Converted Graphite to Carbon Nanotubes by Flame Method

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Abstract
Graphite converted to multi walled carbon nanotubes by a flame deposition method in the atmospheric pressure at 150°C, the process has included Combustion process of graphite in Oxygen/ Nitrogen gases without using catalyst by homemade reactors. The product was assembled on the upper part of the reactor were characterized using Raman spectroscopy, X-ray diffraction, photo- images and scanning electron microscopy SEM. The analysis shows that the combustion process succeeded to separate graphite sheets and forming a mixture of graphite nanotubes with graphene mixture after removing some Vander Walls forces. The work includes supposing mechanism for producing or convert planer graphite to the tubular structure of graphite or multi-walled carbon nanotubes.

Keywords: Graphite, MWCNT, Flame Method, Photo-image, Raman Spectroscopy

1. Introduction:
Graphite or graphene with carbon nanotubes CNTs three types of planer and tubular structure of carbon atoms with sp² hybridization. The behavior of hybridization sp² with many sheets of carbon characterized by Van der Walls forces which responsible for making graphene sheets. The number of sheets decided the classification for carbon sheets to graphite when number of sheets more than 6 sheets or graphene for less than 6 sheets [1]. The tubular structure of graphene or graphite commonly known as single SWCNTs or few walled carbon nanotubes FWCNTs and multi-walled carbon nanotubes MWCNTs respectively [2-3]. The similarities between graphite, graphene and CNTs in continent and hybridization did not prevent the variance between them in physiochemical properties and behavior when change the dimensions 2D, and 1D respectively [4]. Many techniques were depend to synthesized graphite and CNTs such arch–discarch, laser ablation , chemical vapor deposition and flame deposition [1,5-6]. Mostly the strategy of synthesizing CNTs was still until know unexpansive due to the high temperatures and complex arrangement for preparations. Chen et. al were reported a graphite after mechanical milling at ambient pressure then thermal annealing up to 1400°C can produce large quantity of MWCNTs[7]. Sontara and Prabin were used microwave for conversion reduced graphene oxide into MWCNTs when catalytic by polyaniline (PANI) and Indium tin oxide [8]. In this work the highlighted on a process of transformation graphite to graphene then multi-walled carbon nanotubes by catalytic thermal process at atmospheric pressure. The product was characterized by X-ray diffraction, Raman spectroscopy, and photo images which enhance by scanning electron microscopy.

2. Experimental
2.1Materials:
The graphite was purchased from Fluke with purities 98.99%, and sulfur were obtained from the local market. Hydrogen peroxide H2O2 was purchase from Barcelona, Spain with 60%
percent weight. Nitrogen gas with purities (99.999%) was purchase from Emirates industrial gases.

### 2.2 Flame method

The reactor homemade for applying flame deposition for converting graphite to MWCNTs was explained by the skim diagram in figure 1 and used in our previous work [5-6]. Briefly, the reactor consist of cylindrical chamber with 50 cm in length and 30 cm in radius with three U tubes Heater, 1.5 kW which controlled by thermal cable with accuracy ±1 C. The process include (5/1) ratios of graphite/sulfur mixture respectively on the lower part of chamber which produce 580°C for the flame as shown in figur1. The flow of air/N2 gas was fixed at 500/200 cm³/min inside the chamber which tested to produce CO gas and ensure continues burning the graphite for 20 min at 150 °C. the temperature was rises 17°C after reaching the degree of reaction inside the chamber which 150°C as mentions previously. After precipitation the chamber was switched off before cool the system and purified with characterization the product.

![Figure 1: The skim diagram of homemade reactor](image)

### 3. Characterization

The crystalline and morphology analysis for processing of converted graphite to carbon nanotubes were done by X-ray diffraction Raman spectroscopy, photo-microscopic and scanning electron microscopy SEM. The XRD analysis were done with (Riga Rotalflex) (RU-200B) apparatus by using Cu Kα radiation at 0.15405 nm and Ni filter, 100 mA voltage, 40 kV, scan resolution was 5°/min and 0.02° for analysis from 2θ=10° to 2θ= 80°. The change in active groups were examine by Sentara infinity 1 Broker at 530 nm, from leaser light with intensity 2m W for 5 lops per 2s. The lab microscopy CD for graphite species after and before reacting in chamber were taken with 3 µm scope images. The Scanning electron microscopy SEM measurements were carried out with a JEOL JSM-6700F.

Figure 2 shows two patterns, the first for starting material which is graphite with two sharp and strong characteristic peaks of graphite at 26.5° and 43° for 002 and 100 patterns respectively [9]. The second for graphite after reaction which is mostly shows two peaks; at 2θ = 25.9° could be related to C (001) reflection of graphite, and 43.8° for lattice plane of (002) [10].
Raman spectroscopy for graphite after and before reaction were represent in figure 3 includes the graphite in the lower part, the characteristic peaks at 1315 cm$^{-1}$ and 1650 cm$^{-1}$[5]. The upper part shows three peaks at 1350 cm$^{-1}$, 1580 cm$^{-1}$ and 2700 cm$^{-1}$ with strongly and clearly distinct which can be related to forming many graphite's tubular structure from planer graphite [6] . The images of microscope shows few filaments of graphite in figure 4 which increased in after reaction as shown in figure 5.

Figure 2: XRD patterns for graphite and synthesized MWCNTs

Figure 3: The Raman spectroscopy for Graphite (lower skim) and synthesized MWCNTs (upper skim)
However, achieve more clear prove scanning electron microscopy SEM were taken for the product which shows many tubular structure of carbon as shown in figure 6. The photo images microscope shows more than 20 µm in length and less than 130 nm in diameter for band of filaments and many fragments of graphite with more than 30 µm² in area. The SEMs image for compositions of thread assemblies, wrapped and widespread on each other which refers to forming huge amount of CNTs.
4. Discussion:
In this work a simple chemical method for converting graphite to forming CNTs bundles by homemade reactor at 150 °C from coal. The XRDs patterns and Raman spectroscopy with images demonstrate forming the tubular structure. The process of converting planar graphite to tubular graphene orientations or CNTs was represented in figure 9. The process includes thermal decomposing and free radical condensation for the product from first step on the upper part of reactors. The heating with combustion in the presence of sulfur, causing Activated the ends of the graphite layers by carboxyl, epoxide and others function groups [11]. The last activation process will lead to decoupling Van der Waals forces between graphite sheets which composed the graphite [12]. The suppose mechanism was agree with Van der et al. and Reilly with Whitten [13] [14] when suppose, the donor or accepter electrons can enhance the condensation process of free radicals species. The process shows similar behavior when pyrolysis of graphite by breaking the Van der Waals bonds between carbons sheets which produce different fragments of graphite free radicals [15]. The process of separation sheets of graphite was enhance when many edge of graphite was oxidized by burning, forming many carbonyl and hydroxide with epoxide groups. Graphite after burning mostly when active functional groups forming at the edge of sheets, the repulsive forces causing increase the distance between the sheets.
Conclusion:
This method could depend for synthesizing of carbon nanotubes which characterized as an easy techniques and inexpensive. It was demonstrated that, the graphite was convert to graphene oxide sheets under thermal decomposition, which mostly were scrolled to CNTs. During decomposition thermal reactions Heating or burning graphite mostly causing many active functional groups at the edge of sheets, repulsive with each other and increase the distance between the sheets. The growth of CNTs are enhance, when the sulfur is mixed with coal due to increase the decomposition the graphite to graphene.

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