CHAPTER I
INTRODUCTION

Environmental problem is a globally concerned topic. Several wastewaters are derived from the industrial processes. Organic compounds, such as phenol, are main contaminants in the industrial wastewater. The effluents can be discharged from industries such as petroleum refining, dyestuff, steel, coal tar, synthetic resins and liquefaction (Saravanan *et al.*, 2009). Besides, phenol and phenolic compounds can be achieved from daily life, such as disinfectants and veterinary medicine (Luenloi *et al.*, 2011). However, phenol and phenolic compounds have been reported to have a high stability, high environmental toxic, and can damage human health (Guo *et al.*, 2006). Thus, the environmental protection agency (EPA) has limited the phenol concentration is standard surface water to less than 1 part per billion (ppb) (Busca *et al.*, 2008).

Several conventional methods have been developed to eliminate phenolic compounds in wastewater, such as physical methods (adsorption), chemical oxidation, and biological treatment. However, the conventional processes for treatment of these effluents are insufficient to purify a large quantity of wastewaters generated from different operations of pollutants. 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 (Hinda *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).

Heterogeneous photocatalysis using TiO_2 as photocatalyst appears as an emerging destructive technology due to its several advantages. Firstly, it destroys the pollutants by decomposing or transforming into less harmful substances in the presence of UV and near-UV illumination. Secondly, non-toxic material can be used as semiconductor photocatalyst, such as 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. Moreover, TiO_2 photocatalyst is largely available, inexpensive, and non-toxic, and shows relatively high chemical stability, also implying an environmentally friendly process. The primary photocatalytic processes occur upon irradiation of light with energy greater than or equal to the band gap of 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 $O_2^{\bullet-}$ radicals, to decompose organic pollutants.

TiO_2 has proven to be the most widely used photocatalyst due to its strong oxidizing power, non-toxicity, and long-term photostability (Pirkanniemi *et al.*, 2002). However, the photocatalytic efficiency of TiO_2 to remove organic contaminant decreases substantially because of the high recombination ratio of photo-induced electrons (e^-) and holes (h^+) (Han *et al.*, 2009). Therefore, several efforts have been studied to develope heterogeneous photocatalysts that can be efficiently used for degradation of organic contaminant. One of the most promising photocatalysts is strontium titanate ($SrTiO_3$) because of its superior physicochemical properties, such as excellent thermal stability, high photocorrosion resistibility, and good structure stability as the host for metal ion doping (Ohno *et al.*, 2005).

Recently co-modification of two components for TiO_2 to prepare three-component junction photocatalysts has attractive interest, because these photocatalysts exhibit higher photocatalytic activity and special characteristics in comparison with pure TiO_2 and TiO_2 modified by one component (Han *et al.*, 2009). Khunrattanaphon *et al.* (2011) investigated the synthesis of $SrTi_xZr_{1-x}O_3$ (x = 0-1) photocatalysts and photocatalytic activity in acid black (AB) diazo dye used as a model contaminant in textile wastewater. The effects of varying Ti-to-Zr molar ratio

(as expressed by x in the $SrTi_xZr_{1-x}O_3$), calcination conditions, and Pt loading were investigated. It was found that a suitable Ti-to-Zr molar ratio provided the photocatalyst with comparatively high photocatalytic efficiency. The Pt loading with an appropriate content could further enhance the photocatalytic efficiency.

In this work, mesoporous-assembled $SrTi_xZn_{1-x}O_3$ nanocrystal photocatalysts were synthesized by a sol-gel process with the aid of a structure-directing surfactant. The metal loadings on the synthesized mesoporous-assembled $SrTi_xZn_{1-x}O_3$ photocatalysts were carried out by a photochemical deposition method. Experimental investigation was performed on the photocatalytic degradation of phenol as a model contaminant in wastewater. The effects of various synthetic parameters, including Ti-to-Zn molar ratio, calcination conditions for the photocatalyst preparation, and Ag, Cu, and Pt loadings, were investigated on the photocatalytic phenol degradation performance. Therefore the effect of dissolved oxygen in case of flow N_2 and O_2 were used to improve phenol degradation performance.