Inorganic Chemistry Communications 71 (2016) 45–49

Contents lists available at ScienceDirect

Inorganic Chemistry Communications

journal homepage: www.elsevier.com/locate/inoche

Facile one-step synthesis of BiOCl/BiOI heterojunctions with exposed {001} facet for highly enhanced visible light photocatalytic performances

Xiang Yu [a,b,1], Jinjin Yang [a,1], Kaihang Ye [a], Xionghui Fu [a], Yi Zhu [a,*], Yuanming Zhang [a]

[a] Department of Chemistry, Jinan University, Guangzhou 510632, PR China
[b] Analytical & Testing Center, Jinan University, Guangzhou, 510632, PR China

ARTICLE INFO

Article history:
Received 12 March 2016
Received in revised form 28 June 2016
Accepted 30 June 2016
Available online 2 July 2016

Keywords:
Photocatalyst
Heterojunctions
{001} facet
Electron injection

ABSTRACT

Flowers-like structure BiOCl/BiOI heterojunctions with exposed {001} facets have been prepared by a facile one-step hydrothermal method. The 70% BiOCl/BiOI heterojunction exhibited the highest photocatalytic activity. The highly enhanced visible light photocatalytic performance was mainly ascribed to the synergistic effect of {001} crystal facets, sensitization of RhB, increasing photo absorption and heterojunctions. The synergistic effect of coupled system could open up new opportunities to develop high-performance photocatalysts for degradation of organic pollutants in water.

Contents

1. Introduction

In recent years, photocatalysis techniques have been suggested as the most promising methods response to pollution and energy crisis [1–3]. In all of such photocatalysts, bismuth oxyhalide (BiOX, X = Cl, Br, I) has drawn worldwide attention due to its unique layered-structure which is composed of $[Bi_2O_2]$ slabs interleaved with double halogen atoms along c-axis [4–8]. The strong interlayer covalent bonding of $[Bi_2O_2]$ slabs and the weak interlayer van der Waals interaction result in an efficient separation of photoinduced electron–hole pairs, which make BiOX an excellent photocatalyst for potential applications in environmental remediation and energy conversion [9–10]. Unfortunately, due to the inherent drawbacks (band gap, light harvesting, less activity sites, and so on), BiOX photocatalytic efficiency is still low which incapacitates their practical applications. In order to overcome these drawbacks, various methods have been developed to enhance the photocatalytic performance [11–13], such as cocatalyst [14–15], doping [16–17], sensitization [18–19], internal electric field tuning [5], defect introduction [20–21], crystal facet engineer [22], heterojunction construction [23–24] and so on. Among them, But using single measure is far from enough, coupling with two or more strategies could be a good choice, so that we can utilize synergistic effect to improve photocatalytic activity [25]. Li et al. [26] has synthesized BiOCl/BiOI composites with enhanced visible light photocatalytic activity by a simple hydrothermal method. They attributed the high photocatalytic activity to the coupled system of BiOCl/BiOI. But they didn't explain the effect of the crystal

* Corresponding author.
E-mail address: tzhury@jnu.edu.cn (Y. Zhu).
[1] Xiang Yu and Jinjin Yang equally contributed to this work.

http://dx.doi.org/10.1016/j.inoche.2016.06.034
1387-7003/

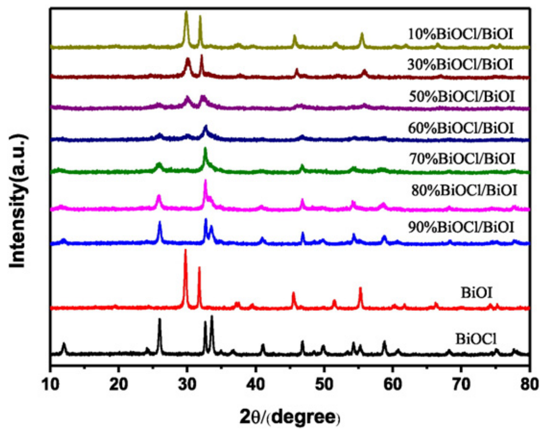

Fig. 1. XRD pattern of as-prepared samples.

facets of the photocatalyst. Sun et al. [27] reported that BiOCl/BiOI heterojunctions with special crystal facets could be used as excellent photocatalyst in decomposing RhB. However, the synthetic methods require complicated multi-step synthesis.

In this paper, we designed and prepared BiOCl/BiOI heterojunctions with exposed {001} facets by a facile one-step hydrothermal method. The structures, morphologies, optical properties and photocatalytic properties were studied. The as-prepared photocatalysts showed high visible-light photocatalytic activity toward degradation of RhB and excellent recyclability. At the same time, the possible photocatalytic mechanisms of the BiOCl/BiOI composites coupled system were discussed by different experiments accordingly. The experimental section was in the Supplementary material.

