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Enhanced Photocatalytic Degradation of Methyl Orange using Ag-Doped TiO_2 Photocatalyst

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Abstract: In the present study, Ag-doped Titanium dioxide (Ag-TiO_2) photocatalyst was prepared by wet impregnation method. The effect of dopant concentration, incubation temperature and incubation time on the photocatalytic degradation of Methyl Orange (MO) in aqueous suspension under Ultra Violet (UV) light irradiation were studied systematically. The synthesized photocatalyst was characterized using XRD and SEM-EDX mapping. The characterization results confirmed that Ag was successfully doped into TiO_2 with anatase phase structure. The Ag-TiO_2 photocatalyst exhibited the highest dye removal of 85% efficiency with 5 wt.% dopant concentration when the incubation temperature and time were 70°C and 8 h, respectively. The kinetic study revealed that photocatalytic reaction follows Langmuir Hinshelwood (L-H) Model and pseudo-first order law with the highest regression coefficient of 0.992. Ag-TiO_2 was found to be an efficient photocatalyst showing enhanced photocatalytic activity for MO decolorization under UV irradiation.

Key words: Dye, titanium oxide, doping, photocatalyst, photodegradation, Ag-TiO_2

INTRODUCTION

Dyes are used primarily in the production of consumer products including paints, textiles, cosmetics, plastics and papers. Dye containing waste waters are usually recalcitrant to degradation by the conventional biological treatments due to its high toxicity as these compounds are often hardly biodegradable or even biocides (Oller *et al*., 2011). The main issue is dyes contain a number of dangerous chemical substances such as dioxin, formaldehyde and heavy metals. These substances can potentially cause acute and chronic effects on the exposed living organisms and due to their stability, dyes remain in the environment for a long period of time. Besides, the presence of dyes on water surface prevents the sunlight from penetrating into the water and thus retards algae photosynthesis.

There are several decrement technologies including adsorption (Kyzas and Matis, 2015), microbial degradation (Casalatto *et al*., 2011) and advanced oxidation processes (Zuorro and Lavecchia, 2014) which have been proposed for removal of azo dyes from textile discharges. Photocatalysis, however, offers better solutions compared to the other technologies for the removal of azo dyes due to its ability to mineralize the pollutants completely. TiO_2 is feasible in terms of its inexpensiveness, non-toxicity and high redox potentials (Tan *et al*., 2017). Nevertheless, pure unmodified TiO_2 has several drawbacks including its wide band gap energy level 3.0~3.2 eV resulting in poor absorbance of visible light (Hou *et al*., 2009), low quantum efficiency derived from the high recombination rate of photo-induced electron-hole (e^-/h^+) pairs (Gou *et al*., 2017), rapid recombination rate of photo-generated electron-hole pairs and inefficient utilization of UV light (Zhao *et al*., 2016). In this regard, modification of TiO_2 surface by metal doping was proven to enhance its photocatalytic activity (Mohamed *et al*., 2013) through electrons trapping which can greatly increase the efficiency of charge separation and also prevent recombination of electron-hole pairs. Behnajady and Eskandarloo (2013) showed that Ag-doped TiO_2 by liquid impregnation method improved the photocatalytic performance in the degradation of AR88. Zuas and Budiman (2013) used co-precipitation method to dope 3 wt.% of Cu with TiO_2. 90% of Congo Red dye was decolorized over Cu-TiO_2 photocatalyst, compared to

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