Journal of Water Process Engineering 10 (2016) 165–171

Contents lists available at ScienceDirect

Journal of Water Process Engineering

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

Enhanced photocatalytic activity of degradation of azo, phenolic and triphenyl methane dyes using novel octagon shaped BiOCl discs/MWCNT composite

S. Vadivel [a], J. Theerthagiri [b], J. Madhavan [b], T. Santhoshini Priya [c], N. Balasubramanian [c,*]

[a] Department of Chemistry, NGM College, Pollachi 642001, India
[b] Solar Energy Lab, Department of Chemistry, Thiruvalluvar University, Vellore 632115, India
[c] Department of Chemical Engineering, A. C. Tech Campus, Anna University, Chennai 600 025, India

ARTICLE INFO

Article history:
Received 20 September 2015
Received in revised form 9 November 2015
Accepted 2 December 2015
Available online 10 March 2016

Keywords:
BiOCl nanodiscs
Carbon nanotube
Hexamine
Electron hole recombination
Photodegradation

ABSTRACT

Novel octagon disc-like multiwall carbon nanotubes (MWCNT)/bismuth oxychloride (BiOCl) composite photocatalysts have been prepared through a one-pot hydrothermal process in the presence of hexamine as surfactant. The crystallanity and morphology of as prepared samples were studied by X-ray diffraction (XRD), Raman spectroscopy, scanning electron microscopy (SEM), transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). The MWCNT/BiOCl composite photocatalysts exhibited an obvious improved photocatalytic performance for congo red (CR), malachite green (MG) and bromophenol blue (BP) dye degradation. The photocatalytic studies shows that MWCNT could disperse and combine with BiOCl nanodiscs on its surface, which facilitated electron–hole separation, and contributed to improve the photocatalytic activity. A possible mechanism for the enhanced photocatalytic activity of MWCNT/BiOCl composite was also discussed.

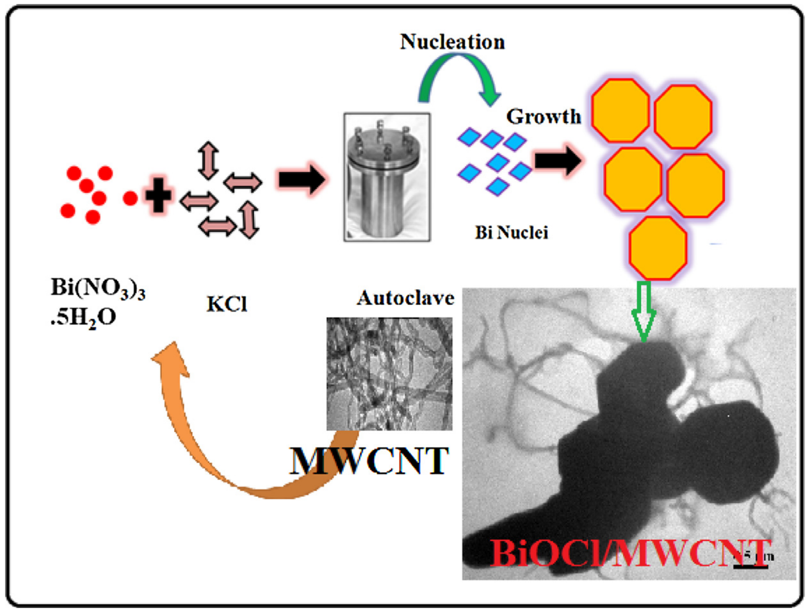
1. Introduction

With the growing needs in the environmental decontamination of hazardous and radioactive elements, photocatalysis process has been considered as most feasible and economic method to solve those problems [1,2]. TiO_2 is one of the earliest most extensively studied material for environmental remediation owing to its outstanding photocatalytic property, ease of synthesis, low cost, non toxic and highly stable under ambient conditions [3]. In the meantime TiO_2 free photocatalytic materials are however up to now in their infancy [4]. In recent years as alternatives to TiO_2, bismuth based photocatalysts such as BiOF, BiOCl, BiOI, BiOBr, $BiVO_4$, Bi_2O_3 and $BiWO_6$ have been studied in photocatalytic applications [5,6]. Among these BiOCl has been paid much attention because of its excellent optical, electrical and photocatalytic properties. BiOCl exhibits tetragonal structure consisting of [Cl–Bi–O–Bi–Cl] sheets stacked together by the nonbonding interaction through the Cl atoms along the c-axis [5,7]. The weak interlayer vanderwaals interaction and strong interlayer bonding of BiOCl give rise to high structural and optical properties which made BiOCl attractive in various applications. Presently the unique performances of BiOCl in photocatalytic degradation under both visible light and UV light irradiation have been given enormous importance [8]. However BiOCl still faces the similar challenges alike the most photocatalytic materials such as limited light absorption rate, energy loss and rapid recombination rate during degradation process [9,10]. Thus several researchers managed to enhance the photocatalytic properties by metal doping and hetereojunction formation to enhance the light absorption in semiconductors. A detailed study has been done by incorporating materials such as TiO_2, g-C_3N_4, BiOBr can also enhance the photocatalytic performance [11,6]. Therefore some investigations tried to improve the photocatalytic activity of BiOCl nanostructures by various carbanaceous materials to prevent the recombination rate.

