carbon spheres prepared by polyaniline.

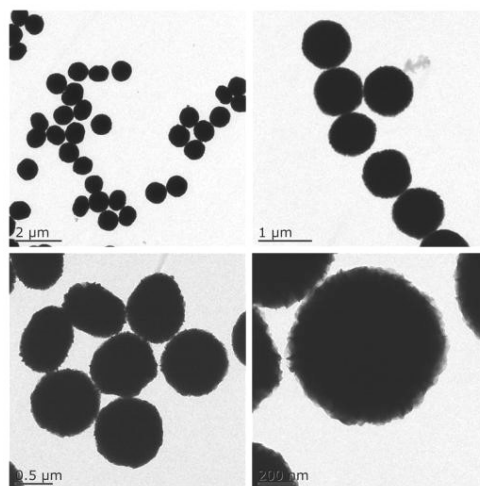


Fig. S2 TEM images of polyaniline carbon-loaded BiOBr/FeCl₃(10.0%)/AC prepared by solvothermal method.

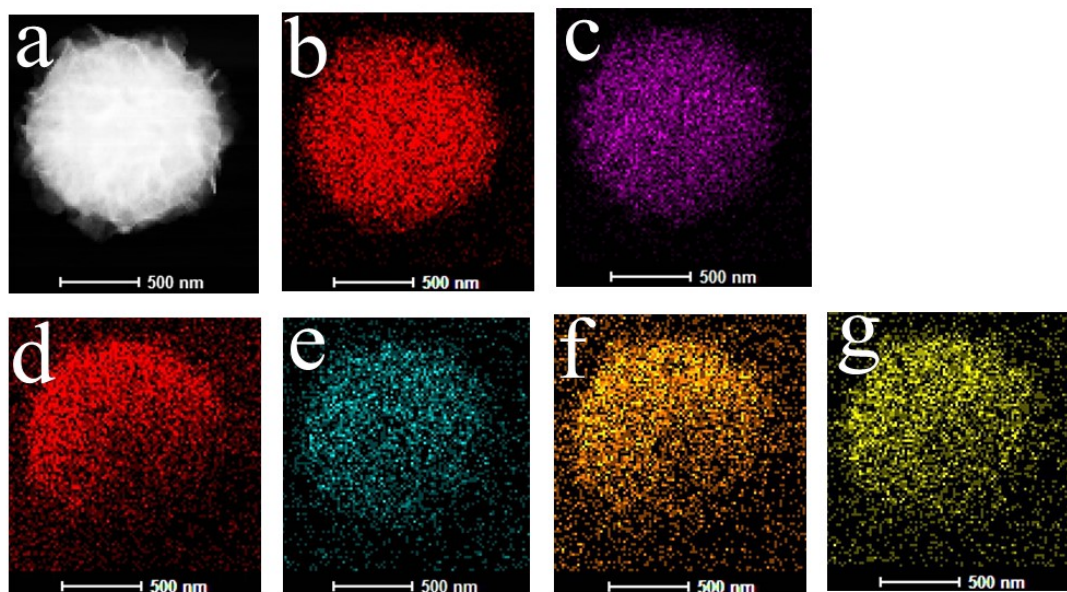


Fig.S3 Elemental mapping of BiOBr/FeCl₃/AC. (a) Selected microsphere of BiOBr/FeCl₃/AC; (b) BiLα₁; (c) BrLα₁; (d) C Kα₁; (e) FeLα₁; (f) N Kα₁; (g) O Kα₁.

