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Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites: one-step solution combustion synthesis, characterization and photocatalytic properties

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In the present study,  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites, as novel efficient photocatalysts, were synthesized *via* a one-step solution combustion synthesis (SCS) using bismuth nitrate ( $Bi(NO_3)_3$ , $^5H_2O$ ) as an oxidant, tartaric acid ( $C_4H_6O_6$ ) as a fuel, and silver nitrate ( $AgNO_3$ ) as an Ag source. The amount of Ag in the composite was tailored by varying the AgNO<sub>3</sub> content during the SCS process. The orthorhombic  $Bi_5O_7NO_3$  crystal structure was confirmed by XRD, FT-IR and XPS. It was found by EDS and TEM that in the Ag-containing composite, Ag was uniformly distributed on the  $Bi_5O_7NO_3$  matrix. The Ag decoration improved the  $Bi_5O_7NO_3$  photocatalytic efficiency for methyl orange (MO) degradation, likely owing to the relatively low recombination rates of electrons and holes. The 5 mol% Ag/ $Bi_5O_7NO_3$  composite exhibited the best photocatalytic performance (95% in 60 min), which was 1.5 times higher compared to that of pure  $Bi_5O_7NO_3$ . In addition, a mechanism of the photocatalytic MO degradation reaction was proposed, in which the reactive species  $O_2^-$  played an important role in degrading pollutants.

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## 1. Introduction

According to the United Nations World Water Development Report launched at the 8th World Water Forum, the global demand for water is growing by 1% per year, and the growing rate would accelerate significantly in the next two decades. Unfortunately, water pollution in almost all rivers of Latin America, Africa and Asia, has further deteriorated since the 1990s, while the pollution trend may get worse in the near future.<sup>1</sup> To solve the water pollution issue, extensive efforts have been made to develop visible light-driven photocatalysts, as promoted by solar energy, for pollutant degradation,<sup>2,3</sup> where semiconductor materials are typically used. Among these materials, owing to their wide visible light absorption range and their ability to generate superoxide/hydroxide radicals under visible-light irradiation, bismuth-based semiconductors have been reported as photocatalyst candidates for degrading water pollutants and decomposing organic molecules. Such materials include  $Bi_2O_3$  (e.g.  $\alpha$ ,  $\beta$ , and  $\delta$  phases),<sup>4,5</sup> BiVO<sub>4</sub>,<sup>6</sup> BiOBr,<sup>7</sup> Bi<sub>3</sub>NbO<sub>7</sub>,<sup>8</sup> Bi<sub>2</sub>WO<sub>6</sub>,<sup>9</sup> BiFeO<sub>3</sub>,<sup>10</sup> Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>,<sup>11</sup> etc.

Recently, bismuth oxynitride  $(Bi_5O_7NO_3)$ , as a novel photocatalyst, has attracted wide attention, due to its excellent photocatalytic performance under visible-light irradiation.<sup>11,12</sup> In particular, Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> shows great potential in improving photocatalytic activity via proper modification owing to its intense absorption in the UV-light region.<sup>13</sup> Several methods, including hydrothermal processing,<sup>11</sup> precipitation,<sup>14</sup> thermal decomposition,<sup>15</sup> etc., were used to synthesize Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. Solution combustion synthesis (SCS), an energyand time-efficient approach without addition of any surfactant or extra chemicals, has been used for synthesizing thousands of nanomaterials.<sup>7,16-18</sup> In the literature, various bismuth-containing composites, e.g. BiOCl,<sup>18</sup> BiVO<sub>4</sub>,<sup>19</sup> and BiFeO<sub>3</sub><sup>20</sup> have been successfully prepared by SCS. However, to the best of our knowledge, no report on the SCS of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and its composites was published. Therefore, investigation on the SCS of Bi5O7NO3 and its composites is of interest for their preparation and determination of their photocatalytic properties.

Metal nanoparticle decoration has been recognized as an efficient strategy for improving photocatalytic performance, as it can store electrons to increase the separation efficiency of photo-generated charges.<sup>21</sup> When noble metal nanoparticles, such as Au, Ag and Pt, were used to modify semiconductors, further enhancement was achieved.<sup>22–24</sup> Abdullah *et al.*<sup>14</sup> synthesized Ag-modified Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> adsorbents *via* a precipitation method, which showed better adsorption ability than Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. However, there are only a few reports<sup>14</sup> on Agdecorated Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. It is of importance to symmetrically study the adsorption, photocatalytic activity and mechanism of Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites.

