



CHAPTER I INTRODUCTION

The global environmental problem is an increasingly concerned issue and needs to be solved properly. One of the most commonly found problems is wastewater problems. The World Bank estimates that 17 to 20 % of industrial water pollution comes from textile dyeing and treatment ([www.airdye.com/about /how](http://www.airdye.com/about/how)). It is necessary to be aware of due to the toxic aromatic intermediates, the coloration of natural waters, and the mutagenicity and carcinogenicity. The textile industry causes a serious wastewater problems. A more complex environmental problem associated with the textile wastewater is that the contained organic dyes are resistant to microbial degradation, and thus they can unavoidably be converted to the toxic or carcinogenic compounds. Especially, an abundant class of synthetically colored organic compounds is azo dye, such as Methyl Orange and Acid Black, which is characterized by the presence of azo group ($-N=N-$) bound to aromatic rings (Yang *et al.*, 2004, and Liu *et al.*, 2005).

Several techniques have been developed for dye removal from textile effluents, such as physical methods (e.g. adsorption), chemical methods (e.g. chlorination and ozonation), biological methods (e.g. biodegradation), and their combination (Lachheb *et al.*, 2002 and Konstantinou and Albanis, 2004). However, the conventional processes for treatment of these effluents are insufficient to purify a large quantity of wastewaters generated from different operations of textile dyeing and washing. Some methods, such as coagulation, electrochemical oxidation, and active sludge, have recently been examined and proved to be effective. Other methods, such as flocculation, reverse osmosis, and adsorption on activated carbon, have also been investigated (Lachheb *et al.*, 2002). The drawback of these methods, however, is an incomplete destruction of the pollutant compounds, since they just transfer the compounds present from the aqueous to another phase, thus causing secondary pollution problem. Recently, chemical oxidation involving advanced oxidation processes (AOPs) is one of the latest techniques to treat the effluents. This technique normally uses strong oxidizing agents, such as ozone, hydrogen peroxide, chlorine, and potassium permanganate, to force degradation of

more resistant organic molecules; however, it is expensive and of limited scale (Amar, 2007). Thus, photocatalysis technology has been widely investigated as an alternative and efficient AOP for pollutant eradication, with an emphasis on the development of effective photocatalysts (Puangpetch *et al.*, 2008).

In recent years, heterogeneous photocatalysis using a semiconductor photocatalyst appears as an emerging destructive technology due to its several advantages. Firstly, it destroys the pollutants by degrading or transforming into less harmful substances in the presence of UV and near-UV illumination. Secondly, non-toxic material can be used as a photocatalyst, particularly titania or titanium dioxide (TiO_2). Thirdly, this process can be operated at room temperature and atmospheric pressure. Fourthly, it leads to the total mineralization of most of organic pollutants. Finally, the photocatalytic process is receiving increasing attention because of its low cost due to the use of sunlight as the source of irradiation, also implying an environmentally friendly process. TiO_2 -based photocatalysis is one of the most promising methods for complete mineralization of organic dye pollutants. The primary photocatalytic processes occur upon irradiation of light with energy greater than or equal to the band gap of TiO_2 photocatalyst, and the electrons and holes are then generated and trapped on the photocatalyst surface, subsequently producing reactive oxygen species, such as OH^\bullet and $\text{O}_2^{\bullet -}$ radicals, to degrade the dye pollutants. Therefore, the charge separation in the photocarrier generation can be increased, and the energy needed for photoexcitation is reduced, both of which allow the TiO_2 to absorb light efficiently and to initiate the reaction rapidly (Ioannis *et al.*, 2003, and Yang *et al.*, 2004).

In most works, dispersion/suspension of TiO_2 in wastewater during the photocatalytic treatment shows great photoactivity, but requires other troublesome filtering processes to separate the photocatalyst from the treated wastewater (Amar, 2007). Therefore, utilization of TiO_2 in an immobilized mode is more practical because it solves the problems of TiO_2 separation, recovery, and reuse as compared to a suspension mode, where immobilization of TiO_2 has been prepared on glass, organic polymer, silica gel, zeolite, metal, and carbon (Lim, 2004). Nevertheless, the photocatalytic degradation of dye contaminants by using an immobilized

nanocrystalline mesoporous-assembled TiO_2 photocatalyst has not been extensively investigated, so this research will focus on this kind of photocatalyst.

In this research, experimental investigation was performed on the photocatalytic degradation of Acid Black diazo dye, as a model dye contaminant in textile wastewater, by using the nanocrystalline mesoporous-assembled TiO_2 immobilized on a glass plate, where the mesoporous-assembled TiO_2 nanocrystal was synthesized by a sol-gel process with the aid of a structure-directing surfactant. Various preparation parameters during the immobilization step were studied on the photocatalytic degradation performance.