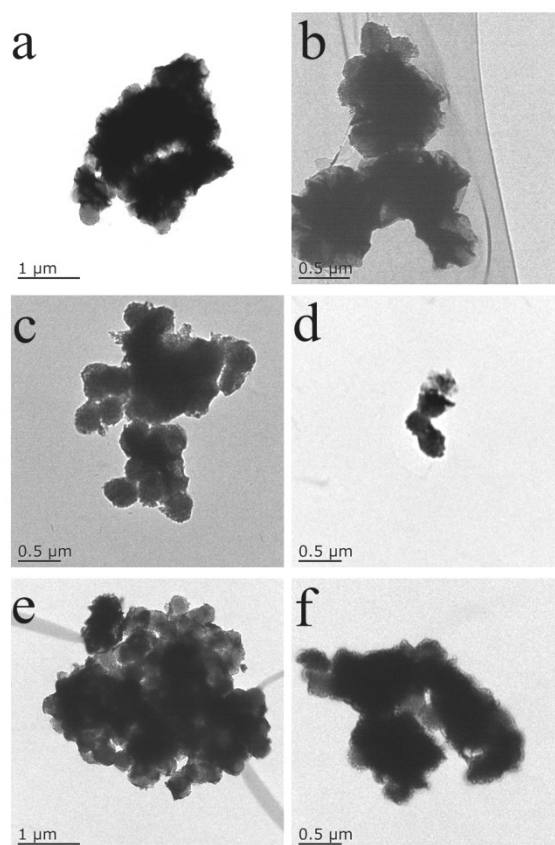


Fig. S4 TEM images of polyaniline carbon-loaded BiOBr/FeCl₃ prepared by solvothermal method with low concentration reactants. a, b (Bi(NO₃)₃·5H₂O, 5.0 mg); c, d (Bi(NO₃)₃·5H₂O, 10.0 mg); e, f (Bi(NO₃)₃·5H₂O, 15.0 mg).

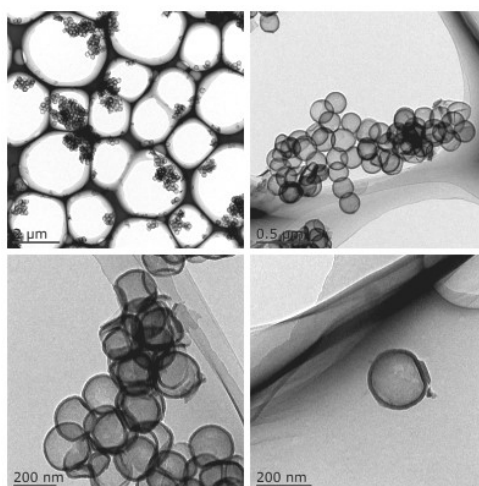


Fig. S5 TEM images of carbon spheres prepared by polydopamine.

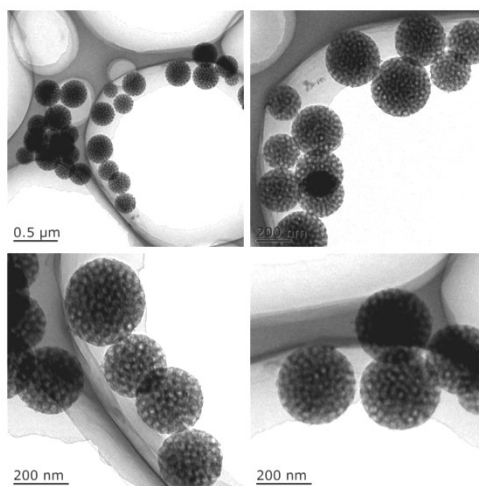


Fig. S6 TEM images of carbon spheres prepared by phenolic resin.

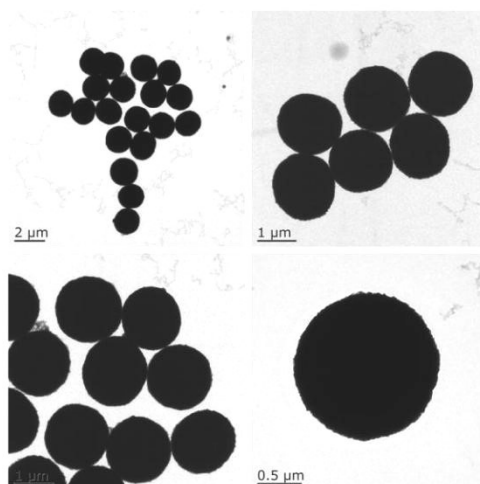


Fig. S7 TEM images of polydopamine carbon-loaded BiOBr/FeCl₃(10.0%) prepared by solvothermal method.

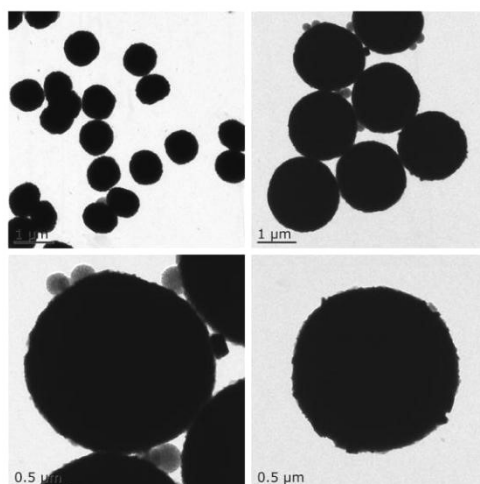


Fig. S8 TEM images of phenolic resin carbon-loaded BiOBr/FeCl₃(10.0%) prepared by solvothermal method.

