Chemical Papers 67 (10) 1277–1284 (2013)
DOI: 10.2478/s11696-013-0395-8

ORIGINAL PAPER

Efficient photodegradation of resorcinol with Ag_2O/ZnO nanorods heterostructure under a compact fluorescent lamp irradiation

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Received 2 November 2012; Revised 18 January 2013; Accepted 23 January 2013

Ag_2O/ZnO heterostructure has been recently synthesized using a facile chemical-precipitation method. X-ray diffraction, field-emission scanning electron microscopy, transmission electron microscopy, and energy dispersive X-ray spectroscopy results confirmed the Ag_2O nanoparticles loading on ZnO nanorods. The Ag_2O addition increased the visible light absorption ability and a red shift for Ag_2O/ZnO heterostructure appeared when compared to pure ZnO. Photoluminescence spectra showed lower emission yield on the Ag_2O/ZnO heterostructure than on pure ZnO. Such a decrease in the emission yield represents the fraction of the excited state Ag_2O sensitizer involved in the charge injection process. Under compact fluorescent lamp irradiation, the Ag_2O/ZnO heterostructure demonstrated higher photocatalytic activity than pure ZnO in the degradation of resorcinol, which can be attributed to the high separation efficiency of the photogenerated electron-hole pairs based on the cooperative roles of Ag_2O loading on ZnO nanarods. All these characteristics represent a significant contribution of the Ag_2O/ZnO heterostructure to the practical applications in indoor environmental remediation.

Keywords: zinc oxide, silver(I) oxide, heterostructure, photocatalytic, resorcinol

Introduction

Synthesis of photocatalysts based on titanium(IV) oxide (TiO_2) and zinc oxide (ZnO) materials for the degradation of dyes and other hazardous pollutants has attracted much interest in the last two decades (Nayak et al., 2008; Padervand et al., 2011; Sin et al., 2011; Lam et al., 2012). Nevertheless, the rapid recombination of the electron-hole pairs has prevented practical application of this technique. To address this lapse, several studies focusing on the reduction of the recombination rate of electron-hole pairs have been done. It has been established that coupling of semiconductor metal oxides with different band gap widths is an efficient method to improve the photocatalytic activity by prolonging the separation of charge carriers and extending the energy range of photoexcitation. So far, metal oxides like copper(II) oxide (CuO) (Barreca et al., 2011a, 2011b, 2011c; Maccato et al., 2012), tin dioxide (SnO_2) (Hirano et al., 2011), iron(III) oxide (Fe_2O_3) (Ghorai et al., 2011), tungsten trioxide (WO_3) (He et al., 2011), and rare earth oxides (Li et al., 2011a) have been coupled with TiO_2 or ZnO materials to improve their photocatalytic activities.

Depositing noble metals including Ag, Au, and Pt on the surfaces of TiO_2 and ZnO materials has been proven to be another efficient route to enhance their photocatalytic activities (Coleman et al., 2005; Li et al., 2011b; Simon et al., 2011, 2012). In particular, the deposition of Ag nanoparticles on ZnO can depress the recombination of the charge carriers and thereby increase their lifetime via the conduction band electron trapping (Gao et al., 2011). Although many promising results have been obtained, scant attention has been

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