CHAPTER 1

INTRODUCTION

1.1 Introduction

Nanotechnology is the science and technology of small things that are less than 100 nm in size. For comparison, one nanometer is 10^{-9} meters or about 3 atoms long, a human hair is about 80,000 nanometers wide. Scientists have discovered that materials at small dimensions, such as small particles or thin films in an order of nano-scale can have significantly different properties than the same materials at larger scale. There are thus endless possibilities for improvement on some properties of materials if we can understand these differences and learn how to control the assembly of small structures. In general, most agree that three things are important.

1. Small size, measured in the range of 100 nanometers or less.
2. Unique properties because of the small size.
3. Control the structure and composition on the nanometer scale in order to control the properties.

Nanoparticles (NPs) have attracted the attention of an increasing number of researchers from several disciplines in the last ten years. NPs are generally used now in materials science community to indicate particles with diameters smaller than 100 nm. The small size of NPs which is responsible for the different properties, such as electronic, optical, electrical, magnetic, chemical and mechanical with respect to the bulk material makes them suitable for new applications.

The important materials which have attracted a great deal of attention due to its unique properties are *titanium dioxide* (TiO_2) and *iron oxide* (Fe_2O_3). It is well known that TiO_2 and Fe_2O_3 nanostructures are widely used as catalyst for many applications due to its photocatalytic and magnetic properties. Moreover, TiO_2 was used not only as photocatalyst but also as photoanode in photoelectrochemical solar cells because of its chemical stability, low cost and non-toxicity. However, TiO_2 only absorbs near UV light (E_g = 3.2 eV for anatase phase) and doesn't match the solar light. Fe_2O_3 has been considered to be promising for applications in solar energy conversion because it has a bandgap (E_g = 2.2 eV) which smaller than that of TiO_2, but it is liable to be photocorroded and the lifetime of photogenerated minority carries is very short. Therefore, Fe_2O_3 doped TiO_2 have been investigated to extend the absorption threshold to visible light and improve their photocatalytic activity. However, the photocatalytic properties of the nanoparticles depending on its crystal phase, particle size and also crystallinity. Thus, the synthesis technique of the nanoparticles is very important to control their morphology and structural properties. In this work, a novel sparking process and a pyrosol technique which are a very simple and low-cost scheme to synthesize TiO_2 and Fe_2O_3 nanoparticles were successfully synthesized. The comparison of morphology, the particle sizes and its crystallinity of each technique were discussed.

1.2 Research objective

In this thesis, we have developed the synthesis of colloidal TiO_2 NPs by a novel sparking process which is the cost-effective, simple to manipulate and applicable to large-scale area deposition method. Moreover, Fe_2O_3 NPs were successfully prepared by pyrosol method. The research objective of this work can be separated as followed:

(1) To synthesize colloidal TiO_2 NPs by sparking process.

(2) To synthesize Fe_2O_3 NPs by pyrosol method.

(3) To characterize morphology, structural and optical properties of the obtained samples by SEM, TEM, XRD, Raman spectroscopy and UV-vis.

(4) To investigate the photocatalytic and antibacterial activities of the obtained NPs in the dark, under solar light and UV light.