CHAPTER I
INTRODUCTION

Carbon nanotubes are molecular-scale carbon fibers with diameter roughly in the range of 1-100 nm. There are two types of the carbon nanotubes. The first type is multi walled carbon nanotubes (MWNTs) and another is single walled carbon nanotubes (SWNTs). The SWNTs are dramatically attractive because of their special structures and properties. For examples, they have high strength and stiffness, high thermal and electrical conductivity. Then, SWNTs are believed to use in many captivating potential applications.

Presently, there are three major methods for SWNTs synthesis: (i.) the carbon arc discharge technique (Bethune *et al.*, 1993), (ii.) the pulsed laser vaporization technique (Guo *et al.*, 1995), and (iii.) the catalytic decomposition of carbon-containing molecules (Kitiyanan *et al.*, 2000). Among these techniques, the catalytic method has been considered as a promising approach for a large-scale production at a relatively low cost. This technique utilizes metal deposited on support such as silica. Therefore, as-prepared SWNTs are attached on the catalytic support. However, high purity of SWNTs is required in various applications. Therefore, the purification of the raw single walled carbon nanotubes is one of the important steps that limit the scaling up to commercial scale.

There are several research workers to develop purification methods. For examples, Bandow *et al.*, (1997) demonstrated a procedure for one-step SWNTs purification by microfiltration in an aqueous solution containing a cationic surfactant. This technique could purity the SWNT from ~76% to >90%. However, this process can be applied only dilute and relatively pure samples. A conventional method to separate SWNTs from silica support is chemical treatment by using concentrated HF or concentrated NaOH (Matarredona *et al.*, 2003). However, both chemical treatment and membrane extraction display some negative impacts such as toxicity, high operating cost, and structural change of purified SWNTs. Therefore, any new purification method with the ultimate goal of attaining defect-free structure is of interest. This work will focus on applying froth flotation as an alternative separation process for SWNTs purification.

Froth flotation is one of surfactant-based separation processes (Scamehorn, 2000). It is widely utilized not only in the areas of mineral processing but also in sewage treatment, water purification, bitumen recovery from tar sands, and coal desulfuriation. In froth flotation, separation of a binary solids mixture may be accomplished by the selective attachment of hydrophobic solid particles to gas bubbles (typically air). The other hydrophilic solid particles remain in the liquid (typically water). The difference in the density between the air bubbles and water provides buoyancy that preferentially lifts the hydrophobic solid particles to the top of the column. There are several advantages of flotation operation such as rapid operation, low space requirement, high removal efficiency, and low cost (Choi and Choi, 1996). The carbon nanotubes tends to attach at the air bubbles while they ascend through solution and are concentrated in the form or froth at the top of the flotation cell. As a result, the formation of stable bubble particle aggregates is required in the froth flotation technique to enhance separation efficiency (Freund, 1995). The schematic diagram of froth flotation to remove carbon black from water is demonstrated in Figure 1.1.

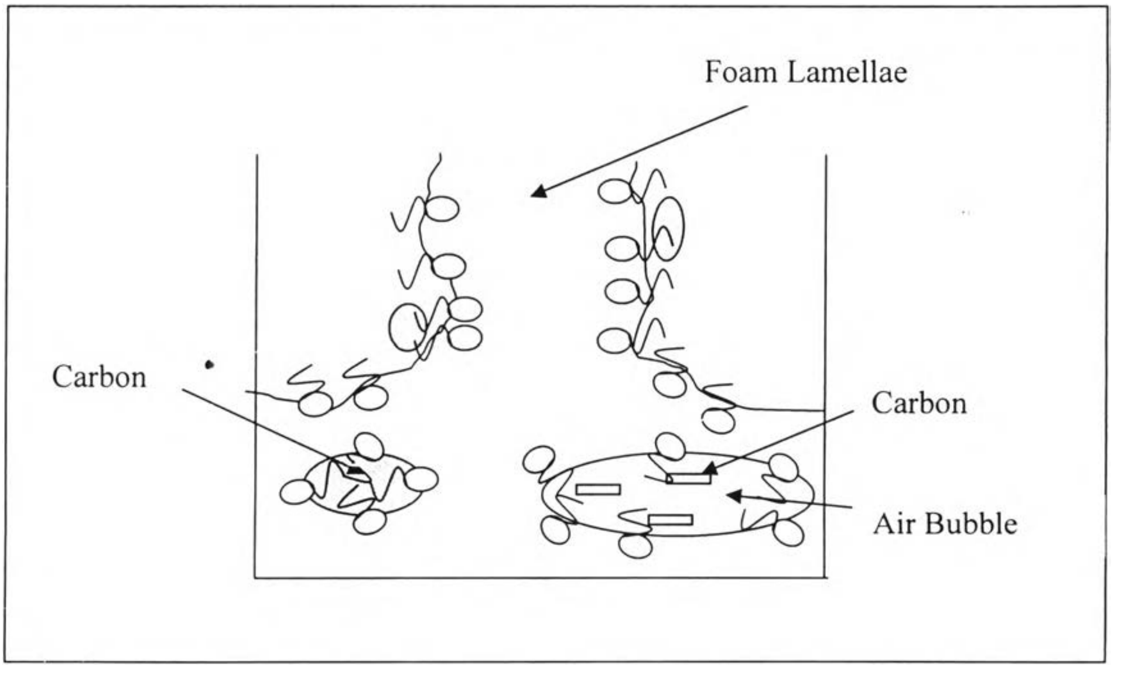

Figure 1.1 Schematic diagram of froth flotation process (Chungchamrienkit, 2004).

In this research, the removal of silica was studied by using sodium hydroxide (NaOH) and triethylenetetramine (TETA) prior to froth flotation step. The effects of the NaOH concentration, TETA volume, temperature and reaction time were studied for the dissolution of silica gel. Moreover, the use of sonication to break the bond between as-prepared SWNTs (AP-SWNTs) and silica support was investigated. The Laser Raman spectroscopy and Temperature Programmed Oxidation (TPO) were used to characterize the purified carbon both qualitative and quantitative, respectively.