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In the present study,  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites were synthesized *via* a one-step SCS route. The band gap energies of  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites were analyzed from the UV-vis spectra and Tauc plots. Furthermore, the adsorption and photocatalytic degradation properties of  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites were evaluated by degrading MO. Active species trapping experiments were

## 2. Experimental

#### 2.1 Synthesis

reaction.

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All materials, including bismuth nitrate pentahydrate  $(Bi(NO_3)_3 \cdot 5H_2O, AR 99.0\%)$ , tartaric acid  $(L-C_4H_6O_6, ACS 99.5\%)$ , silver nitrate (AgNO<sub>3</sub>, AR 99.8%), and MO (AR 99.0%), were purchased from Aladdin Chemical Reagent Co., Ltd, China and used directly without any further purification. The amounts of reagents for each sample are shown in Table 1. In a typical synthesis procedure, 5 mmol  $Bi(NO_3)_3 \cdot 5H_2O$ , 3.7 mmol  $C_4H_6O_6$  and 0.5 mmol AgNO<sub>3</sub> were dissolved in 30 mL 4 mol  $L^{-1}$  nitric acid under magnetic stirring at 60 °C to obtain a clear solution. Then the mixture was transferred into a muffle furnace, followed by heating at 500 °C for 30 min. This sample was labeled 10 mol% Ag (mol% means the molar ratio of Ag/Bi). The samples denoted as  $Bi_5O_7NO_3$ , 5 mol% Ag, and 3.3 mol% Ag were synthesized using the same procedure with various AgNO<sub>3</sub> contents (see Table 1).

conducted to propose the mechanism of the photocatalytic

#### 2.2 Characterization

The crystal phases and structures of the as-prepared samples were characterized by powder X-ray diffraction (XRD; Bruker D8 Advance diffractometer) at 40 kV and 40 mA with Cu Ka radiation. The surface chemistry was analyzed by FTIR (Vertex 80 V). The microstructures were characterized by scanning electron microscopy (SEM; Quanta 250) and energydispersive spectrometry (EDS; Uantax 400). The morphologies and size of the resultant products were obtained by highresolution transmission electron microscopy (HRTEM; Tecnai G2 F20). The surface chemical composition was determined by X-ray photoelectron spectroscopy (XPS; Escalab 250Xi) with Al K<sub> $\alpha$ </sub> radiation (20 eV pass energy, 900  $\mu$ m spot size). To calibrate the binding energy shifts caused by charge effects, all binding energies were referenced to the C 1s peak of adventitious carbon at 284.8 eV. The optical properties were evaluated using a UV-vis spectrophotometer (Lambda 750 s, USA) at 463 nm, while the photoluminescence spectra (PL) were

Table 1 The amounts of reagents for each sample			
Samples	Bi(NO <sub>3</sub> ) <sub>3</sub> ·5H <sub>2</sub> O (mmol)	C <sub>4</sub> H <sub>6</sub> O <sub>6</sub> (mmol)	AgNO <sub>3</sub> (mmol)
Bi <sub>5</sub> O <sub>7</sub> NO <sub>3</sub>	5	3.7	0
10 mol% Ag	5	3.7	0.5
5 mol% Ag	5	3.7	0.25
3.3 mol% Ag	5	3.7	0.16

recorded using a fluorescence spectrophotometer (VARIAN 3000, USA) upon 325 nm excitation.

#### 2.3 Photocatalytic performance test

The photocatalytic performance was evaluated by degradation of 20 mg L<sup>-1</sup> MO in an aqueous solution under ultraviolet and visible light irradiation. A 150 W halogen lamp was used over the beaker as the light irradiation source. For each test, a 0.1 g as-prepared photocatalyst was added to 50 mL MO solution (20 mg L<sup>-1</sup>). Prior to irradiation, the suspensions were magnetically stirred for 30 min in the dark to ensure adsorption–desorption equilibrium between the photocatalyst and organic dye. At the given time intervals (10 min), 5 mL solution was taken and centrifuged for 5 min (10 000 rpm). The degradation efficiency was reported as  $C_0$ – $C/C_0$ , where *C* is the MO concentration after degradation and photocatalysis, while  $C_0$  is the initial concentration.

