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PHOTOCATALYTIC COMPOSITE MATERIALS BASED ON GRAPHENE AND TITANIUM OXIDE PREPARED BY DIFFERENT METHODS

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Summary: Titanium(IV) oxide - graphene or graphene oxide nanocomposite were prepared by one-pot thermal hydrolysis of suspension graphene or graphene oxide nanosheets and titanium oxide in three different forms as a starting materials. Graphene nanosheets were produced in a large quantity from natural graphite using a high intensity cavitation field in a pressurized ultrasonic reactor. The graphene oxide was prepared by improved Hummers method. The direct interaction between TiO2 nanoparticles and graphene sheet prevents the re-agregation of the exfoliated sheets of graphene. Graphene and even graphene oxide has the ability to locally reduce the titanium to active form of Ti3+ ion. The graphene nanosheets make Ti3+ ions stable in the TiO2 matrix and form a heterojunction system with titania.

The better photocatalytic properties on the TiO2-graphene oxide nanocomposite systems irrespective of light sources could be attributed to synergy effects including the increase in specific surface area with graphene oxide amount. As well as to the formation of both $\pi-\pi$ conjugations between organic pollutants molecules and graphene skeleton and the ionic interactions between organic pollutants and oxygen-containing functional groups at the edges or on the surfaces of graphene based nanosheets. Graphene oxide works as the adsorbent, electron acceptor and photosensitizer and efficiently enhances the organic pollutants photodecomposition.

First preparation method of titanium oxide utilized thermal homogeneous hydrolysis by urea or hydrazine monohydrate. Second method used the peroxo-complex of titania as an intermediate. All these methods have own specifications and limitations. Each method provides a various morphologies and size of primary particles and aggregates with significant effects on the photocatalytic activity.

The prepared a series of samples were characterized by surface area (BET) and porosity (BJH) determination, X-ray diffraction (XRD), infrared and Raman spectroscopy (IR, RS), scanning and transmission electron microscopy (SEM, TEM) (Fig.1). UV-VIS diffuse reflectance spectroscopy was employed to estimate the band gap energies. The relative photocatalytic activity of the as-prepared thin layers of titania-graphene and titania-graphene oxide nanocomposite in poly(hydroxyethyl methacrylate) was assessed by the photocatalytic decomposition of OrangeII under UV and visible light.