

## SYNTHESIS OF CARBON NANOTUBE AND ITS MEDICAL APPLICATIONS: A BRIEF REVIEW

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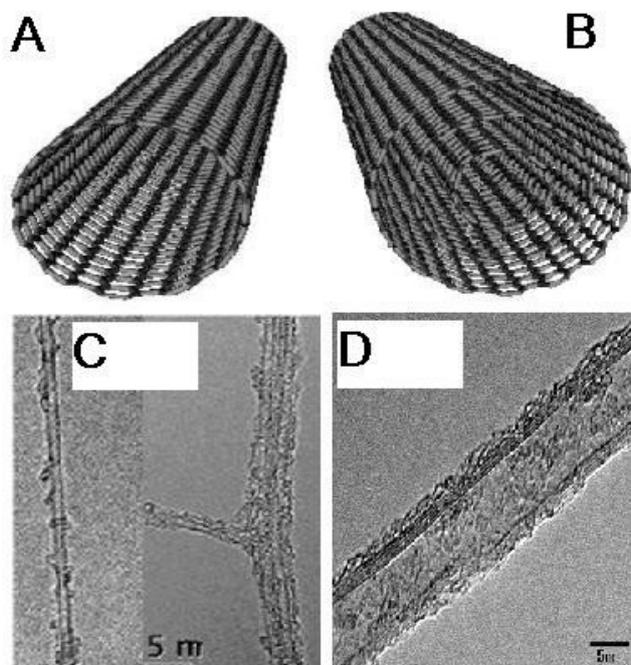
### ABSTRACT

Now a days of synthesis of carbon nanotube have been done by the researchers on their applications in various fields. Specially for applications in medicine, gene, and drug delivery areas. Many different production methods for carbon nanotubes (CNTs) have been introduced; Various methods are used for fabricating CNTs few more popular methods for producing CNTs are carbon arc-discharge method, laser ablation method and chemical vapor deposition method (CVD).. Parameters such as structure, surface area, surface charge, size distribution, surface chemistry, and agglomeration state as well as purity of the samples have considerable impact on the reactivity of carbon nanotubes.. Carbon nanotubes (CNTs) are very useful in today's world of medical research and are being highly researched in the fields of efficient drug delivery and biosensing methods for disease treatment and health monitoring.

**KEYWORDS:** Carbon nanostructures, Drug delivery, Nanotubes

### INTRODUCTION

Carbon is the chemical element with atomic number 6 and has six electrons which occupy  $1s^2$ ,  $2s^2$ , and  $2p^2$  atomic orbital. It can hybridize in  $sp$ ,  $sp^2$ , or  $sp^3$  forms. Discoveries of very constant nanometer size  $sp^2$  carbon bonded materials such as graphene [Ouyang M et al.(2001)]. fullerenes and d carbon nanotubes [Chico L et al.(1995)]. Graphene is a one atom thin sheet of carbon, this sheet of one atom thick carbon rolled up in a cylindrical shape can be imagined as carbon nanotube. Carbon nanotubes can be further categorized into single wall carbon nanotubes (SWCNTs) and multiwall carbon nanotubes (MWCNTs). Figure 1.1 shows the structure of single wall carbon nanotubes (SWCNTs) and multiwall carbon nanotubes (MWCNTs). (Eatemadi et al.( 2014).)



**Figure 1.1** single-walled nanotube(SWNT) or multi-walled nanotubes (MWNT) Types

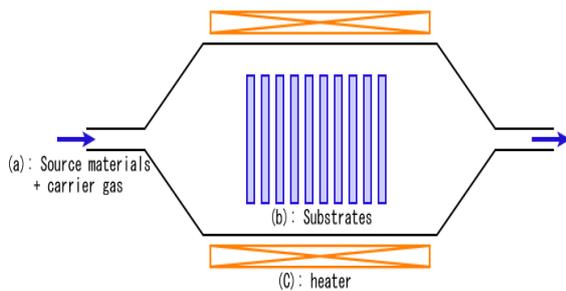
There are many different **types of carbon nanotubes**, but they are normally categorized as either single-walled nanotube(SWNT) or multi-walled **nanotubes** (MWNT). A single-walled **carbon nanotube** is just like a regular straw. It has only one layer, or wall, and Multi-walled nanotubes (MWNTs) consist of multiple rolled layers (concentric tubes) of grapheme