## 3. Results and discussion

The X-ray diffraction patterns of the as-prepared samples are shown in Fig. 1. Fig. 1a demonstrates that  $Bi_5O_7NO_3$  obtained by SCS is indexed to an orthorhombic structure (JCPDS 51-0525) with the major peaks at  $2\theta = 7.56^{\circ}$ ,  $27.6^{\circ}$  and  $30.6^{\circ}$ , corresponding to diffraction peaks of the (002), (321), and (008) planes, respectively. Several new peaks (at  $2\theta = 38^{\circ}$ ,  $44^{\circ}$ , and  $77^{\circ}$ ) as shown in the XRD patterns of Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites are indexed to the cubic Ag (JCPDS 04-0738), indicating that the Ag particles exist in the composites. Fig. 1b shows the magnified XRD patterns in Fig. 1a in the  $2\theta$  range of 36–  $48^{\circ}$ , where the diffraction peaks of Ag ( $2\theta = 38^{\circ}$  and  $44^{\circ}$ ) gradually become stronger along with increasing Ag content. The XRD results indicate that highly crystalline  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites are successfully prepared *via* the one-step SCS.

The functional groups of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> analyzed by FTIR spectroscopy are shown in Fig. 2. The FT-IR spectra of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> confirm the presence of different types of oxygen functionalities. The peaks at 1300 cm<sup>-1</sup> and 1375 cm<sup>-1</sup> correspond to the symmetric and asymmetric stretching modes of the coordinated NO<sub>3</sub><sup>-</sup> group, respectively.<sup>25,26</sup> The absorption band at 1031 cm<sup>-1</sup> refers to monodentate nitrate groups,<sup>27</sup> and it changes more sharply for the Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composite, which can be ascribed to the incomplete decomposition of NO<sub>3</sub><sup>-</sup> of AgNO<sub>3</sub>. Bands in the range of 300-800 cm<sup>-1</sup> can be attributed to the stretching modes of the Bi-O bonds of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. As compared with the IR spectra of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and the 5 mol% Ag composite, Ag addition leads to significant strengthening and spreading of bending vibration peaks at 3350 cm<sup>-1</sup>, corresponding to a stretching vibration of OH groups, which can be attributed to OH groups bonded via the hydrogen bridge.28

XPS analysis was conducted to obtain the chemical environments of various elements in the 5 mol% Ag composite (see Fig. 3). The peak positions were calibrated for the surface charge using the C 1s peak at 284.5 eV as a reference. As



shown in Fig. 3a, the Bi, Ag, O, N and C elements were detected by the typical spectrum test. To evaluate the chemical state of bismuth, the HR spectrum of the Bi 4f doublet  $(4f_{7/2} \text{ and } 4f_{5/2})$  is acquired and indicated in Fig. 3b. The 5 mol% Ag shows the main  $4f_{7/2}$  peak at 158.3 eV and  $4f_{5/2}$ peak at 163.2 eV, which correspond to the Bi3+ oxidation state in accordance with the Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> phase.<sup>29</sup> The peak at 530.2 eV coincides with the binding energy of Bi-O of bismuth trioxide,<sup>30</sup> and peaks at 531.9 eV and 533.5 eV can be assigned to the presence of nitrate groups  $NO_3^{-.31,32}$  The N 1s peak at around 405.9 eV is due to the presence of nitrate groups NO<sub>3</sub><sup>-</sup>. Fig. 3f shows the Ag 3d XPS spectra with two peaks at about 367 and 373 eV, which are attributed to Ag  $3d_{5/2}$  and Ag  $3d_{3/2}$ , respectively.<sup>26,33</sup> The elements detected by XPS are consistent with the XRD results, which further confirm that the Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composite was successfully synthesized via SCS.

As shown in Fig. 4, the morphology and element distribution of the as-prepared  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites are analyzed by SEM and EDS mapping. Fig. 4a shows that  $Bi_5O_7NO_3$  particles are composed of a nanosheet-like structure, and the nanosheets agglomerate together forming relatively large  $Bi_5O_7NO_3$  particles along with micropores, which likely accounts for particle sintering as well as gas



Fig. 2 FTIR spectra of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites.

release during SCS.<sup>16,19</sup> The Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites (Fig. 4b and c) exhibit more clearly the nanosheet-like morphology. It appears that the skeleton is formed *via* nanosheets stacking layer by layer with a nanosheet thickness of  $\sim$ 16 nm. The EDS mapping images (Fig. 4e–h) show that Bi, O, N and Ag elements uniformly distribute over the whole sample. No obvious morphology difference between Ag and Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> was identified, which indicated that Ag uniformly decorated on the Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> matrix.

