Chemical Engineering Journal 219 (2013) 225–237

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Photo-Fenton like degradation of tetrabromobisphenol A with graphene—$BiFeO_3$ composite as a catalyst

Junjian An [a], Lihua Zhu [a], Nan Wang [a,*], Zhou Song [a], Zeyu Yang [b], Dongyun Du [b], Heqing Tang [b,*]

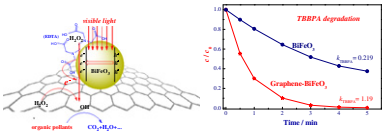
[a] College of Chemistry and Chemical Engineering, Huazhong University of Science and Technology, Wuhan 430074, PR China
[b] Key Laboratory of Catalysis and Materials Science of the State Ethnic Affairs Commission and Ministry of Education, College of Chemistry and Materials Science, South-Central University for Nationalities, Wuhan 430074, China

HIGHLIGHTS

- Graphene—$BiFeO_3$ composite is prepared by assembling $BiFeO_3$ nanoparticles on graphene sheets.
- The composite exhibits larger specific surface area than $BiFeO_3$.
- The composite exhibits much higher photo-Fenton like catalytic activity than $BiFeO_3$.
- TBBPA is efficiently degraded by photo-Fenton like process catalyzed by the composite.

GRAPHICAL ABSTRACT

Graphene—$BiFeO_3$ composites were synthesized by growing $BiFeO_3$ nanoparticles on graphene sheets. The composite exhibited good photo-Fenton like catalytic activity.



ARTICLE INFO

Article history:
Received 2 August 2012
Received in revised form 4 January 2013
Accepted 5 January 2013
Available online 12 January 2013

Keywords:
Graphene
$BiFeO_3$
Photo-Fenton process
Oxidative degradation
Tetrabromobisphenol A

ABSTRACT

Graphene—$BiFeO_3$ nanoscaled composites were prepared with a sol–gel method and evaluated as highly efficient photo-Fenton like catalyst under visible light irradiation. The graphene—$BiFeO_3$ composite had a specific surface area of 35.07 $m^2 g^{-1}$, being considerably larger than that of $BiFeO_3$ nanoparticles (7.50 $m^2 g^{-1}$). The composite exhibited excellent visible light-Fenton like catalysis activity, being influenced by calcination temperature, graphene content and solution pH value. Under optimal conditions with visible light irradiation, the graphene—$BiFeO_3$ composite yielded fast degradation of tetrabromobisphenol A with a apparent rate constant of 1.19 min^{-1}, which was 5.43 and 3.68 folds of that achieved by using $BiFeO_3$ and the mixture of $BiFeO_3$ and graphene, respectively. The significantly enhanced visible light-Fenton like catalytic properties of the graphene—$BiFeO_3$ composite in comparison with that of $BiFeO_3$ was attributed to a large surface area, much increased adsorption capacity and the strong electron transfer ability of graphene in the composite.

1. Introduction

Carbon materials including graphite, carbon black, activated carbon, carbon nanotubes, carbon nanofibers, etc., have aroused great attentions as catalyst carriers in the field of heterogeneous catalysis [1–3]. Graphene is a new type of carbon materials. Owing to the perfect two-dimension cycle planer structure, graphene can function as an excellent catalyst carrier. Mastalir et al. prepared Pd—graphene oxide nanoparticles by fixing Pd nanoscaled particles on graphene oxide and found that the Pd—graphene oxide nanoparticles showed high catalytic activity and selectivity towards the hydrogenation of ethyne in liquid phase [4]. Recently, TiO_2—graphene oxide composites were well reported for their applications in photocatalytic degradation of pollutants [5–7]. Graphene was also used to prepare composites with C_3N_4 [8], ZnS [9], ZnO [10] and $La_2Ti_2O_7$ [11] to improve photocatalytic performances of these catalysts.

Heterogeneous photo-Fenton processes have been found to show strong catalytic ability to remove organic pollutants. Bossmann et al. studied the reaction mechanism of the oxidative degradation of polyvinyl alcohol (PVA) by the photochemically enhanced

* Corresponding authors. Tel./fax: +86 27 87543632 (N. Wang), tel./fax: +86 27 67843323 (H. Tang).
E-mail addresses: wnanhust@yahoo.com.cn (N. Wang), hqtang62@yahoo.com.cn (H. Tang).

1385-8947/$ - see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.cej.2013.01.013