Synthesis of Carbon Nanotubes Using Aliphatic Alcohols as a Carbon Source

Muhammed GJ1 and Hussein F2*
1Chemistry Department, College of Science, University of Babylon, Hilla, Iraq
2College Pharmacy, University of Babylon, Hilla, Iraq

Introduction

Carbon nanotubes (CNTs) are graphite layers with hexagonal carbon rings rolled into cylinders which are discovered first in 1991 [1,2]. According to their unique properties of carbon nanotubes (CNTs) which coming from their atomic structure and size therefore CNTs take wide concerns in technology and science and wide range of application which CNTs entering in it such as electrodes, hydrogen storage and sensors [3,4]. CNTs have different structures and diameters which classified into three types such as: single-walled carbon nanotubes (SWNTs) and multi-walled carbon nanotubes (MWCNTs) in addition to few wall carbon nanotubes (FWNTs) [5,6].

Different Methods are used for the synthesis of carbon nanotubes, such as, laser ablation [7], arc discharge [8] and chemical vapor deposition (CVD) [6,9]. Among different method were used for the synthesis CNTs, CVD is the preferred method because it is produce large quantity of CNTs and easy to control the properties of the product [10,11].

Carbon monoxide, hydrocarbons and alcohols such as ethanol, 1-propanol and 2-propanol are sources of carbon can be used in CVD method. Because of alcohols are makes less impurity and safe to treatment in the synthesis CNTs therefore consider the best carbon sources [6,12-14]. Ethanol can participate in the purification of the resulting CNTs when decomposition and produce OH radicals which act as etching agent by removing amorphous carbon during growth [15]. The process of synthesis CNTs can be done in two ways: the first without catalyst and the second by using a catalyst [16]. In this regard CVD method was used to synthesis CNTs by using alcohols such as ethanol, 1-propanol and 2-propanol as a source of carbon at temperature of 750°C.

Briefly, the process of synthesis CNTs includes heating the quartz tube furnace to the required temperature, and Fe/MgO was used as catalyst, then evaporating alcohol at a temperature below its boiling point by using a magnetic heater stirrer with the continuous flow of N2 gas which is used as a carrier gas at rate equal to 100 cm3/min. The volume of alcohol which were used was 30 cm3 and the process of evaporation took 1:30 hr. The heater of tube furnace was turn off when the evaporation process had finished with the continuous flow of N2 gas until cooling the tube of the precipitation reaction. The purification process of the product which was divided into two types according to the type of synthesis CNTs such as with catalyst and without catalyst. The two products were purified by using the same ways which include: oxidation the remaining product by (30%) H2O2 for 4 days at 70°C with their percentage of purification were Raman spectroscopy and thermal gravimetric analysis (TGA). Raman spectroscopy was used to identification of CNTs and provide important information about CNTs such as microscopic structure, electron quantum confinement, phonon and quality of tube [19]. Raman spectra as shown in Figure 1, contains three major peaks: D band at ~1352 cm−1 which corresponding to amorphous carbon impurities and defects in the CNTs sample, the second peak G band was shifted at ~1599 cm−1 because of high frequency in plan stretching of the C–C bonds, the last peak 2D band at ~2550 cm−1 is related to the process of double resonance [20]. The I_D/I_G ratio of the synthesized CNTs from 1-propanol with catalyst, ethanol with catalyst, 2-propanol with catalyst, ethanol without catalyst and 2-propanol without catalyst were 1.35, 1.8, 1.8, 2, 2.1 respectively. The increase the ratio of I_D/I_G which explain the increase number of defects on the sidewall of CNTs.

The TGA was used to evaluation the purities and qualities and to investigation of the presence of CNTs and to identify different types of carbon species [21]. According to the TGA analysis as show in Figure 2, it could be concluded that yield contains MWCNTs with less ratio of FWCNTs when was not used the catalyst, while the yield was mostly FWCNTs when the catalyst was used as shows in Table 1.

References


*Corresponding author: Hussein F, College Pharmacy, University of Babylon, Hilla Iraq, Tel: 00964 780 4009236; E-mail: abohasan_hilla@yahoo.com
Received July 29, 2015; Accepted July 30, 2015; Published August 05, 2015
Copyright: © 2015 Muhammed GJ, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.


<table>
<thead>
<tr>
<th>Type of carbon source</th>
<th>Weight loss%</th>
<th>The range of temperatures °C</th>
<th>Type of CNTs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol with catalyst</td>
<td>18.11</td>
<td>380-580</td>
<td>FWCNTs</td>
</tr>
<tr>
<td>Ethanol without catalyst</td>
<td>28.94</td>
<td>350-580</td>
<td>MWCNTs with less ratio of FWCNTs</td>
</tr>
<tr>
<td>1-Propanol with catalyst</td>
<td>12.33</td>
<td>210-500</td>
<td>mostly FWCNTs</td>
</tr>
<tr>
<td>1-Propanol without catalyst</td>
<td>-</td>
<td>-</td>
<td>No yield</td>
</tr>
<tr>
<td>2-Propanol with catalyst</td>
<td>35.18</td>
<td>400-900</td>
<td>FWCNTs in addition to MWCNTs</td>
</tr>
<tr>
<td>2-Propanol without catalyst</td>
<td>22.96</td>
<td>400-600</td>
<td>MWCNTs and FWCNTs</td>
</tr>
</tbody>
</table>

**Table 1:** The result and conclusions of synthesized CNTs.