CHAPTER I
INTRODUCTION

Since the discovery of carbon nanotubes by Sumio Iijima, Carbon nanotubes have dramatically fascinated because of extraordinary electrical properties (Issi *et al.*,1995) thermal properties (Rosen *et al.*,2000), and mechanical strength (Cornwell *et al.*, 1997). Single-Walled Carbon Nanotubes (SWNTs) have exceptional potential for nano-technological application in various fields such as emission display (Bonard *et al.*,1998), nanoscale transistor (Tans *et al.*,1998), supercapacitors (Niu *et al.*,1997), and lithium-ion batteries (Che *et al.*,1998). SWNTs can be either metallic or semiconductor, depending on their spiral conformation (charity) and diameters. Moreover, they exhibit to be a potential candidate for an aerospace application because SWNTs have great Young's modulus, tensile strength and light weight. They are also used as reinforced composite materials (Ajayan *et al.*, 2001), artificial muscles (Collins *et al.*, 2000), and hydrogen storage (Dillon *et al.*, 1997).

Typically, for production of SWNTs, there are three major methods: laser ablation, electrical arc discharge, a hydrocarbon catalytic decomposition. Generally, both the arc discharge and laser evaporation techniques can produce superior quality nanotubes (Jorunet *et al.*, 1997). However, these two techniques are costly because they require high temperatures. Moreover, they are hardly to scale up (Hafner *et al.*, 1998). On the other hand, the hydrocarbon catalytic decomposition has been considered as a promising approach for large scale production (Shinohara *et al.*, 1999); the process is simple and has a higher productivity than the arc discharge process, However, all of the SWNTs produced from this method consists of 5-10% of SWNTs with large fractions of impurities such as amorphous carbon, transition metals, possibly multi-walled carbon nanotubes (MWNTs), the other fullerenes and the support material. These impurities directly restricted the superlative performance of SWNTs. Therefore, purification of the SWNTs is considerably required for various applications.

During the past decade, most efforts have been directed toward improving the purity as well as the quality of as-prepared SWNTs and several techniques including chemical acid or gas oxidation, filtration, chromatography, and field-flow fractionation have been applied. Chattopadhyay, and co-workers (2002) reported the results of treating SWNTs with refluxing nitric acid over varying periods of time. It exhibited that not only removed most of the metal catalysts, but also consumed a significant fraction of the nanotubes, resulting in producing carboxylic acid groups at the ends of the SWNTs. Accordingly, a method for metal catalysts removal without destructive on their structure was studied by using some mild oxidants such as concentrated HCl with sonication (Li et al., 2000). The purified SWNTs were separated by micro-filtration, chromatographic isolation (Yanlian *et al.*, 2005) or centrifugal purification (Hongbing et al., 2005); however, these methods have a several drawbacks such as high production cost, high energy consumption and side-walled modification. Therefore, a new purification method with the ultimate goal of attaining defect-free structure of SWNTs was focused by applying froth flotation in this study. The advantages of froth flotation process are low energy requirement.

In this research, the proposed purification method for SWNTs consisted of four sequential steps: (i) oxidative pretreatment to eliminate amorphous and encapsulate-disordered carbon layer and convert metallic catalysts to metal oxides, (ii) acid treatment to dissolve the oxidized catalysts. (iii) silica dissolution to remove silica from as-prepared SWNTs, and (iv) froth flotation to separate and concentrate SWNTs using two types of surfactants, sodium dodecyl benzene sSulfonate (anionic surfactant), and also alcohol ethoxylate (surfonic L24-7: nonionic surfactant).