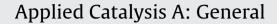
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Photocatalytic activity of single and mixed nanosheet-like Bi₂WO₆ and TiO₂ for Rhodamine B degradation under sunlike and visible illumination

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ARTICLE INFO

Article history: Received 14 November 2011 Received in revised form 23 January 2012 Accepted 14 February 2012 Available online 22 February 2012

Keywords: Photocatalysis Bi₂WO₆ TiO₂ Rhodamine B Sunlike illumination

ABSTRACT

The photocatalytic activity, under sunlike illumination, for Rhodamine B (*RhB*) degradation using Bi_2WO_6 -TiO₂ samples, is reported. Two different kinds of Bi_2WO_6 -TiO₂ samples were studied, obtained by distinct methods: first, a mechanical mixing, by adding to synthesized nanosheet-like Bi_2WO_6 powder the corresponding amount of TiO₂ nanoparticles (P25) in order to obtain physical mixtures of both catalysts with different percentages of TiO₂ (5, 10 and 50 wt%); second, a single Bi_2WO_6 -TiO₂ heterostructure was prepared by adding commercial TiO₂-P25 to the Bi_2WO_6 precursors (50 wt%) prior to the hydrothermal treatment, thus obtaining a sample with "in situ" TiO₂ incorporation. Comparisons between the photocatalytic behaviour of these samples and those exhibited by the single materials Bi_2WO_6 and TiO₂ (P25) were carried out, in order to establish the effect not only of the TiO₂ addition but also of the way in which TiO₂ (P25) is incorporated. The role of each single photocatalyst in the mixtures in the *RhB* degradation and mineralization under sunlike and just visible illumination was also studied.

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1. Introduction

It is widely recognized that TiO_2 is one of the most significant inorganic photocatalytic materials [1–3]. The relatively high quantum yield and its elevated stability are the key reasons for the preponderance of this semiconductor, which has become a virtual synonym for photocatalysts. However, it is only under the illumination of ultraviolet rays that it has high photocatalytic activity, and this fact has profoundly influenced the latter research in photocatalysis, so that modification of TiO_2 to achieve efficient photoactivation in the visible spectrum is an active field of research [4–11].

With the aim of obtaining enhanced photocatalytic performance, many studies on different modifications of TiO_2 have been performed [2,11–13]. Moreover, during the last few years an increasingly great number of new photocatalysts have been synthesized and tested as possible alternatives to TiO_2 to improve its spectral absorption range or the dynamic of charge carrier separation [14–16]. However, though a significant number of these new photocatalysts adequately perform under visible light, they typically display poor performance with respect to TiO_2 commercial references (e.g., Degussa P25) under sunlight [17,18].

In general terms, it can be said that photocatalytic activities are closely related to the structure of the photocatalysts [19–24]. This can be specially contemplated in Aurivillius based compounds, which form hierarchical structures with specific morphology and high order. These compounds have been considered concerning their role in the systematic study of structure-property relationships. In fact, several Aurivillius based compounds have been reported to exhibit interesting properties for photocatalytic applications. Among these, Bi₂WO₆ is the simplest member and perhaps the most studied example within this family [25-30]. Additionally, considerable effort has been taken to synthesize these hierarchical photocatalysts with small size so as to increase the separation rate of photoinduced charge carriers and consequently to achieve high activities [25]. An important point that must be stressed here is that in most cases the photocatalytic experiments reported for those systems were carried out using only visible illumination $(\lambda > 400 \text{ nm})$ instead of UV–vis light. Thus, the comparison with TiO₂-based systems arises difficult and it is complicated to ascertain that these single phase photocatalysts are a real firm alternative to TiO_2 for solar applications. And thus, even though TiO_2 (P25) is among the most widely used materials utilized as standard photocatalyst, it suffers a practical drawback: the band-gap of 3.2 eV limits the light absorption features of this TiO₂ to the UV region.

In a previous paper, some of us reported the improved photocatalytic activity of Bi_2WO_6 -TiO₂ heterostructures when sol-gel TiO₂ was prepared simultaneously with Bi_2WO_6 [31]. Based on a wide structural and morphological characterization, it was shown that Bi_2WO_6 -TiO₂ heterostructures presented a particular

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⁰⁹²⁶⁻⁸⁶⁰X/\$ - see front matter © 2012 Elsevier B.V. All rights reserved. doi:10.1016/j.apcata.2012.02.016