CHAPTER I
INTRODUCTION

Nowadays, the environmental problem is a globally concerned topic. Especially, wastewater problems have been spread throughout the world. The major source of wastewaters commonly found is azo dye pollutant, which is discharged to environment from textile industry (Chang *et al.*, 2009). The contaminated wastewaters always contain high concentrations of organic azo dye, 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 to treat wastewaters containing the dye pollutants, including physical methods (e.g. adsorption), chemical methods (e.g. chlorination and ozonation), biological methods (e.g. biodegradation), and their combinations (Hinda *et al.*, 2002 and Konstantinou and Albanis, 2004). The existing physical/chemical methods have some drawbacks of being economically unfeasible (more energy and chemical demands), being unable to remove the recalcitrant azo dyes and their organic metabolites completely from such effluents, generating a significant amount of sludge that may cause secondary pollution problems, and substantially increasing the cost of these treatment methods and complicated procedures (Saratale *et al.*, 2009). However, photocatalysis technology has been widely investigated for degradation of the pollutants in wastewater by degrading or transforming into less harmful substances in the presence of UV and near-UV illumination. Comparatively, it is also an inexpensive technology due to the use of sunlight as the source of irradiation, thus implying an environmentally friendly process (Puangpetch *et al.*, 2008).

Titania (TiO_2) has been widely employed for the photocatalytic degradation of organic compounds and for other environmental cleanup applications. There are many advantages of using TiO_2 as a photocatalyst since it is largely available, nontoxic, chemically stable, and resistant to photocorrosion (Sasikala *et al.*, 2010). However, its major disadvantage is that it is active only under UV irradiation due to its wide band gap, thereby limiting its photocatalytic efficiency. So far, many efforts have been devoted to improve the photocatalytic performance of TiO_2 for the degradation of various organic pollutants by doping metals and other semiconductors with wide or narrow band gaps, reducing particle size, and changing morphology (Ozaki *et al.*, 2007). Thus, the photocatalytic activity of TiO_2 can be enhanced by some improved properties, including decreased band gap, nanometered size, new surface composition and structure, enhanced quantum efficiency, and high crystallinity.

More recently, codoping of one or two components with TiO_2 to prepare two- or three-component TiO_2-based systems has attracted considerable interest since these composite systems can provide a higher photocatalytic activity and peculiar characteristics compared with pure TiO_2. For instance, Nagaveni *et al.*, (2004) prepared the Fe^{3+} and Cu^{2+} metal ion-substituted nanocrystalline anatase TiO_2 and observed that most of the metal ion-doped TiO_2 showed higher photocatalytic activity than the commercial TiO_2 (Degussa P25) for photodegradation of 4-nitrophenol. In recent years, In_2O_3-TiO_2 composite photocatalysts have been explored by some researchers. Yang *et al.* (2008) reported that the metallic silver and In_2O_3-codoped TiO_2 nanocomposites (Ag/In_2O_3-TiO_2) showed an enhanced photocatalytic activity. Compared with pure TiO_2, the In_2O_3-TiO_2 composite photocatalysts showed an efficient separation of photogenerated carriers and an enhancement of photocatalytic activity under UV irradiation.

Indium oxide (In_2O_3) has been extensively reported as one of the most interesting materials, and a great number of applications have been reported, such as in the development of solar cells, photovoltaic and optoelectronic devices, and liquid crystal displays (Gopchandran *et al.*, 1997). In_2O_3 is a semiconductor that has been demonstrated to increase the photocatalytic and photoelectron chemical responses of semiconductor oxide by reducing energy band gap, enhancing electron transfer, and reducing recombination of the photocatalytic charge carriers. Doping TiO_2 with In_2O_3 is therefore expected to be beneficial to improve the photoactivity of TiO_2 due to its band gap alteration. In addition, metallic silver (Ag) is an extremely intriguing metal to be investigated because it can remarkably enhance charge carrier separation (Sato, 1998), enhance quantum efficiency, and possess size-and-shape independent optical properties (Alivisatos, 1996).

In this work, mesoporous-assembled In_2O_3-TiO_2 mixed oxide nanocrystal photocatalysts were synthesized by a sol-gel process with the aid of a structure-directing surfactant. The Ag loading on the synthesized mesoporous-assembled In_2O_3-TiO_2 mixed oxide photocatalyst was carried out by a photochemical deposition method. The photocatalytic activity of the prepared photocatalysts was performed on the degradation of Congo Red (CR) diazo dye as a model contaminant in wastewater from textile industry. The effects of various synthetic parameters, namely In_2O_3-to-TiO_2 molar ratio, calcination temperature, and Ag loading, were investigated on the photocatalytic CR dye degradation performance. In addition, the effects of some operating parameters, including water hardness and initial solution pH, on the photocatalytic activity were examined.