CHAPTER I

INTRODUCTION

1.1 Motivations

Photocatalytic process has been of continuous interest in the treatment and purification of air and water since it can complete the reduction of metal ions. Furthermore, organic species can be completely mineralized to carbon dioxide or become non toxic materials by photocatalytic pathway (Fu et al., 1998). Titanium dioxide (TiO_2) has been widely used as a photocatalyst due to its activity, photostability, non-toxicity and commercial availability (Oppenländer, 2003). As a result of the cost and difficulties in separating the TiO_2 particles from the suspension after completion of the reaction, the powder TiO_2 application is found not practical for commercial use (Hilmi et al., 1999; Matthews, 1987; Zhang, Zhu et al., 2003). In order to overcome these disadvantages, preparations of TiO_2 thin film have been developed by different techniques, for example chemical vapor deposition, chemical spray pyrolysis, electrodeposition and the sol-gel method. Many researches have focused on preparation by the sol-gel process since this method is very simple, easy to operate and can be applied to complex surfaces or large surface areas. Moreover, this technique is suitable for thin film deposition on many substrates such as stainless steel, alumina, silica/glass, etc (Pozzo et al., 1997; Sonawane et al., 2002).

By controlling the photocatalytic property, the synthetic TiO_2 thin film can be used in industrial application. In this research, TiO_2 thin films were prepared using titanium tetraisopropoxide (TTiP) as a titanium-precursor and ethanol as a solvent. Polyethylene glycol with molecular weight 600 (PEG 600) and diethylene glycol (DEG) were used as organic/polymer additives. The 316 type stainless steel was selected as a substrate as it is inexpensive, corrosive resistance and commercial available. Besides, it can be modified to any shape that is suitable for photoreactor. The effects of ethanol and additives mole ratio, calcination temperature and coating cycle on the film properties were studied in order to find a role of each parameter on

thin film characteristic by the sol-gel method. In this work, chromium was selected as the tested pollutant as it is frequently found in effluent streams discharging from chrome plating, electronic, metallurgical and leather tanning industries (Richard, 1998; Schrank et al., 2002). The photocatalytic activity of synthetic TiO_2 thin film in chromium removal was also reported in this work.

1.2 Objectives

The main objective of this work is to synthesize TiO_2 thin film which is coated on stainless steel using the sol-gel method for photocatalytic reduction of chromium(VI). The specific objectives are:

1.2.1 To investigate the role of ethanol, PEG 600 and DEG on film properties and photocatalytic activity for chromium(VI) removal.

1.2.2 To study the effects of calcination temperature on film properties and photocatalytic activity for chromium(VI) removal.

1.2.3 To study the effects of coating cycle on film properties and photocatalytic activity for chromium(VI) removal.

1.2.4 To test for photocatalytic reduction of Cr(VI) using the TiO_2 thin film.

1.3 Hypotheses

Amounts of ethanol, PEG600 and DEG, calcination temperature, and coating cycle are the important parameters affecting on TiO_2 thin film properties and photocatalytic activity for chromium(VI) removal. The films prepared with the optimum condition have high efficiency in chromium(VI) removal by photocatalytic process.

1.4 Scope of the study

1.4.1 TiO_2 thin film was prepared by sol gel dip-coating process.

1.4.2 Factors affecting the film properties were studied including the mole ratio of chemical precursors, calcination temperature and coating cycle.

1.4.3 Chemical precursors used in this work were titanium tetraisopropoxide (TTiP), ethanol, polyethylene glycol with molecular weight 600 (PEG 600) and diethylene glycol (DEG).

1.4.4 Photocatalytic activity of TiO_2 thin film was measured using chromium (IV) synthesis wastewater.

1.5 Benefits of this work

Results from this research can be further used to prepare TiO_2 thin film on stainless steel plate by sol-gel technique. Moreover, they can be applied to design a full-scale photoreactor that is practically used in industrial wastewater treatment containing chromium(VI) by photocatalytic process.