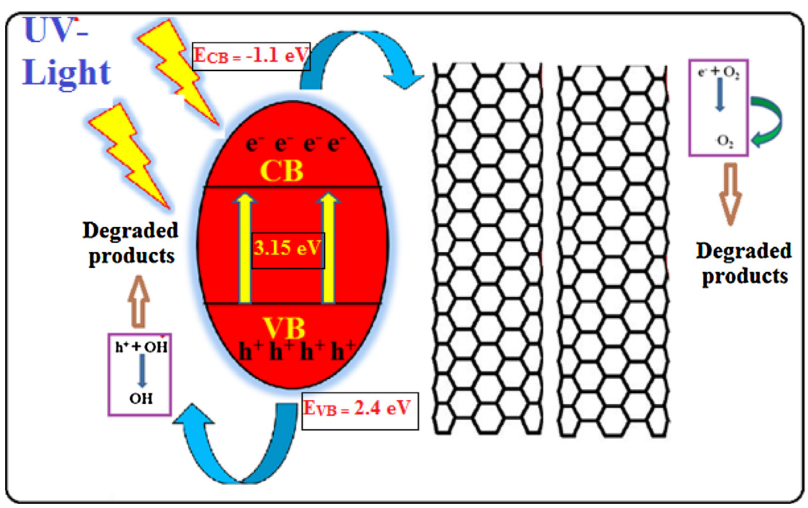
Meanwhile MWCNT represents another type of non metal 1-dimensional materials gained much attention due to their excellent mechanical, physiochemical and electronic properties [12]. With the advantages of high surface area MWCNT can be used as adsorbent in wastewater treatment for removing organic pollutants. Recently, MWCNT incorporated composites have been found to be effective in improving the charge transfer between the semiconductor interfaces and exhibit high photocatalytic activity, due to the hollow geometry and excellent charge transfer properties[13].

* Corresponding author.
E-mail addresses: nbsbala@annauniv.edu, nbsbala@gmail.com (N. Balasubramanian).

http://dx.doi.org/10.1016/j.jwpe.2015.12.001
2214-7144/



Scheme 1. Schematic illustration of methodology for the formation of BiOCl/MWCNT composite.



Scheme 2. Mechanism of the pathway of the BiOCl/MWCNT composite for the degradation of dyes.

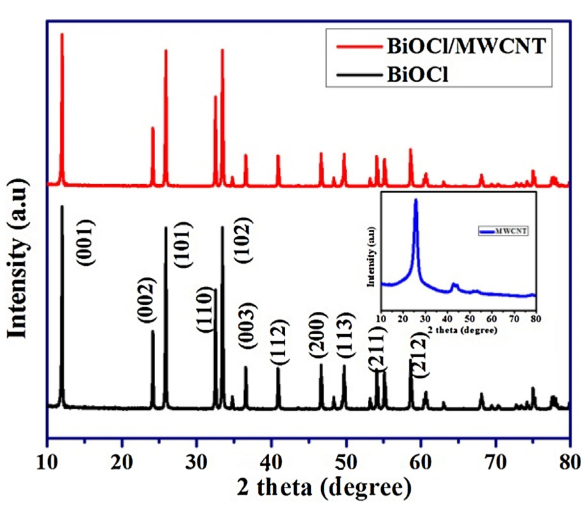


Fig. 1. XRD patterns of BiOCl, BiOCl/MWCNT composite (inset) MWCNT.

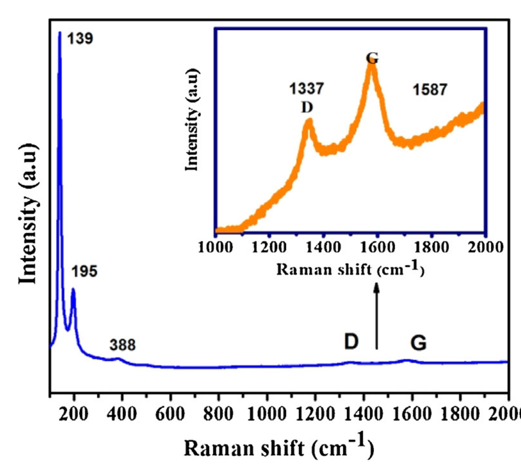


Fig. 2. Raman spectra of BiOCl/MWCNT composite (inset enlarged D & G bands of MWCNT).