



Formation of carbon Nanomaterials in water without catalyst by arc plasma technique

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ABSTRACT

Simple technique was used for formation of carbon nanomaterials without using any type of gases .The used arc plasma technique between the pure graphite electrodes with different diameters for anode submerged in water at room temperature.arc plasma is produced using D.C power supply with current (30-90amp),and voltage (5-20volt).The nanomaterials were produced in the form of floating on the surface of water and other nanomaterials deposited on the bottom of the container and the other deposit on the cathode's rod,and nanocolloidal dispersed through the water. The results of these experiments were examined by Atomic force microscope(AFM), scanning electron microscope(SEM) Simple technique was used for formation of carbon nanomaterials without using any type of gases .The used arc plasma technique between the pure graphite electrodes with different diameters for anode submerged in water at room temperature.arc plasma is produced using D.C power supply with current (30-90amp),and voltage (5-20volt).The nanomaterials were produced in the form of floating on the surface of water and other nanomaterials deposited on the bottom of the container and the other deposit on the cathode's rod,and nanocolloidal dispersed through the water. The results of these experiments were examined by Atomic force microscope(AFM), scanning electron microscope(SEM) and the cathode's rod were examined by optical microscope after arc plasma.

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Introduction

Carbon nanotubes(CNT) have recently attracted great interest as new nanomaterials due to their excellent mechanical, electrical and chemical characteristics. Considerable efforts has been expended searching for potential applications of CNT in a world wide range of scientific fields such as electronics, biology, medicine, energy, materials engineering and aero science [1,2].carbon nanotubes were first reported by Iijima in carbonaceous deposit on cathode obtained during the D.C arc discharge prcess of a graphite electrode in helium gas [3].carbon nano particles have attracted great attention because of their unique mechanical and electrical properties[4]. Three typical synthesis methods have been developed for the production of CNT, including the conventional arc discharge in an inert gas[5], laser vaporization[6] and chemical vapor deposition(CVD)[7,8].the widely used method to fabricate carbon nanomaterials require vacuum system to generate plasma using an arc discharge[9,10],laser ablation or glow discharge [11]. These methods suffer in bulk production from not only the high investment and running costs of the vacuum equipment also low yield of the desired products the vacuum processes also yield, in addition to the desired nanomaterials unwanted contaminants(amorphous carbon and disordered nano particles). So that a time consuming and costly purification steps must be carried out. Therefore a process that allows the generation of nanotubes or nanoonions with minimum contamination is desirable. In their method an arc discharge was generated in liquid nitrogen between two carbon electrodes. Although their method is superior to conventional ones in terms of simplicity,

the rapid evaporation of a liquid nitrogen poses a problem after their report an even more economical technique using water instead of liquid nitrogen was used to successfully produce nanotubes[12]. Working independently on a water arc, we found that high concentration nano particles can be obtained as floating powder on the water surface while the rest of the product emitted is found at the base of the water[13]. Carbon nanofibers (CNFs) are electrically and thermally conductive and have very good mechanical properties. CNFs are less expensive and can be manufactured at high yields, justifying further in-depth investigation of their impact on nanocomposites. CNFs have a cup-stacked structure which results from the vapor deposition process used to produce them .The relatively low efficiency of catalyst results in microstructural defects in CNFs, which require special treatments in order for CNFs to achieve desired properties. A number of treatment methods have been used, which include acid treatment, heat treatment (to eliminate defects), plasma treatment (to purify), and surface functionalization (to improve interface adhesion)[14].

Experimental procedure

The arc discharge was generated between two pure graphite electrodes in water. These electrodes emerged in the container and they were horizontally aligned on the same axis with about 0.5mm gap. One of the brass electrode holders was free to move(anode) forward and backward using a micrometer, which enables proper electrodes gap adjusted during arc discharge. The power supply is turned on the anode electrode is then moved gradually towards the cathode electrode using a manual micrometer. Once the electrodes are in touch to generate the

discharge the anode turned red hot subsequently, the anode electrode is moved backwards to maintain the gap about 0.5mm. Simultaneously the plasma in spherical shape is formed, When the arc discharge stabilized the rod are kept at about 0.5mm a part while the carbon deposited on the cathode. The power supply is turned off after (2-6min) and left for a while for cooling. Fig(1) show the photograph setup of arc discharge system.



