Chemical Engineering Journal 215–216 (2013) 740–746

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Microwave-assisted synthesis of nano-scale $BiVO_4$ photocatalysts and their excellent visible-light-driven photocatalytic activity for the degradation of ciprofloxacin

Weidong Shi *, Yan Yan, Xu Yan

School of Chemistry and Chemical Engineering, Jiangsu University, Xuefu Road 301, Zhenjiang 212013, PR China

HIGHLIGHTS

- ▶ The organic additives-free microwave-assisted synthetic method for $BiVO_4$ photocatalysts was developed.
- ▶ The as-prepared sample exhibits a unique strawberry-like structure.
- ▶ The 2 wt.% Pt loaded samples greatly outperform the pure $BiVO_4$ sample in CIP degradation.
- ▶ A tentative mechanism of charge transfer process in CIP degradation was proposed.

ARTICLE INFO

Article history:
Received 14 June 2012
Received in revised form 29 September 2012
Accepted 1 October 2012
Available online 21 November 2012

Keywords:
Microwave-assisted synthesis
Visible-light-driven
$BiVO_4$
Photocatalytic degradation
Ciprofloxacin

ABSTRACT

New-type synthetic methods of $BiVO_4$ photocatalysts with high visible-light-driven photocatalytic activity are much desired. In this study, the branched $BiVO_4$ nanocrystal photocatalysts were successfully synthesized by a facile microwave-assisted method. They have unique strawberry-like structure with 5 nm sized mastoids scattered on the 200 nm sized particle surface. The obtained photocatalyst exhibits excellent visible-light response (Eg = 2.5 eV) and super-high activities in degradation of ciprofloxacin (CIP). After Pt loading, the photocatalytic activities of branched $BiVO_4$ photocatalysts were enhanced tremendously. Pt nanocrystals on the particle surface not only act as charge collectors and transporters but also produce many active sites. The 2 wt.% Pt loaded $BiVO_4$ nanocrystal photocatalysts exhibit the CIP visible-light-driven photodegradation ratio of 91.97%, which show enhancement of ca. 25% compared with undecorated pure $BiVO_4$ photocatalysts.

1. Introduction

As is well known, ciprofloxacin (CIP) is a famous broad-spectrum antibacterial agent widely used for treating bacterial infection. It is widely found in aquatic environments, which may pose serious threats to the ecosystem and human health by inducing proliferation of bacterial drug resistance. The removal of CIP from the environment became a mandatory issue. Unfortunately, the conventional degradation processes lack of enough efficiency for its removal. The photocatalytic degradation processes provide a good tool for the transformation and degradation of CIP. Recently, some studies on the high-efficiency photocatalytic degradation of CIP by semiconductor-based (such as TiO_2 and ZnO) photocatalyst have been reported [1–4]. Until now, the photocatalyst with the highest photodegradation ratio of CIP is the Fe^{2+}/Fe^{3+} immobilized on TiO_2/fly-ash cenospheres from Yan et al. which only can reach 80% in 60 min under visible light irradiation [4]. Therefore the visible-light-driven photocatalyst with higher photo-degradation ratio is still desired.

As a ternary oxide semiconductor, $BiVO_4$ has been recognized to be an effective visible-light-driven photocatalyst for applications of dye-treatment in wastewater [5–11] and oxygen production from water splitting [12–14]. Besides the decoloration of dye, the photodegradation of antibiotics by $BiVO_4$-based photocatalysts have also been reported [15]. So $BiVO_4$ can be considered as an ideal candidate of the photocatalyst for the visible-light-driven degradation of CIP due to its high efficiency and broad photo-response. But, the lack of synthetic methods for $BiVO_4$ photocatalyst with small size and high surface area has vastly restricted its application. Thus, it is also much desired to develop a new synthetic method for $BiVO_4$ photocatalyst with high photocatalytic activities.

Microwave-assisted synthesis has been developed to be a facile synthetic method for inorganic nano-scale materials due to its

* Corresponding author.
E-mail address: swd1978@ujs.edu.cn (W. Shi).

1385-8947/$ - see front matter
http://dx.doi.org/10.1016/j.cej.2012.10.071