Chemical Engineering Journal 215–216 (2013) 591–599

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Visible light-induced efficiently oxidative decomposition of p-Nitrophenol by CdTe/TiO_2 nanotube arrays

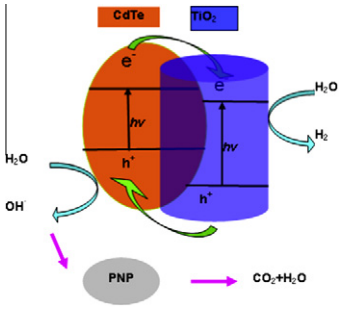
Hui Feng [a,b], ThanhThuy Tran. T [a,c], Lan Chen [a], Lijuan Yuan [a], Qingyun Cai [a,*]

[a] State Key Laboratory of Chemo/Biosensing and Chemometrics, College of Chemistry and Chemical Engineering, Hunan University, Changsha, IN 410082, China
[b] Department of Chemistry and Chemical Engineering, Hunan Arts and Sciences College, Changde, Hunan Province 415000, China
[c] Department of Chemistry, Ho Chi Minh City University of Industry, Ho Chi Minh, Viet Nam

HIGHLIGHTS

- CdTe/TiO_2 NTAs composites was prepared by pulse electrodeposition method.
- The composites shows high photocatalytic activity and stability for PNP degradation.
- Effect of CdTe amount, initial concentration, pH and hole scavengers was studied.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 13 June 2012
Received in revised form 7 November 2012
Accepted 9 November 2012
Available online 17 November 2012

Keywords:
TiO_2
Nanotube arrays
CdTe
p-Nitrophenol
Photocatalytic
Degradation

ABSTRACT

The photocatalytically oxidative decomposition of p-Nitrophenol (PNP) with the CdTe nanoparticles-modified TiO_2 nanotube arrays (CdTe/TiO_2 NTAs) as catalyst was investigated under visible light ($400\ nm < \lambda < 800\ nm$) irradiation. The CdTe/$TiO_2$ NTAs show much higher degradation rate ($0.0312\ min^{-1}$) than the unmodified TiO_2 NTAs ($0.0071\ min^{-1}$). The enhanced photocatalytic activity is attributed to the extended absorption in the visible light resulting from the narrow-band-gap semiconductor CdTe and the effective separation of photogenerated carriers. The photocatalytic activity of the photocatalyst is decreased by hole scavengers, indicating an oxidative degradation route with the photogenerated holes acting as the oxidant.

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1. Introduction

Since 1976 when Carey et al. [1] successfully applied TiO_2 in the photocatalytical degradation of organic pollutants, TiO_2-based nanostructured materials have attracted great attentions of global environment and energy researchers. Among all of the TiO_2 nanostructured materials, vertically oriented TiO_2 nanotube arrays prepared on a Ti foil by electrochemical anodization have become exceedingly in demand [2–4]. However, the wide band gap of 3.2 eV (385 nm) for anatase and 3.0 eV (410 nm) for rutile limits its applications as a photocatalyst because that only the UV light can be absorbed. As UV light constitutes only 5% of the solar spectrum [5], 95% of the solar photons are useless for TiO_2 photocatalysts. Considering the efficient utilization of the visible light (accounting for 43% of the total sunlight) to generate electron–hole pairs for promoting photocatalytic redox reactions, it is therefore evident that any modification of the TiO_2-based photocatalysts resulting in a lowering of its band gap will represent a breakthrough in the field. Various semiconductor nanoparticles with narrow band gap, including CdS [6–8], PbS [6,9], Bi_2S_3 [6,10], CdSe [11,12], and

* Corresponding author.
E-mail address: qycai0001@hnu.edu.cn (Q. Cai).

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http://dx.doi.org/10.1016/j.cej.2012.11.044