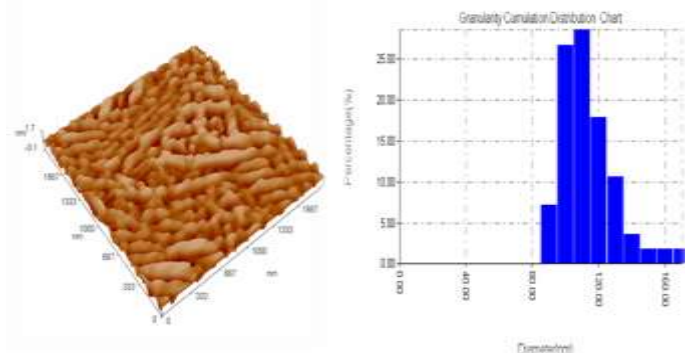
Fig.1: Setup of arc-discharge system

Results and discussion

Arc discharge was generated in graphite rods. Anode rods with 3 and 6mm diameters of graphite were used. Graphite rod of 6mm diameter were used as cathode. In such experiment the diameter of anode is especially important because only the anode is consumed by arc discharge process.

Atomic force microscope

The morphological characteristics of carbon nanoparticles have been studied using Atomic force microscope (AFM) to observe nanostructures. Fig(1) shows the image of carbon nanoparticles when the diameter of cathode 6mm and the anode diameter 6mm. The average of obtained particles is 108nm. Fig(2) shows the carbon nanoparticles when the cathode diameter 6mm and anode diameter 3mm. The average of obtained particles is 52nm.



Fig(1): AFM image of carbon nanostructures with electrodes diameters 6 and 6mm

In figures(1) and (2), the carbon nanostructures CNTs, CNFs and carbon nanoparticles as shown in previous figures immobilized on glass substrate have different diameters, lengths and form aggregates. The morphology of the surface appears to be homogeneous and composed by peaks that are assigned to the CNTs tips exposed on the surface. The height values reported in the images does not correspond to the true thickness of the CNTs, CNFs and carbon nanoparticles film. This is due to the impossibility of the AFM tip to reach the substrate because the high density of the CNTs, CNFs and carbon nanoparticles films.

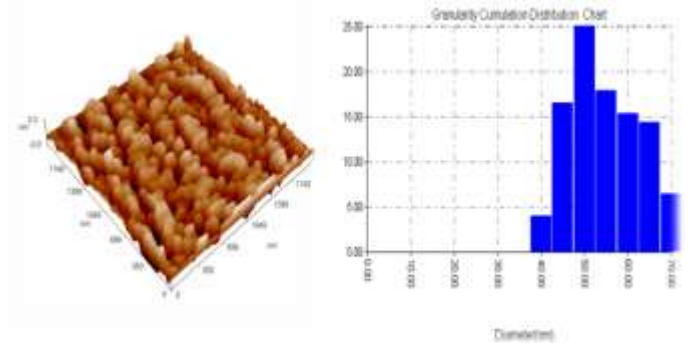
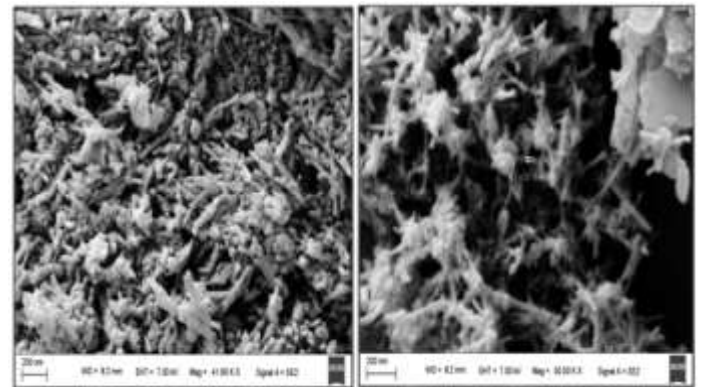
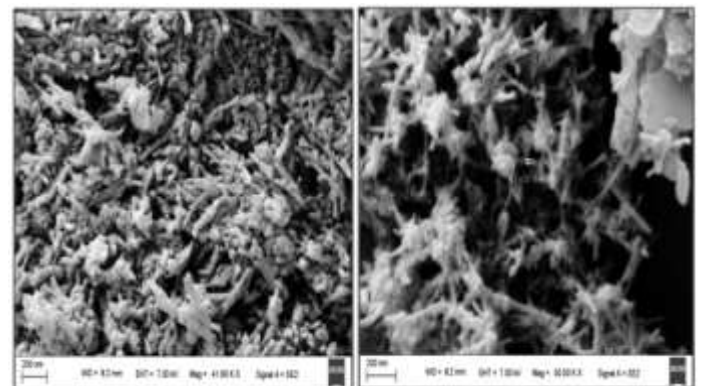