Further detailed information obtained by TEM and HRTEM analysis of the as-prepared  $Ag/Bi_5O_7NO_3$  composites is shown in Fig. 5. It shows that the 5 mol% Ag composite (Fig. 5a) is composed of many sheets stacking together layer by layer, consistent with the SEM results. The HRTEM images in Fig. 5b and c display lattice spacings of 0.289 nm, 0.322 nm and 0.232 nm, corresponding to the (008) and (321) planes of  $Bi_5O_7NO_3$  and the (111) plane of Ag, respectively. It can be obviously seen that Ag (as circled with red rings in Fig. 5b) is surrounded by  $Bi_5O_7NO_3$ , which further demonstrates that the Ag-decorated  $Bi_5O_7NO_3$  composite has been successfully synthesized *via* the one-step SCS method.

As shown in Fig. 6a, the optical properties of the asprepared  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites were characterized by UV-vis diffuse reflectance spectroscopy (DRS). The optical absorption performance of semiconductors is evaluated on the basis of the band gap energy ( $E_g$ ) as calculated by eqn (1).<sup>34</sup>

$$\alpha h v = k (h v - E_g)^{n/2} \tag{1}$$

In eqn (1),  $\alpha$ , h, v, k, and  $E_g$  represent the absorption coefficient, Planck's constant, the light frequency, a constant and the band gap energy, respectively.<sup>34</sup> The value of n is determined by the type of optical transition in the semiconductor (n = 1 for direct transition and n = 4 for indirect transition). According to previous reports, Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> pertains to indirect transition and the value of n is set as 4.<sup>11</sup> The Tauc plots of the corresponding samples are shown in the inset of Fig. 6a. The band gap energies of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>, 3.3 mol% Ag, 5 mol% Ag and 10 mol% Ag composites are estimated to be 2.95 eV, 2.69 eV, 2.85 eV and 2.92 eV, respectively. As is shown, the

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Fig. 3 XPS survey spectrum of the 5 mol% Ag composite (a). High-resolution spectra of: Bi 4f (b), O 1s (c), N 1s (d) and Ag 3d (f).



Fig. 4 SEM images of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> (a), 3.3 mol% Ag (b) and 5 mol% Ag (c); EDS mapping images (d) for Bi (e), Ag (f), N (g) and O (h) of the 3.3 mol% Ag composite.



Fig. 5 The TEM (a) and HRTEM (b and c) images of the 5 mol% Ag composite.

calculated band gap energy of the Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites decreases with increasing Ag concentration, which can be ascribed to the increasing plasmon absorption of Ag particles at ~510 nm.<sup>33</sup> Fig. 6b indicates the PL spectra of the asprepared samples, in which PL spectra related to the transfer behavior of the photo-induced electrons and holes can reflect the separation efficiency of photo-generated charge carriers.<sup>35</sup> It appears that  $Ag/Bi_5O_7NO_3$  nanocomposites exhibit lower photoluminescence intensity than the pure  $Bi_5O_7NO_3$ , especially the 5 mol% Ag composite. A lower PL intensity generally indicates a lower recombination rate of charge carriers.<sup>36</sup> These observations imply that  $Ag/Bi_5O_7NO_3$  composites show





Fig. 6 (a) UV-vis diffuse reflectance spectra (DRS) of  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites. (b) PL spectra of  $Bi_5O_7NO_3$  and  $Ag/Bi_5O_7NO_3$  composites.

narrower band gap energies and lower recombination rates of electrons and holes as compared with pure Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>, both beneficial for the enhancement of the photocatalytic properties.<sup>34,37</sup>

The adsorption and photocatalytic activities of MO on pure Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites are shown in Fig. 7. The MO adsorption efficiency of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> achieves 25% in 30 min, remaining essentially constant (see Fig. 7a). The adsorption efficiencies for 3.3 mol% Ag, 5 mol% Ag and 10 mol% Ag composites are 27%, 33% and 29% in 30 min, respectively. As shown in Fig. 7b, all the samples exhibit good photocatalytic performance under ultraviolet and visible light irradiation for MO degradation. When Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> was employed, the photocatalytic efficiency was 64% at 60 min, while efficiencies for 3.3 mol% Ag, 5 mol% Ag and 10 mol% Ag composites were 87.9%, 95% and 92% in 60 min, respectively. These results indicate that Ag decoration significantly improves the photocatalytic performance of Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. In addition, it was found that the 5 mol% Ag composite shows the best photocatalytic performance among the various Ag/ Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites, which is approximately 1.5 times that of the pure Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub>. The photostability of the photocatalysts was evaluated through recycling experiments for the photodegradation of MO under ultraviolet and visible-light irradiation, as shown in Fig. 7c. The 5 mol% Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composite shows remarkable photostability, in which the MO degradation efficiencies are 95%, 92%, 90% and 90% for the 1st, 2nd, 3rd and 4th cycles, respectively.