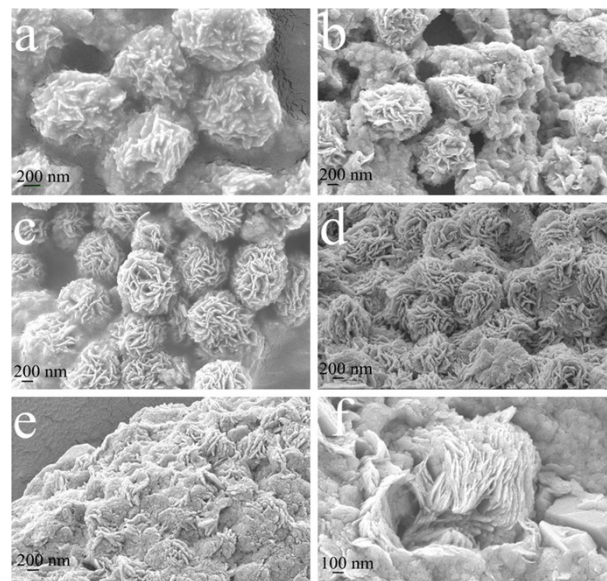


Fig. S9 SEM images of BiOBr microspheres fabricated from different ionic liquid surfactants at the same concentration. (a) $[C_{16}mim]Br$; (b) $[C_{16}imC_2]Br$; (c) $[C_{16}imC_4]Br$; (d) $[C_{16}imC_8]Br$; (e) $[C_{16}imC_{12}]Br$; (f) $[C_{16}imC_{16}]Br$.

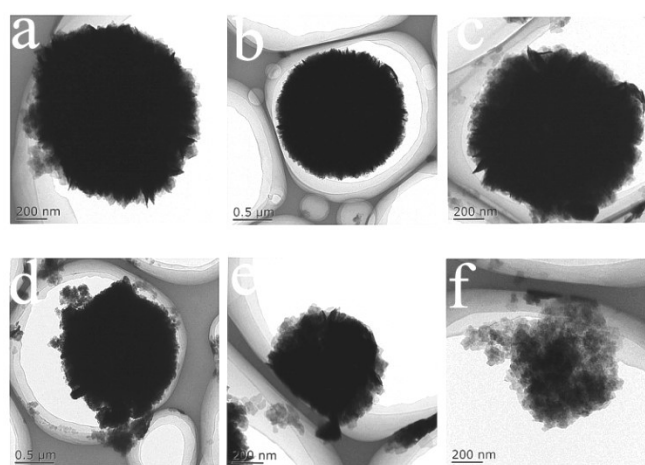


Fig. S10 The TEM images of the BiOBr micro-sphere fabricated by different ionic liquid surfactants. (a) $[C_{16}mim]Br$; (b) $[C_{16}imC_2]Br$; (c) $[C_{16}imC_4]Br$; (d) $[C_{16}imC_8]Br$; (e) $[C_{16}imC_{12}]Br$; (f) $[C_{16}imC_{16}]Br$.

