Chemical Engineering Journal 200–202 (2012) 521–531

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Magnetically recoverable Bi_2WO_6–Fe_3O_4 composite photocatalysts: Fabrication and photocatalytic activity

Xiang Xu [a], Xiaoping Shen [a,*], Guoxing Zhu [a], Liquan Jing [a], Xiansheng Liu [a], Kangmin Chen [b]

[a] School of Chemistry and Chemical Engineering, Jiangsu University, Zhenjiang 212013, PR China
[b] School of Materials Science and Engineering, Jiangsu University, Zhenjiang 212013, PR China

HIGHLIGHTS

- ▶ The Bi_2WO_6–Fe_3O_4 photocatalysts were synthesised by a simple hydrothermal route.
- ▶ Morphological modulation of the products could be easily realized by tuning the pH.
- ▶ The products can effectively photocatalyze the degradation of RhB as a probe reaction.
- ▶ The visible light photocatalysts can be easily harvested by a magnet.

ARTICLE INFO

Article history:
Received 10 January 2012
Received in revised form 15 June 2012
Accepted 21 June 2012
Available online 29 June 2012

Keywords:
Bismuth tungstate
Fe_3O_4
Composite
Magnetic property
Photocatalyst

ABSTRACT

Three-dimensional (3D) hierarchical Bi_2WO_6–Fe_3O_4 microspheres were successfully synthesized by a simple hydrothermal route. These microspheres with average diameters of 2–3 μm are constructed by Bi_2WO_6 nanosheets, which are decorated by Fe_3O_4 nanoparticles with an average diameter of 150 nm. Morphological modulation of the obtained products could be easily realized by tuning the pH value of the reaction system. The photocatalytic properties of the composites were studied with the photo-degradation of Rhodamine B (RhB) as a probe reaction. Comparing with bulk Bi_2WO_6 (SSR-Bi_2WO_6) and TiO_2 (P25), Bi_2WO_6–Fe_3O_4 microspheres show improved photocatalytic activity under visible light irradiation, and can efficiently catalyze the degradation of RhB up to 98.6% within 150 min. Kinetic analysis reveals that the reaction rate constant k of Bi_2WO_6–Fe_3O_4 microspheres is over three times that of P25 and nearly seven times that of SSR-Bi_2WO_6. The Bi_2WO_6–Fe_3O_4 photocatalyst can be easily re-collected from the reaction system upon applying an external magnetic field. This kind of composite photocatalysts with easiness of separation can have potential applications in water treatment and environmental cleaning.

1. Introduction

Semiconductor photocatalysts have attracted much attention because of their applications in solving potential environmental and energy crises [1]. A high-performance photocatalyst should possess a structure appropriate for rapid separation of photogenerated charges, a large specific surface area for many catalytically active sites, and a fair response to visible light so as to maximally utilize sunlight energy [2–12]. Among various semiconductor visible light driven photocatalysts, the Aurivillius phase oxides with general formula $Bi_2A_{n-1}B_nO_{3n+3}$ (A = Ca, Sr, Ba, Pb, Na, K, and B = Ti, Nb, Ta, Mo, W, Fe) have gained much attention due to their layer structure and unique properties [13,14]. Bismuth tungstate (Bi_2WO_6), which is one of the simplest members of the Aurivillius oxide family, possesses excellent visible light driven photocatalytic activity besides many interesting physical properties such as ferroelectric piezoelectricity, pyroelectricity, nonlinear dielectric susceptibility, oxide anion conducting, and luminescent properties [15–20]. Since Kudo and Hijii first demonstrated the photocatalytic activity of Bi_2WO_6 for O_2 evolution in $AgNO_3$ solution [21], many research efforts have been focused on developing various Bi_2WO_6 micro-/nanostructure and investigating their photocatalytic performance under the visible light irradiation, such as square nanoplates [19], hierarchical hollow spheres [22], flower-like microstructures [23] and clew-like structures [24]. However, one important issue of the industrial application for Bi_2WO_6 catalysts is their separation. The obtained Bi_2WO_6 usually has a hydrophilic surface, which make it be easily dispersed in water and would enhance the catalytic properties, but will increase the difficulty of its

* Corresponding author. Tel./fax: +86 511 88791800.
E-mail address: xiaopingshen@163.com (X. Shen).

1385-8947/$ - see front matter
http://dx.doi.org/10.1016/j.cej.2012.06.104