The active species with powerful oxidation ability are typically produced during the photocatalytic process, such as superoxide radicals (O2<sup>-</sup>), hydroxyl radicals ('OH) and holes (h<sup>+</sup>).<sup>34</sup> To investigate the generated active species over the Ag/ Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites, trapping experiments were conducted. Various agents, including isopropyl alcohol (IPA),<sup>37</sup> 1,4benzoquinone (BQ)<sup>38</sup> and ammonium oxalate (AO),<sup>39</sup> were used as the reactive species scavengers for 'OH, O<sub>2</sub><sup>-</sup>, and h<sup>+</sup>, respectively. As shown in Fig. 8, addition of all the scavengers leads to the decrease of MO degradation efficiency, especially for BQ. The MO degradation efficiency sharply reduces to only 16% when BQ is used as the scavenger, while the presence of AO and IPA has a limited effect on the MO degradation, which is 89% and 86%, respectively. It is thus proposed that the reactive  $O_2^{-}$  species plays an important role in the MO photocatalytic degradation.

Based on the above experimental results, a likely mechanism is proposed for MO photocatalytic degradation over  $Ag/Bi_5O_7NO_3$  composites, as shown in Fig. 9. Upon the ultraviolet and visible light irradiation, photo-generated electrons and holes are produced on the  $Bi_5O_7NO_3$ . The Ag-decorated  $Bi_5O_7NO_3$  accepts the photogenerated electrons and prolongs the lifetime of charge carriers due to the surface plasmon resonance (SPR) effect,<sup>40,41</sup> leading to reduced recombination rates of electrons and holes, as well as the enhancement of photocatalytic efficiency, which is confirmed by the photoluminescence (PL) spectra. The photogenerated electrons on the Ag surface could react with  $O_2$  to form  $O_2^-$  species. The



Fig. 7 Time profiles of adsorption (a) and photocatalytic (b) properties of MO over the as-prepared samples and cyclic photocatalytic degradation experiments (c) of MO by the 5 mol% Ag composite under ultraviolet and visible light irradiation.



Fig. 8 Effect of different reactive species scavengers on the degradation of MO over the 5 mol% Ag composite.



Fig. 9 Photocatalytic mechanism of MO degradation over Ag/  ${\rm Bi}_5{\rm O}_7{\rm NO}_3$  composites.

reactive oxygen radical  $(O_2^-)$  can react with methyl orange (MO) to form  $CO_2$  and  $H_2O$  in the photocatalytic reaction,<sup>42</sup> which indicates that  $O_2^-$  is responsible for the degradation of MO.

## 4. Conclusions

In the present study, using bismuth nitrate, tartaric acid and silver nitrate as raw materials, Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> and Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites were successfully synthesized by a rapid and lowcost solution combustion synthesis (SCS) method, in which the Ag content was tuned by varying the AgNO<sub>3</sub> addition. It was found that the Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> contains nanosheets, while AgNO<sub>3</sub> addition enhances the nanosheet-like microstructure. Moreover, based on the EDS and TEM results, Ag is uniformly distributed over the Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> matrix. The 5 mol% Ag composite exhibits superior MO (methyl orange) photocatalytic degradation efficiency (95% in 60 min) under ultraviolet and visible-light irradiation, which is much higher than that of the pure Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> (64% in 60 min). The enhanced photocatalytic activity is likely due to the low recombination rate of photo-generated electron-hole pairs in Ag/Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites. A photocatalytic enhancement mechanism for Ag/ Bi<sub>5</sub>O<sub>7</sub>NO<sub>3</sub> composites is proposed based on active species trapping experiments, in which O<sub>2</sub><sup>-</sup> plays a significant role in degrading MO in the photocatalytic system. The present work

provides a new photocatalyst candidate, which can be rapidly prepared *via* the one-step SCS, for degradation of organic pollutants in water.

## Conflicts of interest

There are no conflicts to declare.

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