Contribution ID: **170** Type: **Poster**

Gamma Radiation Enhancement of Photocatalytic Activity of Conducting Polyaniline–TiO2 Nanocomposites for Degradation of Methyl Orange Dye under Visible Light Irradiation

Thursday, 27 April 2017 14:15 (2 hours)

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Abstract
Environmental pollution on a global scale, as well as the lack of sufficient clean energy sources, have drawn much attention to the need for developing ecologically clean chemical technology, materials, and process. Synthetic dyes are used almost in all branches of the consumer goods industry. About 10000 tons of dyes are produced per year. Inevitably, there are dye losses (approximately 12 % of used amount) during manufacturing and processing operations. The effluents from these operations are usually highly colored, toxic, carcinogenic or mutagenic. As the most of the synthetic dyes is resistant to the light or other degradative environmental conditions, it is necessary to remediate these effluents before they are released to the environment. However, common wastewater treatment plants are ineffective in removal of dyes from the wastewaters. One of possible options to modify these facilities to get better outcome is an application of the Advanced Oxidation Processes (AOPs), i.e., chemical methods based on generation of highly reactive hydroxyl radicals.
In current research, a series of polyaniline-modified TiO2 nanocomposites for photocatalytic degradation of dyes, have been successfully synthesized by sol–gel reactions on TiO2 followed by the chemical oxidative polymerization of aniline using ammonium persulphate (APS) as an oxidant. Fourier-transform infrared spectra (FT-IR), Thermal gravimetric analysis (TGA), X-ray diffraction (XRD), and UV–vis spectra, were carried out to characterize the composites with different TiO2 contents. The UV–vis spectra confirmed that the optical absorption for PANI-TiO2 nanocomposite was more intensive than that for pristine PANI and TiO2 nanoparticles in the visible light region. The intensive visible light absorption and effective charge separation owing to the heterojunction built between TiO2 and PANI lead to remarkable improvement of visible light photocatalysis.
The photocatalytic activities of the prepared nanocomposites were evaluated by photocatalytic degradation of methyl orange (MO) aqueous solution under visible light irradiation. The results showed that the surface polyaniline sensitization had no effect on the crystalline structure but aggravated the agglomeration of TiO2 nanoparticles by forming multi-particles. After being sensitized by PANI, the light response of TiO2 was extended to visible-light regions and the photocatalytic activity of the composite photocatalysts was enhanced. MO could be degraded more efficiently on PANI-TiO2 than on the bare TiO2 when the weight percent of TiO2 was 10wt%. Since gamma-irradiation is able to modify the electronic properties of the photocatalyst, the influence of gamma irradiation on the photocatalytic performance was investigated. A notable enhancement in degradation efficiency and time was found when irradiated nanocomposites were used. It can be included that gamma radiation plays an important role in the photocatalytic activity of PANI-TiO2 nanocomposites.

Country/Organization invited to participate

Egypt

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Session Classification: P-A2

Track Classification: FUNDAMENTAL AND APPLIED RADIATION CHEMISTRY RESEARCH