Photocatalytic Properties of $BiOCl/Bi_2WO_6$ Composite

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Abstract: $BiOCl/Bi_2WO_6$ composite was prepared by a hydrothermal synthesis method. The photocatalytic activity of the product was investigated by degrading Methyl Orange (MO) under visible light irradiation. The as-synthesized sample showed more efficient photocatalytic activity than that of single BiOCl or Bi_2WO_6 .

Keywords: Hydrothermal, photocatalysis, BiOCl, Bi_2WO_6, $BiOCl/Bi_2WO_6$.

1. INTRODUCTION

Semiconductor photocatalysis was extensively studied as a method for solving the problems of environment crises and energy crises [1-6]. Bi-based compounds have been paid much attention because of the excellent specific morphology and structure, among which BiOCl was a wide band gap semiconductor with unique layered structure [7]. It was interesting that we can control morphology, dope with metal ion and compound other semiconductor to improve properties of BiOCl and practical applications [8-13]. Zhang [14] *et al.* synthesized Fe_3O_4/BiOCl nanocomposite with highly efficient activity. Cao [15] *et al.* demonstrated the chemical etching preparation of BiOI/BiOBr heterojunction photocatalysts, which showed an excellent photocatalytic performance. Our group [16] reported the preparation and photocatalytic properties of $BiOCl/Bi_2MoO_6$. The results indicated that the composite exhibited the higher photocatalytic activity than single BiOCl or Bi_2MoO_6. In this paper, we synthesize $BiOCl/Bi_2WO_6$ composite photocatalyst *via* hydrothermal synthesis method. The photocatalytic activity was evaluated by degrading MO under visible light irradiation.

2. EXPERIMENTAL

2.1. Synthesis of BiOCl

BiOCl powder was synthesized by a hydrolysis method. Firstly, $Bi(NO_3)_3$•$5H_2O$ and $BiCl_3$ were dissolved in 50 ml of ethanol. After stirring for 30 minutes, the mixture was transferred into a Teflon-lined autoclave and kept at 170 ℃ for 13 hours. Then the autoclave was cooled down to room temperature naturally, after which the precipitates were collected and washed, dried at 60 ℃ for 3 h .

2.2. Preparation of Bi_2WO_6 and $BiOCl/Bi_2WO_6$

Bi_2WO_6 powder was prepared in a manner similar to that used hydrolysis method except for Na_2WO_4•$2H_2O$ being used instead of $BiCl_3$. $BiOCl/Bi_2WO_6$ powder was also synthesized in the same way apart from Na_2WO_4•$2H_2O$ being added to the mixture.

2.3. Characterization

The powder samples were analyzed by X-ray Diffraction(XRD) on a Bruker D8 diffractometer with Cu Kα radiation. The morphology of the products was observed by the Hitachi S-4800 Scanning Electron Microscope(SEM).

The photocatalytic activity of the samples was characterized by degrading MO at room temperature. A 300 W Xe lamp was used as the visible light source, mounted 30 cm away from the reaction solution. 60 mg of the sample was added in 60 ml MO aqueous solution (10 mg/L) with stirring for 30 min in the dark for the adsorption-desorption equilibrium. Then the solution was stirred under the lamp. After each 10 minutes 6ml solution was extracted to be analyzed for the decreasing concentration of the MO solution and the percentage of degradation.

3. RESULTS AND DISCUSSION

3.1. Phase Analysis

Figure **1** shows the XRD patterns of the samples. Both BiOCl and Bi_2WO_6 displayed pure phases corresponding JCPDS card 06-0249 (a = 3.891 Å and c = 7.369 Å) and card 39-0256 (a=5.456 Å, b=16.435 Å, and c=5.438 Å). No other phase and peak of impurities were observed.

