CHAPTER 1 INTRODUCTION

1.1 Introduction

Nanoscience involves a study of materials on the nanoscale ranging from 1 to 100 nm and involves a study of how to control the formation of one, two and three dimensional assemblies of molecules into a well-defined nanostructure but a point of nanotechnology is to develop material, device, and system with superior characteristics by exploiting the superb properties of molecular systems at nanoscale. In the last decade, research in this field has grown rapidly as scientists and engineers continue to employ nanomaterials with unique and enhanced properties. Every field of science has been affected by the concepts of nanotechnology, especially computing, medicine, sensing, energy production, and environmental protection.

Nanomaterials can be produced from different materials in different shapes such as spheres, rods, wires, and tubes. A point of nanoscience is to develop material, device, and system with superior characteristics by exploiting the superb properties of molecular systems at nanoscale. It has been reported that nanoparticles of metal such as Au, Ag, Li, Na, and Cu, with a variety of dimensions offered many size-dependent properties, e.g. optical, electronic, magnetic, and chemical properties.

Metal oxide nanoparticles have been extensively developed in the past decades because of their outstanding properties such as physical, chemical, optical and electronic properties. They have been widely used in many applications such as catalysts, sensors, semi-conductors, medical science, capacitors and batteries [1-6]. Among them, aluminum oxide (Al_2O_3) and its compounds have long been known for more than century, e.g. aluminum hydroxide (AlOOH) and aluminum trihydroxide ($Al(OH)_3$).

Alumina, aluminum oxide or Al_2O_3 generally refers to corundum. It is a white and odorless oxide. Alumina has several phases such as gamma, delta, theta, and alpha. However, the alpha alumina phase is the most thermodynamically stable phase. In general, alumina has many interesting properties; for example high hardness, high stability, high insulation and transparency [7]. Alumina is also widely used in the fire retard, catalyst, insulator, surface protective coating and composite materials [8-12].

Alumina nanoparticles can be synthesized by many techniques including ball milling, sol-gel, pyrolysis, sputtering, hydrothermal and laser ablation [13-18]. Among them, the laser ablation is a widely used technique for the synthesis of nanoparticles since it can be synthesized in gas, vacuum or liquid. This technique offers several advantages such as rapid and high purity process compared with other methods [19]. Furthermore, nanoparticles prepared by the laser ablation of materials in liquid is easier to be collected than that of in gas atmosphere. In the recent years, alumina nanoparticles were synthesized in liquid using a short pulse laser with the pulse width in the range of nanosecond [20-21]. Furthermore, Al target was used as a starting materials for laser ablation in those works.

In this dissertation, the γ-Al_2O_3 nanoparticles were synthesized from Al powders using laser ablation in deionized water with a long pulsed Nd:YAG laser. The laser pulse widths adopted in this work were several milliseconds to obtain the output laser energies of 1, 3 and 5 J, respectively. The particle size and morphology of synthesized nanoparticles obtained at different laser parameters were investigated by field emission scanning electron microscopy (FE-SEM). The chemical compositions were analyzed using energy dispersive spectroscopy (EDS). The structure of the synthesized nanoparticles was carried out using X-ray diffraction (XRD) technique. The optical property of synthesized nanoparticles was investigated using UV-visible spectroscopy. The chemical bonding were carried out using X-ray photoelectron spectroscopy (XPS).

1.2 Objectives

The goals of this thesis can be concluded as follows

1.2.1 To synthesize alumina nanoparticles by laser ablation in deionized water.

1.2.2 To study effect of laser parameter on size and morphology of alumina nanoparticles.

1.2.3 To study the structure of alumina nanoparticles.

1.2.4 To study the optical properties of alumina nanoparticles.

1.2.5 To study the chemical bonding of alumina nanoparticles.