CHAPTER I

INTRODUCTION

Titanium dioxide (TiO_2) is one of the most popular materials. TiO_2 is widely used in many industrial applications such as, cosmetics, fillers, coating material, pigments, as well as photocatalyst. It has been used as a raw material supporting global industries, worth more than 5.5 billion US$. Although the TiO_2 has been commercially processed for over 85 years, it is still being fascinating research subject. In recent years, researchers paid special attention to developing a nano-sized TiO_2, which can be utilized as a photocatalytic material for environmental redemption. It was used to purify air pollution and variety of organic toxic contaminants in water. So far, the TiO_2 has been known as the photocatalytic material that possesses high activity, chemical inertness, strong oxidizing power, non-toxicity, and long-term stability [1]. Base on the photocatalytic reaction, it generally involves the oxidation and reduction reaction between UV-light generated charges (e^- and h^+) and organic species adsorbed on the TiO_2 surface. This reaction leads to the photoremoval of organic pollutants. It has been pointed out that the photocatalytic activity strongly depended on its microstructure and physical properties [2]. To obtain good performance TiO_2 photocatalyst, it demands high purity surface, desired crystallite size, definite phase composition and surface properties. Therefore, it is important to manipulate the preparation procedure so that the desired properties are obtained. Recent study is focused on extending light absorption of the TiO_2 into the visible region so that it can be more efficient under sunlight. An incorporation of vanadium doping has been widely performed in order to improve the photoactivity of TiO_2 under visible light [3].

Among various preparation methods, sol-gel is by far the most convenience process to prepare nanocrystalline TiO_2 with high photocatalytic activity and chemical purity [4]. In the sol-gel process, the TiO_2 photocatalyst is prepared via the hydrolysis and condensation reaction of titanium alkoxide. These two reactions are influenced by the synthetic condition,

such as the composition of the Ti precursor, water content, type and amount of hydrolysis catalyst, as well as aging time. Previous reports [5] suggested that the transition behavior from amorphous-to-anatase and anatase-to-rutile phase, including physical properties of the TiO_2 photocatalyst, are dependent on the above reaction conditions. Moreover, improper heat treatment also deteriorates the photocatalytic efficiency as it alters the phase composition, crystallize size, and surface area of the TiO_2 photocatalyst.

Although sol-gel method provides chemical homogeneity of final product, the yield of TiO_2 powder is found to be lower than other methods. Moreover, it is very difficult to separate or filter out the powder, particularly for the nano-sized powder. These drawbacks can be solved by immobilizing the TiO_2 onto the solid supports such as sphere, reactor wall, fiber glass, silica gel, as well as ceramic ball. Moreover, the immobilization of TiO_2 in the form of thin film also provides an advantage over TiO_2 powder in several applications. It is used to improve the recovery of the solid after the reaction [6].

The general objective of this study was to develop TiO_2 photocatalyst by sol-gel method. Detail objectives are described as follows;

1. To synthesize nanocrystalline TiO_2 by sol-gel method with desired phase composition and physical property.

2. To study the effect of synthesis parameters such as Ti concentration, water content, aging time, as well as type and amount of hydrolysis catalysts (HCl/HNO_3) on microstructure and property of the TiO_2.

3. To immobilize the nanocrystalline TiO_2 on Al_2O_3 bead and glass tube to avoid particle recovery process and to reduce TiO_2 loading in practical use.

4. To characterize the microstructure and examine the photocatalytic activity of the TiO_2 in the form of powder and coating.