2. Characterization

XRD pattern was measured by X-Ray Diffractometer (XRD, D8 ADVANCE). The surface morphology of samples was obtained using field emission scanning electron microscope (FE-SEM, ULTRA 55, Zeiss company). The transmission electron microscopy (TEM) images, high resolution transmission electron microscopy (HREM) images, selected area electron diffraction (SAED) images and elements composition mapping images were carried on field emission transmission electron microscopy equipped with Oxford energy dispersive X-ray (EDS) analysis system (JEOL company, JEM-2100F). The photocatalytic properties of the products were measured with UV–Vis-NIR Spectrophotometer (UV–Vis-NIR, Shimadzu, UV-2450). The visible-light photodegradation of rhodamine B (RhB) was characterized by a 350 W Xe arc lamp.

3. Discussion

As XRD pattern in Fig. 1 showed, all the peaks could be ascribed to pure tetragonal phases of BiOI (JCPDS No.10-0445) and BiOCl (JCPDS No. 06-0249), respectively. Along with the increase of BiOCl content, the characteristic peaks of BiOI become more and more intense. It could be indicated that BiOI and BiOCl coexisted in a mixed composite. Interestingly, the broad and weak (001) diffraction peak of BiOCl/BiOI

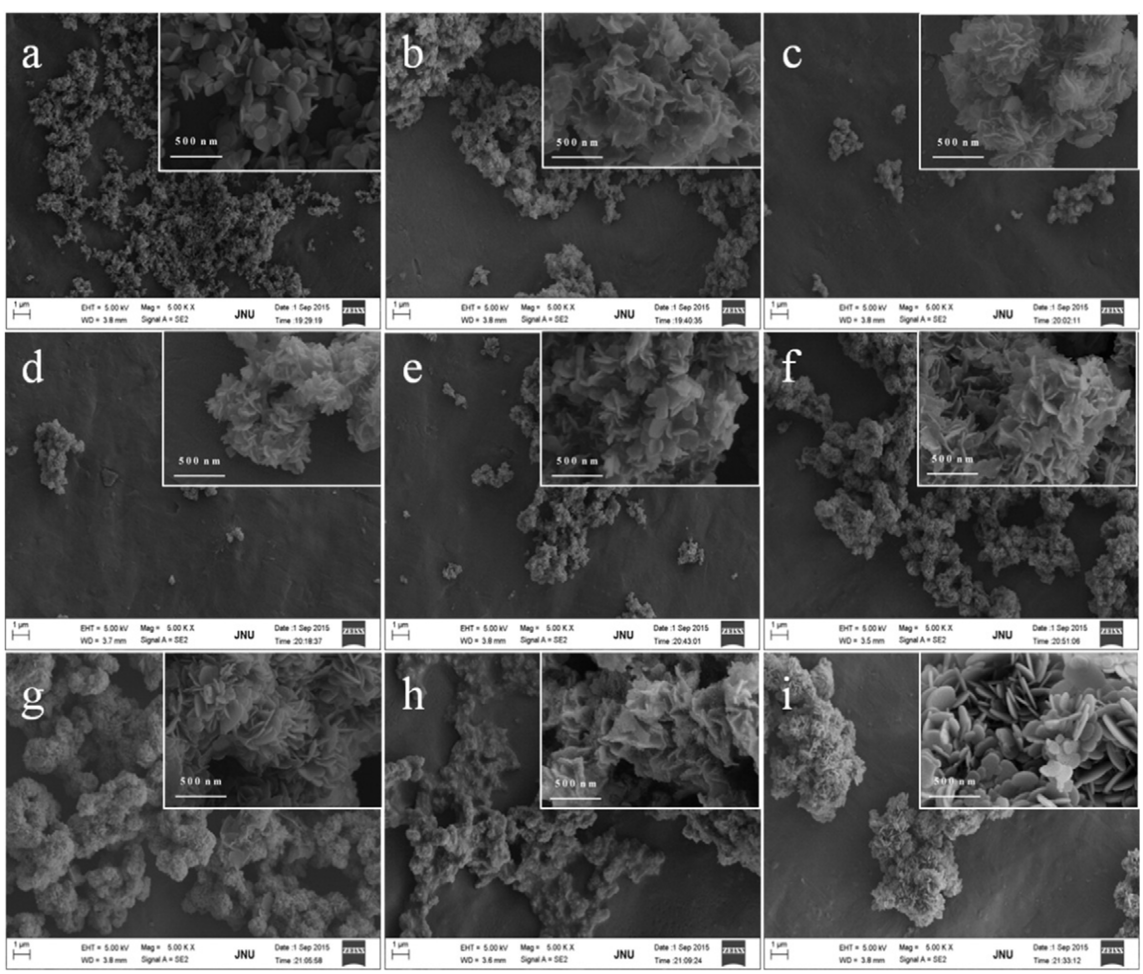

Fig. 2. FE-SEM images of as-prepared products: (a) BiOCl, (b) 10% BiOCl/BiOI, (c) 20% BiOCl/BiOI, (d) 30% BiOCl/BiOI, (e) 40% BiOCl/BiOI, (f) 50% BiOCl/BiOI, (g) 70% BiOCl/BiOI, (h) 90% BiOCl/BiOI, (i) BiOI.