## SYNTHESIS OF CARBON NANOTUBE

Some popular methods for producing CNTs are carbon arc-discharge method, laser ablation method and chemical vapor deposition method

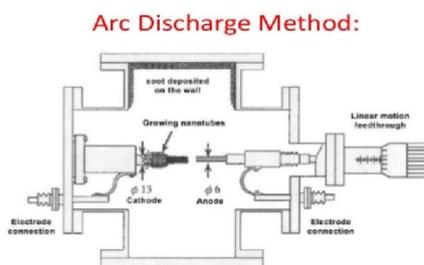
**1. Chemical Vapour Deposition** - It is a vacume deposition method used to produce high quality, high-performance, solid materials. The process is often used in the semiconductor industry to produce thin films.

In typical Chemical Vapour Deposition method, the wafer (substrate) is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired deposit. Frequently, volatile by-products are also produced, which are removed by gas flow through the reaction chamber. Microfabrication processes widely use CVD to deposit materials in various forms, including: monocrystalline, polycrystalline, amorphous, and epitaxial. These materials include: silicon (SiO<sub>2</sub>, germanium, carbide, nitride, oxynitride), carbon (fiber, nanofibers, nanotubes, diamond and graphene), fluorocarbons, filaments, tungsten, titanium nitride and various high-k dielectrics[Rosen, Y, Mattix, B, Rao, A. (2009) ]



### Chemical Vapour Deposition

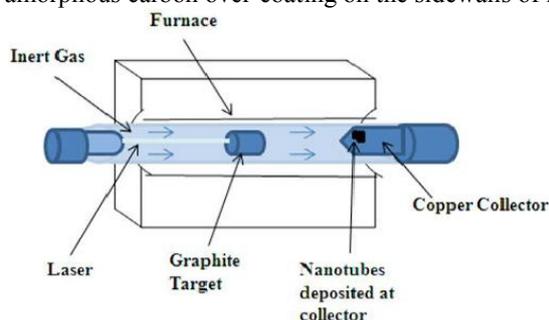
**2. Arc-discharge method** -This method synthesizes nanotubes by using a fairly low voltage power supply to strike an electrical arc between two carbon electrodes. The carbon anode can be enriched with particles of a transition metal in order to aid synthesis. Nanotubes form in the arc and collect on the anode, along with a host of other carbon byproducts. The nanotubes that are synthesized by this means are typically very ropy and multi-walled.



### 3. laser ablation method –

In 1995 Richard E. Smalley and his group used for the first time laser ablation to grow high quality nanotubes. Intense laser pulses ablate a carbon target which is placed in a tube-furnace (see Fig. 3) heated to 1200°C [3].

During the process some inert gas like helium or argon flows through the chamber to carry the grown nanotubes to the copper collector. After the cooling of the chamber the nanotubes and the by-products, like fullerenes and amorphous carbon over-coating on the sidewalls of nanotubes can be collected



#### 2.4. Comparison of three most useful methods of nanutube synthesis

Method	Arc discharge method	Chemical vapour deposition	Laser ablation (vaporization)
Process	Connect two graphite rods to a power supply, place them a few millimetres apart, and throw the switch. At 100 amps, carbon vaporises and forms a hot plasma.	Place substrate in oven, heat to 600 °C, and slowly add a carbon-bearing gas such as methane. As gas decomposes it frees up carbon atoms, which recombine in the form of NTs	Blast graphite with intense laser pulses; use the laser pulses rather than electricity to generate carbon gas from which the NTs form; try various conditions until hit on one that produces prodigious amounts of SWNTs
Typical yield	30 to 90%	20 to 100 %	Up to 70%
SWNT	Short tubes with diameters of 0.6 - 1.4 nm	Long tubes with diameters ranging from 0.6-4 nm	Long bundles of tubes (5-20 microns), with individual diameter from 1-2 nm.
M-WNT	Short tubes with inner diameter of 1-3 nm and outer diameter of approximately 10 nm	Long tubes with diameter ranging from 10-240 nm	Not very much interest in this technique, as it is too expensive, but MWNT synthesis is possible.