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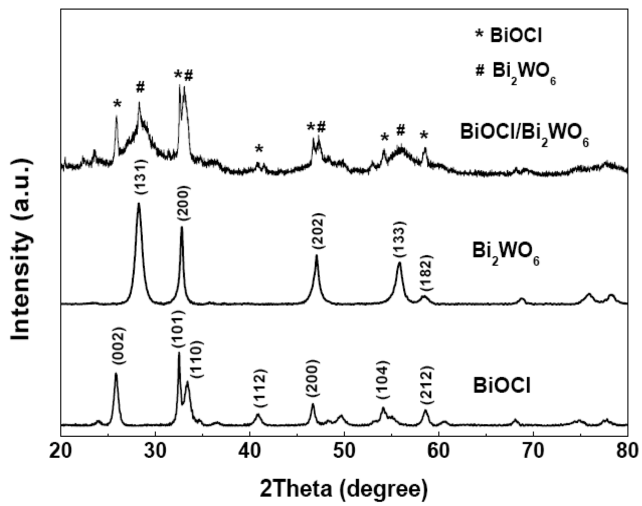

Figure 1: XRD patterns of BiOCl, Bi_2WO_6 and BiOCl/Bi_2WO_6.

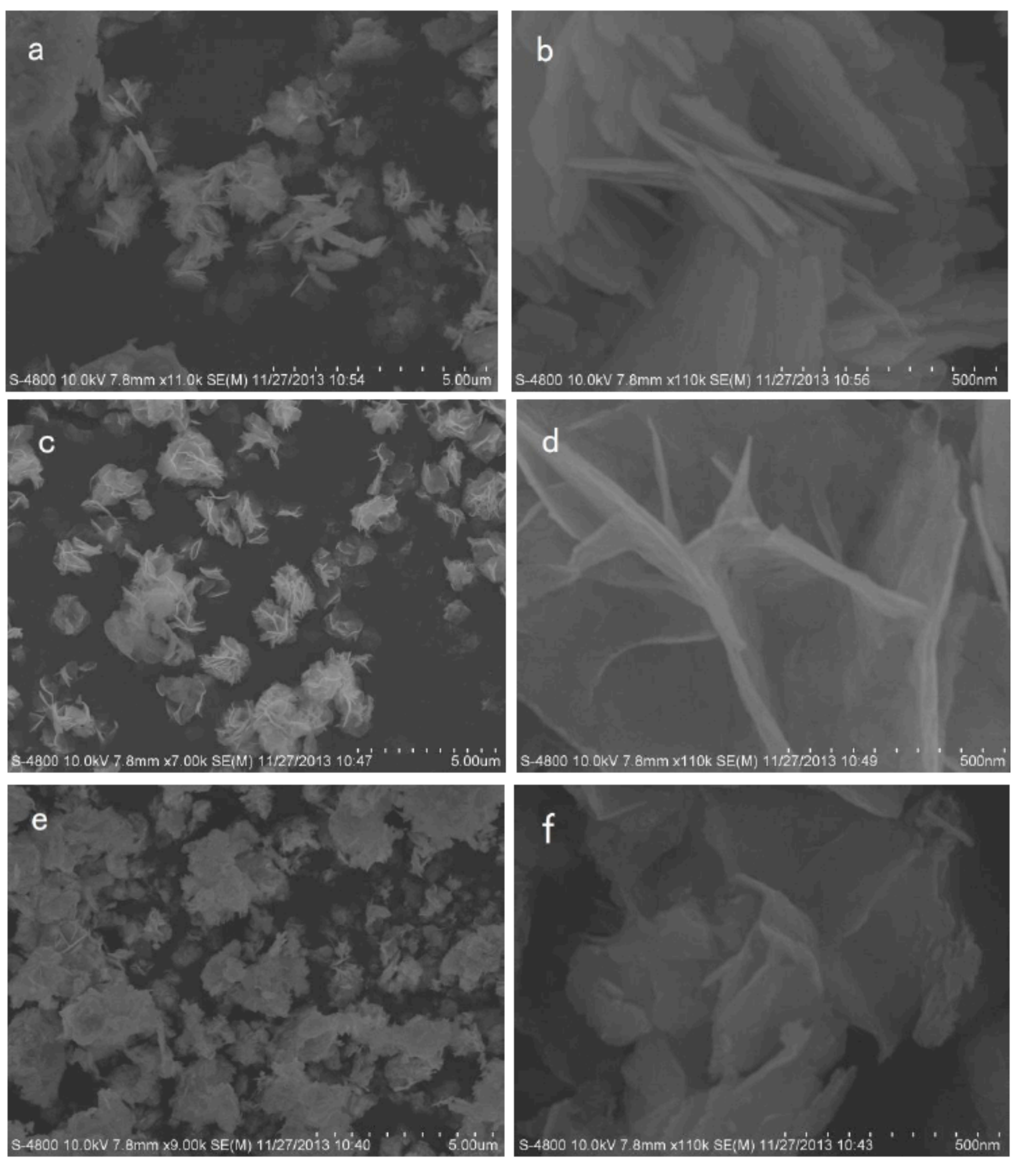

Figure 2: SEM images of (**a,b**) BiOCl, (**c,d**) Bi_2WO_6, (**e,f**) BiOCl/Bi_2WO_6.

3.2. Surface Morphology

The SEM analyses of the samples are showed in Figure **2**. Pure BiOCl is composed of messy nano-sheets with the thickness of about 50 nm. The Bi_2WO_6 presents petal-like microstructure with the petal thickness of 50 nm. The $BiOCl/Bi_2WO_6$ composite are organized by hundreds of thin nanoplates with a thickness of 20nm.

3.3. Photocatalytic Activity

The concentration change of MO degraded by the samples is shown in Figure **3**. When the photocatalytic reactions proceeded for 50 minutes, the concentrations of the MO degradation over the BiOCl and Bi_2WO_6 were 57.1% and 73.4%, respectively. Where as 76.9% of MO was completely degraded by the $BiOCl/Bi_2WO_6$ composite after 50 min. It indicates that $BiOCl/Bi_2WO_6$ composite possesses the