Electronic Supplementary Information

Synthesis of BiOCl$_{1-x}$Br$_x$@AgBr heterostructure with enhanced photocatalytic activity under visible light

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**Experimental**

**Synthesis of AgBr/BiOCl\(_{1-x}\)Br\(_x\) heterostructure**

0.033g Silver nitrate (AgNO\(_3\)), and 0.1g BiOCl\(_{1-x}\)Br\(_x\) nanosheets were dispersed into 20 mL heated EG (105 °C), after cooling down to 50 °C, 10 mL ethanol was added drop by drop followed by vigorously stirring. Then 0.1 g CTAB was added to the mixture following by vigorously stirring for 20 min. The mixture was then transferred into 50 mL Teflon-lined autoclave and seated into the oven under 160 °C for 5 h. After cooling down to room temperature, the precipitates were collected and washed with deionized water and ethanol alternately. After dried in oven at 60 °C for 8 h, the sample was collected and denoted as AgBr/BiOCl\(_{1-x}\)Br\(_x\).
Results and discussion

Fig. S1 XRD diffraction patterns of BiOCl, BiOCl$_{1-x}$Br$_x$ and AgBr/BiOCl$_{1-x}$Br$_x$

Fig. S2 The amplified XRD patterns of BiOCl and BiOCl$_{1-x}$Br$_x$
Fig. S3 XPS spectra of BiOCl: (a) survey spectra, (b) Bi, (c) Cl, (d) O

Fig. S4 XPS spectra of BiOCl$_{1-x}$Br$_x$: (a) Bi, (b) Cl, (c) Br, (d) O
**Fig. S5** (a) SEM image of BiOCl$_{1-x}$Br$_x$, (b) TEM image of BiOCl$_{1-x}$Br$_x$, (c) SEM image of AgBr/ BiOCl$_{1-x}$Br$_x$, (d) TEM image of BiOCl$_{1-x}$Br$_x$@AgBr

**Fig. S6** HRTEM image of BiOCl$_{1-x}$Br$_x$@AgBr
Fig. S7 EDS images of BiOCl$_{1-x}$Br$_x$@AgBr: (a) SEM image, (b) Bi, (c) Cl, (d) Br, (e) Ag, and (f) O

Fig. S8 (a) UV-Vis diffuse reflectance spectra and (b) band gap energies of the samples

Table. S1 the absorption edges, band gap energies, $E_{CB}$ and $E_{VB}$ of the samples

| samples            | absorption edge/nm | $E_g$/eV | $E_{CB}$/eV | $E_{VB}$/eV |
|--------------------|--------------------|----------|-------------|-------------|
| BiOCl              | 359                | 3.42     | 0.15        | 3.57        |
| AgBr               | 493                | 2.46     | 0.08        | 2.54        |
| BiOCl$_{1-x}$Br$_x$| 400                | 3.38     | 0.15        | 3.55        |
| AgBr/BiOCl$_{1-x}$Br$_x$ | 430 | 3.28     |             |             |
| BiOCl$_{1-x}$Br$_x$@AgBr | 450 | 3.26     |             |             |
Fig. S9 (a) photocatalytic activities, (b) kinetic fit of degradation for dyes with different samples

Fig. S10 (a) photocatalytic activities and (b) kinetic fit of BiOCl, BiOCl$_{1-x}$Br$_x$ and BiOCl$_{1-x}$Br$_x$@AgBr for degrading Ofloxacin
Table. S2 The kinetic constants of different samples

| samples                  | kinetic constant/min\(^{-1}\) (for KN-R degradation) | kinetic constant/min\(^{-1}\) (for OF degradation) |
|--------------------------|------------------------------------------------------|---------------------------------------------------|
| P25                      | 8.2×10\(^{-5}\)                                      | ——                                                |
| BiOCl                    | 1.6×10\(^{-3}\)                                      | 4.0×10\(^{-3}\)                                   |
| BiOCl\(_{1-x}\)Br\(_x\)  | 1.3×10\(^{-2}\)                                      | 1.5×10\(^{-2}\)                                   |
| AgBr/BiOCl\(_{1-x}\)Br\(_x\)| 2.3×10\(^{-2}\)                         | ——                                                |
| BiOCl\(_{1-x}\)Br\(_x\)@AgBr | 3.6×10\(^{-2}\)                                      | 4.1×10\(^{-2}\)                                   |

Fig. S11 Photodegradation of phenol over BiOCl\(_{1-x}\)Br\(_x\) and BiOCl\(_{1-x}\)Br\(_x\)@AgBr

Fig. S12 XRD patterns of BiOCl\(_{1-x}\)Br\(_x\)@AgBr before and after photocatalytic experiments
Fig. S13 Electrochemical impedance spectroscopy under light and dark conditions for BiOCl$_{1-x}$Br$_x$@AgBr