

Synthesis SiO₂-TiO₂ nanocomposite materials; characterization and photocatalytic activity

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ABSTRACT: SiO₂-TiO₂ nanocomposite materials have been synthesized by Sonochemical method from tetraethylorthotitanate and tetraethylorthosilicate. The synthesized products were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infrared (FT-IR) spectrum, electron dispersive X-ray spectroscopy (EDX) and ultraviolet-visible (UV-Vis). The results revealed that compared to SiO₂ and TiO₂, SiO₂-TiO₂ nanocomposite materials display smaller crystal size, greater band gap energy. The photocatalytic activity of the synthesized products has been compared in the photodegradation activity of methylene orange (MO).

Keywords: *Methylene orange; Nanocomposite; Photocatalytic; Photodegradation; Sonochemical; Water purification*

INTRODUCTION

Water purification is one of the most important issues in environmental science and synthetic dyes are the main pollutant groups of wastewater. Even in low quantities, presence of dyes can cause serious environmental problems, for instance, growth of aquatic bacteria can be inhibited by interference of penetration of sunlight into water by organic dye molecules. Therefore, much effort has been made to reduce the concentration of organic dyes in the wastewater. Use of photocatalysts has been considered as one of the most promising ways of removing organic compounds from water.

Recently, a TiO₂/SiO₂ mixed oxide was reported to be more active as a photocatalyst than pure titania. The

addition of SiO₂ to TiO₂ enhances the thermal stability of the anatase phase and increases the surface area. Cheng, *et al.*, also reported that silica-doped TiO₂ possessed high photocatalytic activity due to the suppression of the anatase to rutile phase transition and the formation of oxygen vacancies (Gholami, *et al.*, 2013, Kim, *et al.*, 2012, Cheng, *et al.*, 2003).

MATERIALS AND METHODS

All of reagents and solvents were purchased from Merck (proanalysis) and were dried using molecular sieves (Linde 4 Å). XRD patterns were recorded by a Rigaku D-max C III, X-ray diffractometer using Ni-fil-

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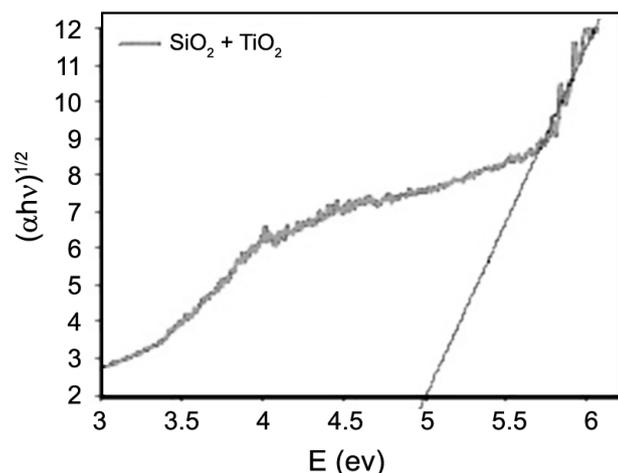


Fig. 1. The corresponding linear portion of the plots of $(\alpha h\nu)^{1/2}$ against $h\nu$

tered Cu K α radiation. Scanning electron microscopy (SEM) images were obtained on a Philips XL-30ES-EM equipped with an X-ray energy dispersive detector. Transmission electron microscopy (TEM) images were obtained on a Philips EM208 transmission electron microscope with an accelerating voltage of Paper Preparation

RESULTS AND DISCUSSION

The energy gaps of as-prepared product are shown (Fig. 1).

The photocatalytic activity of the SiO₂-TiO₂ nanocomposite materials was evaluated by monitoring the degradation of MO in an aqueous solution, under irra-

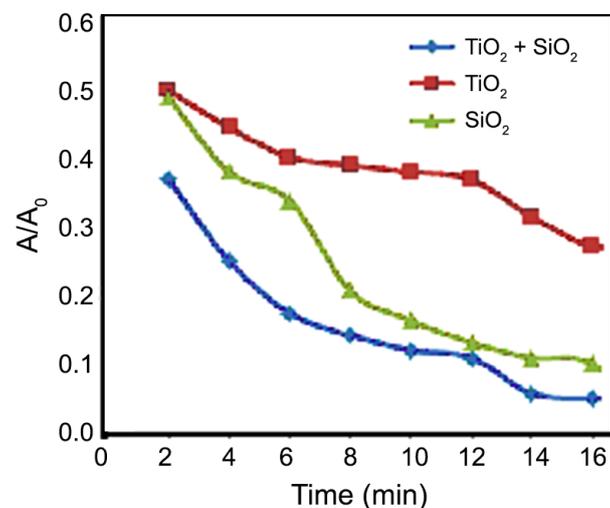


Fig. 2. Decolorization of MB dye of SiO₂, TiO₂ and SiO₂/TiO₂ nanocomposite materials

diation with visible light. Without light or nanostructures, nearly no MO was break down after 200 min, revealing that the contribution of self-degradation was insignificant. However, SiO₂-TiO₂ nanocomposite materials exposed high photocatalytic activity. The heterogeneous photocatalytic processes include many steps, such as diffusion, adsorption and reaction, appropriate distribution of the pore is advantageous to diffusion of reactants and products, which prefer the photocatalytic reaction. In this research, the enhanced photocatalytic activity may be ascribed to suitable distribution of the pore, high hydroxyl content and high separation rate of photo induced charge carriers (Fig. 2).

CONCLUSIONS

SiO₂/TiO₂ nanocomposite with enhanced photocatalytic activity under UV light were prepared by sonochemical method. SiO₂/TiO₂ nanocomposite exhibited much higher photocatalytic activity than SiO₂ and TiO₂ under UV light. Such outstanding photocatalytic activity of SiO₂/TiO₂ nanocomposite can be attributed to the increased adsorption of organic substrate and the low recombination rate of photogenerated electrons and holes

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