better photocatalytic activity than the single compound. Presumably the enhancement of the photocatalytic activity originates from the unique matching band structures of $BiOCl/Bi_2WO_6$ composite, in which the photogenerated electrons on Bi_2WO_6 can inject freely into the CB of BiOCl while the holes can move toward the VB of Bi_2WO_6 so that the electrons and holes are separated effectively. Besides, the high surface area of $BiOCl/Bi_2WO_6$ nanostructure is also beneficial for improving the photocatalytic activity.

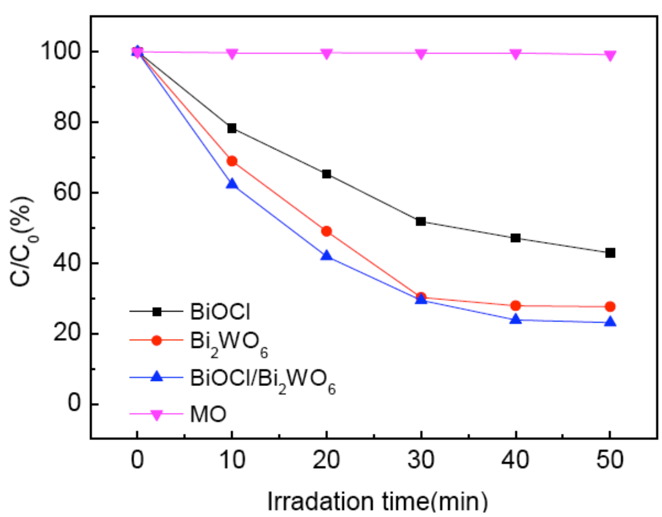

Figure 3: Photocatalytic degradation efficiencies of MO over BiOCl, Bi_2WO_6 and $BiOCl/Bi_2WO_6$.

4. CONCLUSION

In summary, we have successfully prepared the $BiOCl/Bi_2WO_6$ composite photocatalyst *via* hydrothermal method. It is organized by hundreds of thin nanoplates which is shown in SEM. The photodegradation of MO organic dye shows that the $BiOCl/Bi_2WO_6$ has superior photocatalytic activity than that of single BiOCl or Bi_2WO_6.

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