Merits	Can easily produce SWNT, MWNTs. SWNTs have few structural defects; MWNTs without catalyst, not too expensive, open air synthesis possible	Easiest to scale up to industrial production; long length, simple process, SWNT diameter controllable, quite pure	Primarily SWNTs, with good diameter control and few defects. The reaction product is quite pure.
Demerits	Tubes tend to be short with random sizes and directions; often needs a lot of purification	NTs are usually MWNTs and often riddled with defects	Costly technique, because it requires expensive lasers and high power requirement, but is improving

### 3. Carbon nanotube in medical application-

In the beginning of the 21st century, CNTs have been introduced in medical field for drug delivery system in therapeutics. Lots of biomedical applications of CNTs, including drug vectors, biomolecule, gene delivery to cells or organs, tissue regeneration, and biosensor diagnostics and analysis[Wang, X(2009)].

#### IN ANTI-CANCER TREATMENT

Many anti-cancer drugs, such as epirubicin, doxorubicin, cisplatin, methotrexate, quercetin, and paclitaxel, have been conjugated with functionalized CNTs and successfully applied. The chemotherapy agents can be bound to a complex formed by CNT and antibody against antigen overexpressed on the cancerous cell surface. In this way it is possible to carry the drug mostly at the level of the tumor cells.[ Masotti, A, Caporali, A (2013)]. Drugs can be linked with a magnetic CNT complex, obtained by fixing a layer of magnetite (Fe<sub>3</sub>O<sub>4</sub>) nanoparticle on the surface of the nanotubes. In this case, the system CNT drugs can be guided by an externally placed magnet to target a desired organ interested by the cancer cell localization sparing normal counterparts. Moreover[, due to their tiny size and accessible external modifications, CNTs are able to cross the blood-brain barrier (BBB) by various mechanisms targeting for acting as effective delivery carriers to treat brain tumors.[ Caraglia, M, De Rosa (2013)].

A water soluble SWCNT-Paclitaxel (PTX) conjugate has been found to be highly efficient in suppressing tumor growth when compared with free taxol in a murine 4T1 breast cancer cell model, likely for both the extended blood circulation and enhanced permeability and retention (EPR) effect by SWCNT.[ Liu, Z, Chen, K, Davis, C. (2008)].

#### IN ANTIMICROBIAL APPLICATION

Functionalized CNTs can be used in vaccination procedures. CNTs were shown to activate cells deriving from the innate immune system, such as monocytes, macrophages, and dendritic cells.

CNTs themselves might have antimicrobial activity through oxidation of the intracellular antioxidant glutathione, resulting in increased oxidative stress on the bacterial cells and eventual pathogen death[He, H, Pham-Huy(2013)].

#### APPLICATION IN OTHER FEILD

The linkages of other biomolecules such as genes, proteins, DNA, and biosensors to CNTs have been also assessed for gene therapy and tissue regeneration. CNTs can effectively transport the genes inside mammalian cells, maintaining their integrity. In fact, when bound to SWCNTs, DNA probes are protected from enzymatic cleavage and interference from nucleic acid binding proteins.

Siu et al. found both significant uptake and gene silencing in the tumor tissue of Cy3-labeled siRNA raised against the B-raf oncogene (siBraf) linked to SWCNTs. Al-Jamal et al. had reported that amino-functionalized CNT complexed with siRNA were able to lead to functional rehabilitation in an induced stroke model after stereotactic administration.

SWCNTs have strong optical absorption from ultraviolet (UV) to near-infrared (NIR) regions, which can be used for photothermal therapy and photoacoustic imaging from the heat they generate from NIR light absorption. SWCNTs appear to be an excellent platform for biomedical molecular imaging.[ Pondman, KM, Sobik, M, Nayak, A. (2014) ]

Polymethyl methacrylate denture base material modified with multiwalled carbon nanotubes showed better results in terms of fatigue resistance, flexural strength, and resilience compared to conventional materials used in dentistry. Besides these main applications of CNTs, they have been shown as a powerful tool for enantiomer separation of chiral drugs and chemicals in the pharmaceutical industry[Ouyang M (2001)]

## **CONCLUSION**

Carbon nanotubes (purified/modified) have a high potential of finding unique applications in wide areas of medicine. The use of CNTs in the medical area is expected to spread rapidly. Now a days the pharmaceutical industry has used nanoparticles to reduce toxicity and side effects of drugs. CNTs can be used in various medical applications .

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