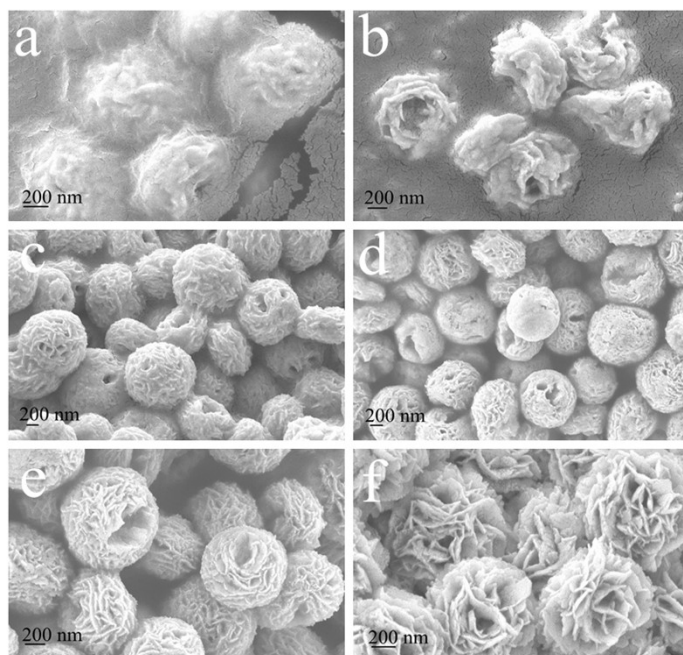


Fig. S11 The SEM images of BiOBr samples prepared at different reaction times in $[C_{16}imC_4]Br$ system: (a) 1.00 h; (b) 2.00 h; (c) 4.00 h; (d) 6.00 h; (e) 8.00 h and (f) 12.0 h.

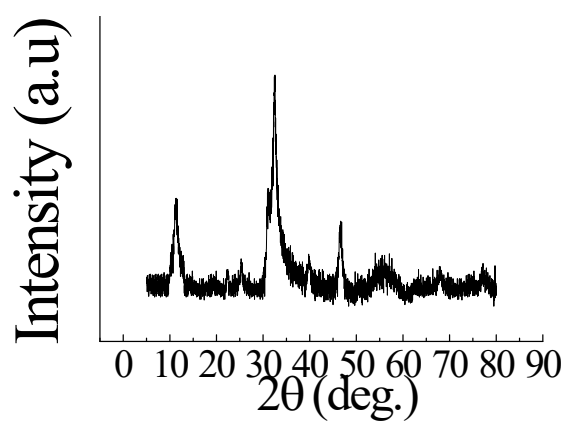


Fig. S12 The XRD patterns of pure BiOBr microsphere.

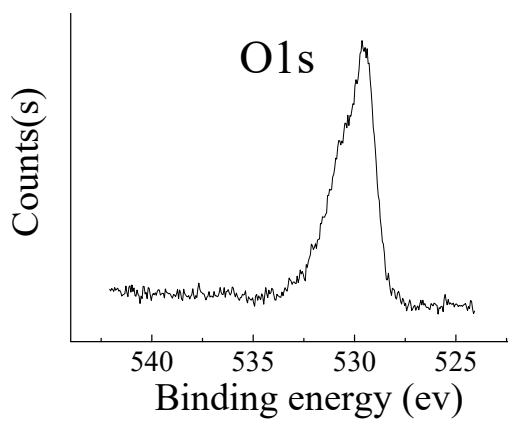


Fig. S13 The XPS spectra of O1s of pure BiOBr.

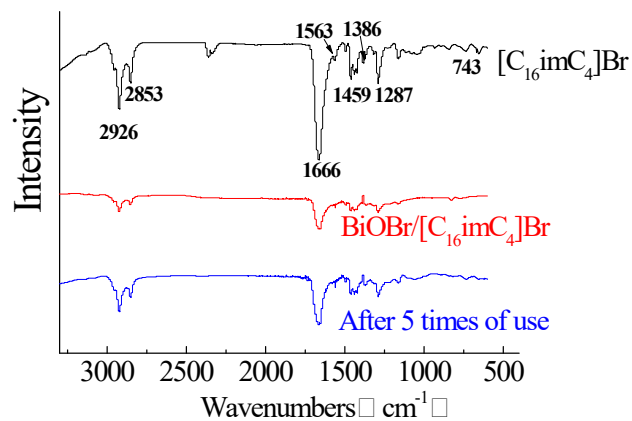


Fig. S14 The infrared spectrogram of the $[\text{C}_{16}\text{imC}_4]\text{Br}$, $\text{BiOBr}/\text{FeCl}_3/\text{AC}$ catalyst before and after catalytic experiments.

