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Enhancement of visible light induced photocatalytic degradation of Eosin-Y by using TiO_2 and Ag doped TiO_2 nano catalyst

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Abstract

TiO_2 and Ag doped TiO_2 were synthesized by sol gel method. Morphology of as synthesized Ag doped TiO_2 nano catalyst was investigated using scanning election microscopy (SEM), Electron dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD). The photocatalytic activity of Ag doped TiO_2 nano catalyst was investigated by degradation of Eosin-Y solution under visible light radiation. The effects of various experimental parameters such as the Eosin-Y concentration, catalyst dose, and pH on the photocatalytic degradation were investigated. The kinetics study shows that the reaction follows first order kinetics. Among the different amounts of dopant that like 1, 2, and 4wt% Ag-doped with TiO_2 nanocatalyst. It was observed that 4 wt % Ag doped TiO_2 shows highest degradation with visible light radiation for Eosin-Y solution than pure TiO_2 nano catalyst. The particle size, morphology and separation of photo induced electron–hole pair are the main factors which influence photocatalytic activity. The degradation by-products formed during the complete degradation process were qualitatively identified by liquid chromatography-mass spectrometry (HR-LCMS) and a detailed degradation pathway has been proposed.

1. Introduction

The faster developments in the field of nanotechnology have stimulated considerable research efforts on the synthesis and manufacturing of novel devices for various high-technological potential applications [1,2]. Nanocrystalline titanium dioxide (TiO_2) has many important applications such as: solar cells [3], photocatalytic splitting of water to hydrogen and oxygen [4], sensors [5], self-cleaning surfaces and degradation of environmental pollutants [6]. Due to the stability of modern dyes, conventional biological treatment methods for industrial wastewater are ineffective, resulting often in an intensively colored discharge from the treatment facilities. Recently, a number of researchers have dealt with heterogeneous Photocatalyst and Fenton based hybrid nanocatalyst for decomposition of many kinds of dyes [7-9] by UV, visible light and solar irradiation [10]. Shoueir et al [11] reported plasmonic Au@TiO_2 photocatalyst bio-based chitosan fiber for the visible light induced photocatalysis of organic and inorganic pollutants. Photocatalytic performance of the TiO_2 can also improve by pulsed laser ablation in liquid [12,13].Again adsorption capability of TiO_2 can be improved by decorating on eggshell nanocrystal [14]. In addition, titania has a relatively high band gap value of 3.2 eV. However for many applications it would be desirable to extend the band gap excitations towards the visible region, and also to prolong the lifetime of photogenerated charge carriers. Doping of titanium dioxide with transition metal like Pt, Au, Pd, Rh and Ag provides a relatively well-studied and convenient way of solving both problems described above. TiO_2 doped with transition metal ions can demonstrate extended band gaps and significantly higher photocatalytic efficiencies [15-19]. However among these transition metals only Ag is inexpensive so that its commercial applications are extended. The dopant concentration is an important parameter to be considered, as the amount of