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# A REVIEW ON CARBON NANOTUBES

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## ABSTRACT

Carbon nanotubes were growing day to day as research work is going to find their applications in variety of fields .Carbon nanotubes are allotropes of carbon with a cylindrical nanostructure and they are nanometer in diameter and several millimeters in length. Carbon nanotubes have many structures, differing in length, thickness and in the type of helicity and no of layers. They were classified into Single-wall Nanotubes (SWNT), Double-wall Nanotubes (DWNT) and Multi-wall Nanotubes (MWNT).In this review classification, important synthesis methods and applications were covered.

**Keywords:** Allotropes, CVD, CNT's, SWCNTs, MWCNTs.

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## INTRODUCTION

Carbon nanotubes are allotropes of carbon with a cylindrical nanostructure and they are nanometer in diameter and several millimeters in length. Carbon nanotubes have many structures ,differing in length ,thickness and in the type of helicity and no of layers . Their length -to- diameter ratio is upto 132000000:1. Carbon nanotubes were discovered accidentally [1] while studying the surfaces of graphite electrodes used in an electric arc discharge [1]. Discovery of carbon nanotubes (CNTs) has the potential of revolutionizing the biomedical research as they can show superior performance because of their impressive structural, mechanical, and electronic properties such as small size and mass, high strength, higher electrical and thermal conductivity, etc. [2,3].Blood compatibility is an important property for most of the biomedical devices to render their intended functions in vivo. The lack of blood compatibility results in adsorption of plasma proteins, platelet adhesion, and activation, triggering the coagulation and complement cascade and clot formation often leading to device failure [4].It is interesting to note that among the currently available delivery systems, which include liposome's, emulsions, polymers and micro particles, CNTs have recently gained popularity as potential drug carriers, therapeutic agents and for applications in diagnosis [5].

## CLASSIFICATION

The carbon nanotubes consist of carbon atoms bonded into a tube shape ,sometimes with a single wall or multiple walls. Carbon Nanotubes can be categorized by their structures:

- Single-wall Nanotubes (SWNT)
- Multi-wall Nanotubes (MWNT)
- Double-wall Nanotubes (DWNT)

The measured specific tensile strength of a single layer of a multi-walled carbon nanotube can be as high as 100 times that of steel, and the graphene sheet (in-plane) is as stiff as diamond at low strain [6].

SINGLE-WALL NANOTUBES (SWNT) VS MULTI-WALL NANOTUBES (MWNT)

| **Single-wall Nanotubes (SWNT)** | **Multi-wall Nanotubes (MWNT)** |
|---|---|
| Anode has to be doped with metal catalyst. | No need to dope with metal catalyst |
| Single layer of graphene | Multiple layer of graphene |
| Purity is poor and easily twisted | Purity is high and not easily twisted |
| produced with the use of metal catalyst and graphite | produced with the use of pure graphite |
| 0.4 -2nm diameter | 2-100nm diameter |
| 90% purity | 95%purity |
| 5-15% Amorphous | 2% Amorphous |
| 300 ~ 600 m2/g of specific surface area | 40 ~ 300 m2/g of specific surface area |

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## SYNTHESIS

The mainly used synthesis methods are:

### Arc discharge

This method creates nanotubes through arc-vaporization of two carbon rods placed end to end, separated by approximately 1mm, in an enclosure that is usually filled with inert gas (helium, argon) at low pressure (between 50 and 700 mbar) [7].

### Laser ablation

The oven is filled with helium or argon gas in order to keep the pressure at 500 Torr. A very hot vapour plume forms, then expands and cools rapidly. As the vaporized species cool, small carbon molecules and atoms quickly condense to form larger clusters, possibly including fullerenes. The catalysts also begin to condense, but more slowly at first, and attach themselves to the carbon clusters and prevent their closing into cage structures. Catalysts may even open cage structures when they attach to them. From these initial clusters, tubular molecules grow into single-wall .

### Chemical vapour deposition (CVD)

Chemical vapour deposition (CVD) synthesis is achieved by putting a carbon source in the gas phase and using an energy source, such as plasma or a resistively heated coil, to transfer energy to a gaseous carbon molecule. Commonly used gaseous carbon sources include methane, carbon monoxide and acetylene. Then, the carbon diffuses towards the supported metal catalyst (usually a first row transition metal such as Ni, Fe or Co) Excellent alignment, as well as positional control on nanometer scale, can be achieved by using CVD7.

## APPLICATIONS

- Carbon nanotubes have potential therapeutic applications in the field of drug delivery, diagnostics, and biosensing.
- Bianco and co-workers initially studied the application of CNTs as a template for targeting bioactive peptides to the immune system [8].
- CNTs are currently being considered to be a suitable substrate for the growth of cells for tissue regeneration, as delivery systems for a variety of diagnostic or therapeutic agents or as vectors for gene transfection [9].
- Due to their high tensile strength, carbon nanotubes filled with calcium and arranged/grouped in the structure of bone can act as bone substitute [10].
- Carbon nanotubes and nanohorns are antioxidant in nature. Hence, they are used to preserve drugs formulations prone to oxidation. Their antioxidant property is used in antiaging cosmetics and with zinc oxide as sunscreen dermatological to prevent oxidation of important skin [11].

- Wu et al reported the use of passive cellular uptake to deliver multiwall carbon nanotubes conjugated with amphotericin B (AmB), an antibiotic that is effective in treating fungal infections, but toxic to mammalian cells when it is free in solution [12].
- Dai and co-workers demonstrated SWNTs as nonviral molecular transporters for the delivery of short interfering RNA (siRNA) into human T cells and primary cells [13].
- In genetic engineering, CNTs and CNHs are used to manipulate genes and atoms in the development of bioimaging genomes, proteomics and tissue engineering [14].
- It has been reported that Paclitaxel loaded PEG--CNT's are promising for cancer therapeutics [15].
- Carbon nanotubes could be an important new weapon and act as a boost to fight against cancer after researchers found that they can improve a treatment called adoptive immunotherapy [16].
- They can be used as lubricants or glidants in tablet manufacturing due to nanosize and sliding nature of graphite layers bound with van der waals forces.
- The gelatin CNT mixture (hydro-gel) has been used as potential carrier system for biomedicals.
- Antibiotic, Doxorubicin given with nanotubes is reported for enhanced intracellular penetration.
- CNT-based carrier system can offer a successful oral alternative administration of Erythropoietin (EPO), which has not been possible so far because of the denaturation of EPO by the gastric environment conditions and enzymes [17].
- Apart from medical applications ,they were also used in Conductive plastics, Structural composite materials, Flat-panel displays, Gas storage, Antifouling paint, Micro- and nano-electronics, Radar-absorbing coating, Technical textiles, Ultra-capacitors, Atomic Force Microscope (AFM) tips, Batteries with improved lifetime and Biosensors for harmful gases.

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