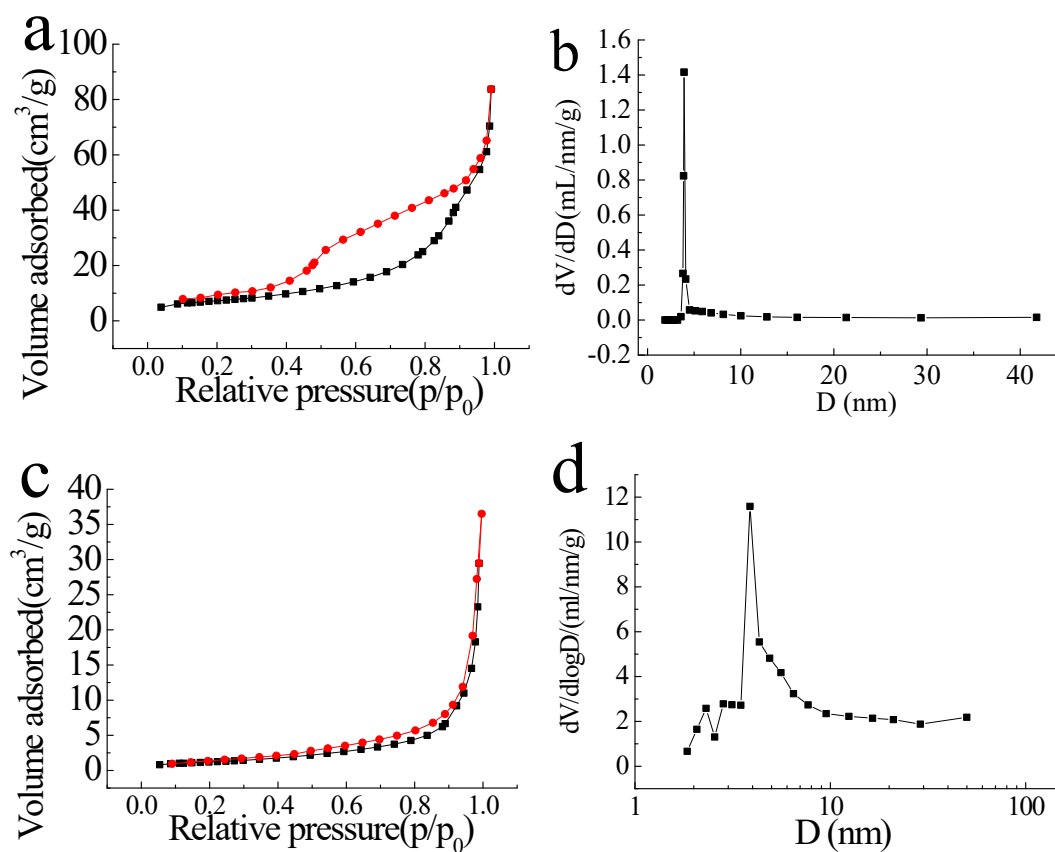


Fig. S15 (a) N_2 adsorption-desorption curve of $\text{BiOBr}/\text{FeCl}_3(10.0\%)/\text{AC}$ sample; (b) the corresponding pore size distribution plots. (c) N_2 adsorption-desorption curve of pure BiOBr microspheres; (d) the corresponding pore size distribution plots.

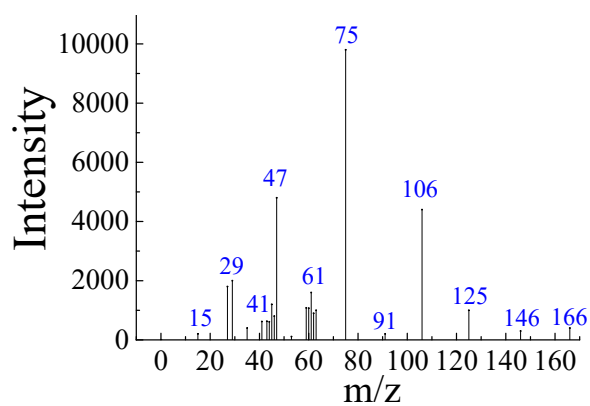


Fig. S16 The MS spectrum of the degradates of CEES with BiOBr/FeCl₃(10.0%)/AC (polyaniline carbon) in the dark.

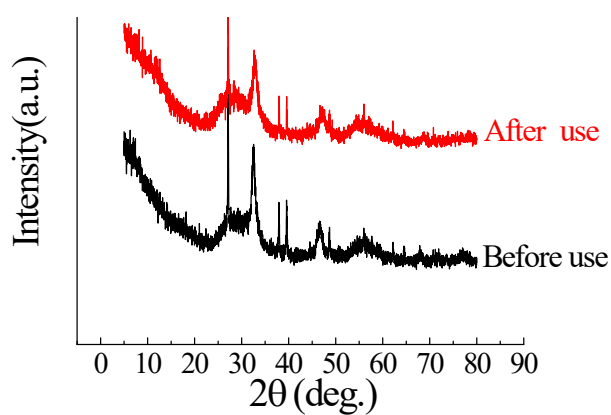


Fig. S17 The XRD patterns of BiOBr/Fe³⁺(10.0%)/AC before and after 5 cycles catalytic experiments.

