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Graphene facilitated visible light photodegradation of methylene blue over titanium dioxide photocatalysts

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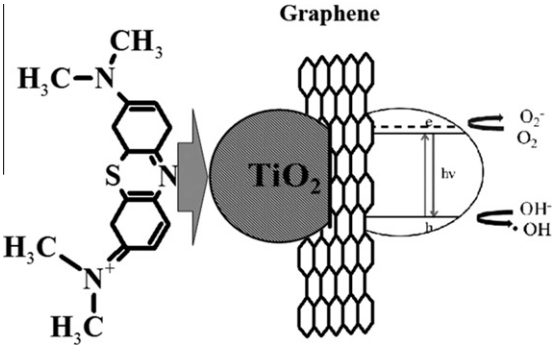
HIGHLIGHTS

- Graphene–titania composites (G–TiO_2) were synthesized by a sol–gel method.
- G–TiO_2 catalysts showed high efficiency in degradation of methylene blue under visible light.
- *In situ* prepared G–TiO_2 presented higher activity than that of G–TiO_2(P25).
- The mechanism of graphene in the enhanced visible light photocatalytic activity was proposed.

GRAPHICAL ABSTRACT



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ABSTRACT

Several graphene–titania composites (G–TiO_2) were synthesized by a sol–gel method using titanium isopropoxide (or P25) as Ti-precursors and reduced graphene oxide (RGO). The structural, morphological, and physicochemical properties of the samples were thoroughly investigated by X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR), field emission scanning electron microscopy (FE-SEM), UV–vis diffuse reflectance (UV–vis DRS), and thermogravimetric-differential thermal analysis (TG-DTA). A significant increase in light absorption to visible light was observed by G–TiO_2 compared with that of naked TiO_2. The photocatalytic activity of G–TiO_2 in methylene blue bleaching under visible light (>430 nm) is much enhanced. G–TiO_2 synthesized from titanium isopropoxide hydrolysis presented higher activity than that of G–TiO_2(P25). Contribution of graphene on the enhancement of visible-light photocatalytic activity of the composite was discussed.

1. Introduction

Photocatalytic decomposition of various organic compounds in aqueous solutions has been widely studied and many nanomaterials have been developed as photocatalysts for this technology [1–4]. TiO_2 has been intensively investigated as a photocatalyst for environmental clean-up and solar energy conversion. However, TiO_2 can only decompose aromatic organics into CO_2 and H_2O under UV-illumination and suffers from a barrier in responding to visible light at wavelengths higher than 387 nm due to a large band gap of 3.2 eV. As a result, only 3–5% of the solar energy that reaches onto the earth surface can be utilized. The common strategies for extending the absorption threshold of TiO_2 to visible light region include doping, coupling or anchoring with other organic or inorganic elements such as nitrogen, carbon, halogen, and metals into the titania lattice [5–11].

Combination of different types of carbon with TiO_2 has been suggested as a promising method for an enhanced photocatalytic performance [12,13]. In the past a few years, graphene as a novel carbonaceous nanomaterial has attracted more and more interests due to its unique and excellent performance in chemical, structural

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