Fig (2): AFM image of carbon nanostructures with electrodes diameters 6 and 3mm Scanning electron microscope(SEM)

Scanning electron microscope(SEM) showed that produced different nano materials such as carbon nanotubes(CNT), carbon nanofibers(CNF) and carbon nanoparticles For floating surface. Fig(3) show SEM image at different magnification(50k,41,9k)X for the floated CNF and nanoparticles with cathode diameter 6mm and anode diameter 3mm. The fiber like CNTs and carbon nanoparticle distributed randomly were observed on the surface of the fine columnar. It is clear from the fig(3) that an aligned CNTs were produced. It is noticing that the percentage of MWCNTs are much larger than spherical and irregular particles. This image demonstrated that the CNT produced typically near of 20-35nm in diameter and the length of the CNTs varies from 100-300nm. Fig(4) show SEM image at different magnification (50kX) for floating surface with cathode diameter 6mm and anode diameter 6mm. The nanoparticles collected on the right side of CNF and this fig shows a thicker CNF with relatively periodic minute as those observed, with 35nm of external diameter.

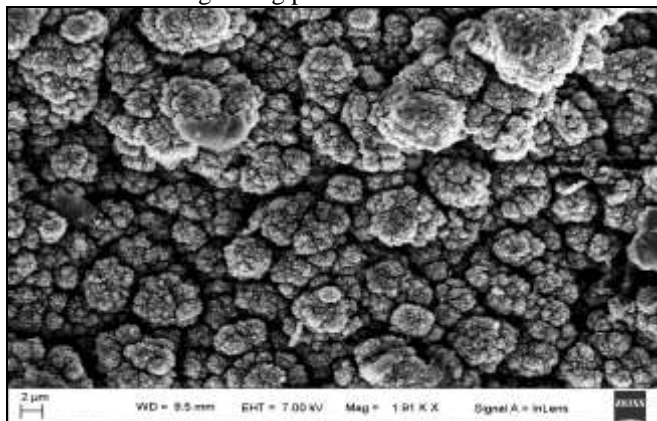


Fig(3): SEM image for floating CNTs, CNFs and nanoparticle with cathode diameter 6mm and anode diameter 3mm



Fig(4): SEM image for floating CNFs, CNTs and nanoparticles with cathode diameter 6mm and anode diameter 6mm.

Fig(5) shows the cathode rod after arc discharge process without catalyst and illustrate the typical micrograph of the deposited carbon on the electrode end which correspond to the arc discharge current of 90A. Stacked graphite layers which is formed due to the sudden quenching of plasma and high current densities used during arcing process.



Fig(5): SEM image for surface cathode after arc plasma.

Table(A) show the amount of yield in gm that deposit on the bottom of container and floating on the surface of the liquid, ph, arc time, temperature and electrical conductivity after arc plasma with different diameter of anode.

Anode diameter(m m)	Yield in gm	Arc time(min)	PH after arc	temperature	Conductivity(us/cm)
3	0.43g m	6	6.5	90C	22.3
6	0.55g m	8	6	98C	23.5

Conclusion

Arc discharge technique in water using arc plasma experiments produce variety of carbon nanomaterials without catalysts. The products also show different shapes and size of carbon nanotubes, nanofibers and nanoparticles.

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