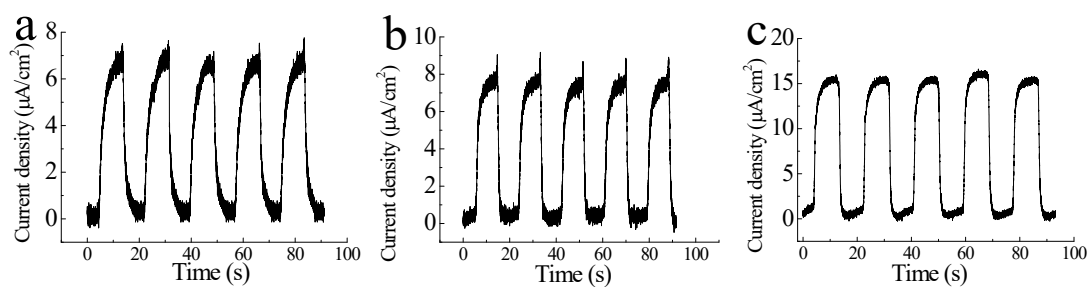


Fig. S18 Photocurrent of polyaniline carbon-loaded BiOBr/FeCl₃ prepared by solvothermal method with low concentration reactants. a (Bi(NO₃)₃·5H₂O, 5.0 mg); b (Bi(NO₃)₃·5H₂O, 10.0 mg); c (Bi(NO₃)₃·5H₂O, 15.0 mg).

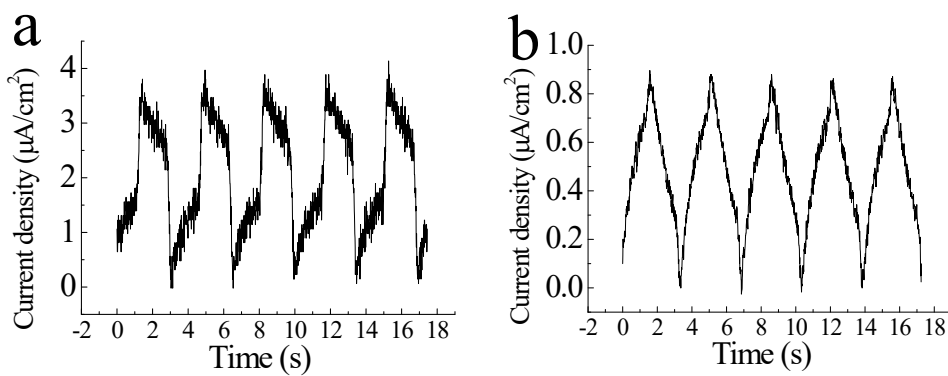


Fig. S19 The instantaneous photocurrent density of different (a) BiOBr/FeCl₃(10.0%)/AC(polydopamine) and (b) BiOBr/FeCl₃(10.0%)/AC(phenolic resin) under simulated sunlight irradiation.

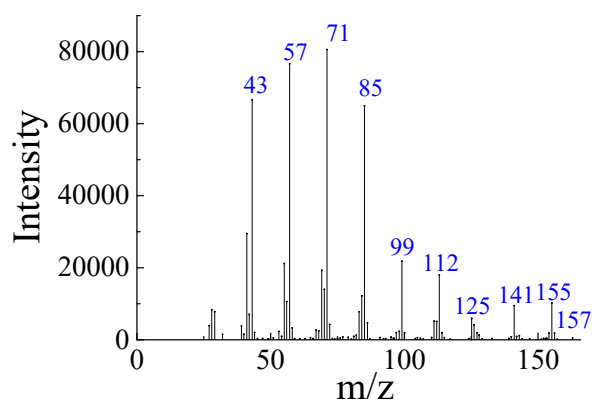


Fig. S20 The MS spectrum of the photocatalytic degradates of CEES after catalytical oxidation by BiOBr/FeCl₃(10.0%)/AC.