CHAPTER I
INTRODUCTION

Volatile organic compounds (VOCs) are one of the most common indoor air pollutants. They are found not only in industrial and manufacturing sites but also in commercial workplaces and domestic households. Many of these compounds are not only irritants, but are also suspected carcinogens and pose significant health risk. There is an urgent need to establish an effective method for VOC remidation from indoor air, since most modern buildings are designed with centralized air-handling systems where the bulk of the indoor air is recycled and recirculated through the building.

The traditional treatment methods for air-borne VOCs include incineration (i.e., thermal and catalytic combustion), adsorption, absorption, condensation, and biofiltration. Although absorption and adsorption columns are simple to operate and can have a large capacity for VOC removal, they respectively produce secondary liquid and solid wastes. Condensation and biofiltration methods have low efficiencies, while the capital investment and operating cost for incineration are high. The corrosive products from the degradation of halogenated compounds also pose a problem for both thermal and catalytic incineration.

Gas phase photocatalytic oxidation is an attractive technology for the degradation of VOCs. It is economical and simple and can be easily implemented. Photocatalytic oxidation is effective in destroying a wide range of common organic pollutants. Simple organic compounds are readily mineralized to carbon dioxide and water at ambient conditions using molecular oxygen as the primary oxidant. However, complex molecules are more difficult to degrade and undesirable intermediates and by-products can be formed. In addition, the rate of decomposition may also be slow. Better catalyst design and formulation are necessary in order to improve its performance for pollution abatement.

Titanium (IV) oxide, TiO_2 or titania is the commonly used environmental photocatalyst for the oxidation of gaseous or aqueous organic pollutants. The TiO_2 catalyst exhibits good activity for photo-oxidation of organic compounds when either oxygen or liquid oxidants are used (e.g., hydrogen peroxide or organoperoxides). It is also chemically stable, commercially available, and inexpensive. The photocatalytic oxidation occurs in the presence of a semiconductor catalyst such as TiO_2 and UV or near-UV light source. The incident photons possessing energies greater than the band gap of the catalyst are absorbed. The absorbed photon then excites a valence electron into the conduction band, creating a positive hole. The resulting electron-hole pair can migrate toward the catalyst surface and initiate redox reactions that oxidize the adsorbed organic molecules.

A good photocatalyst must possess a large catalytic surface and should also exhibit high photon utilization efficiency. The size of the catalyst particles defines the surface area available for adsorption and decomposition of the organic pollutants. When the size of a semiconductor particle is decreased to the extent that the relative proportions of the surface and bulk regions of the particle are comparable, its energy band structure becomes discrete and will exhibit chemical and optical properties different from those of the bulk material.

There are some of the studies of the relationship between the particle size and photocatalytic activity of TiO_2. But there are significant disagreements in the effects of particle size on the photocatalytic activity of TiO_2. Therefore, it is an interesting point to study the particle size effect of TiO_2 catalyst on photocatalytic activity of photo-oxidation reaction.

There are many methods for TiO_2 synthesis and glycothermal method is a new method of titanium (IV) oxide synthesis, which developed to obtain a highly active TiO_2. By applying this method, the physical properties (i.e., crystal size and surface area) of synthesized TiO_2 can be controlled by reaction conditions such as reaction temperature and prolonged reaction time and the choice of organic solvents.

As mentioned above, this research is set up to demonstrate the crystal size effects of nanocrystalline-titania catalyst synthesized by glycothermal method on gas phase photo-oxidation of 2-propanol.

The present study is arranged as followed:

Chapter II presents a literature reviews of the synthesis of titanium (IV) oxide in organic media for the photocatalytic oxidation of VOCs.

The theory related to this work, physical and chemical properties of titanium (IV) oxide, glycothermal synthesis, photocatalytic process, and others are described in chapter III.

Chapter IV presents the catalyst preparation, operational procedure and experimental systems.

Chapter V demonstrates the experimental results of characterization of catalyst samples and of photo-oxidation of 2-propanol. The experimental results are explained.

In the last chapter, the overall conclusion emerged from this work is given.

Finally, the calcination conditions of prepared catalysts, calculation of catalyst crystal size, operating condition of gas chromatograph, and the data of the reaction testing are included in appendices at the end of this thesis.