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Carbon Nano tubes & Its Application In Medical Field & Communication

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Abstract: Carbon nanotubes (CNTs) was discovered by a Japanese researcher Sumio Iijima in 1991 by arc discharge method. CNTs derived their name from their long, tube-shaped hollow structure. They are made from graphite sheet rolled-up continuous hexagonal mesh & carbon molecules at the apexes of each hexagons. CNTs have diameter in nano meter and useful in many nanotechnology applications. These nano tubes are classified into two group: single walled and multi-walled nano tubes. Different properties of nano tubes like strength, thermal conductivity, stiffness have led into various fields. Physical and chemical properties and characteristics of CNTs are still being researched heavily. Carbon nano tubes have huge applications in miscellaneous fields. The history of nano tubes is just the beginning. Current study of CNTs has given a very promising and bright future ahead.

Keywords: CNTs, single and multi-walled nano tubes, properties of nanotubes, applications.

I. INTRODUCTION

In the mid of 1980s, solid carbon was existing only in two forms, i.e. diamond and graphite. These two have different structures as well as properties. Atoms of diamond and graphite were bonded covalently. In 1985 a group of researchers led to an unpredicted and adventitious experiment which discovered a new molecule made purely of carbon. It was expressed like a soccer ball shape hence named “bucky balls”. This bucky ball was recognised as a new allotrope of carbon and called the fullerenes. Fullerenes form a spherical shape like structure made up of hexagons and pentagons. Now this unique allotrope of carbon did not end like this instead produced cylindrical tubes of carbon. This “bucky balls” were now known as carbon nano tubes. Carbon nano tubes is a hollow cylindrical tube- shaped material having diameter in nano meter. It is like a rolled-up graphite sheet with continuous uninterrupted network of hexagons with the carbon molecules at the apexes of each hexagonal. CNTs are seamless tubes which consists of a mixture of metallic and semi-conducting tubes. The properties and characteristics of carbon nanotubes are still under research in labs. Considering the geometry of nanotubes they have three geometries such as: armchair, zig-zag and chiral [example: zig-zag (n, 0) , armchair (n, n) , chiral (n, m)]. Chiral indices (n, m) gives the atomic structure of tube. This n and m refers normally to the x and y axis. The diameter of CNTs is ranging from < 1 nm upto 50 nm. Its thickness is as thick as a human hair.

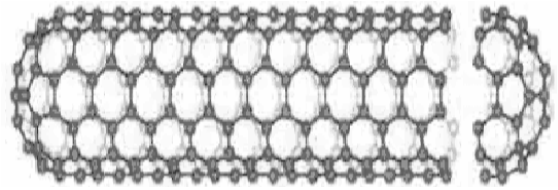

Fig.1. Structure of carbon nanotube

Fig.2. Structure of diamond

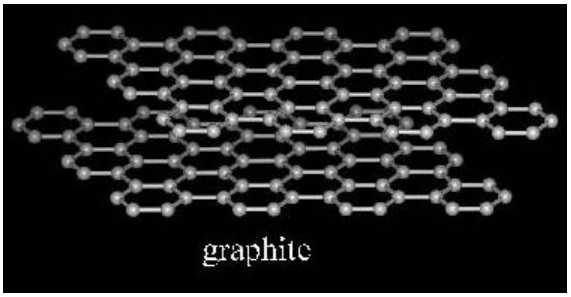

Fig.3. Graphite is composed of graphite sheets of carbon

Fig.4. Fullerene

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II. HISTORY

The history of carbon nanotube started in the year 1952. In 1952 Radushkevich and Lukyanovich published understandable picture of CNTs whose diameter was 50 nm in the Soviet Journal of Physical Chemistry. Further in 1976 Oberlin, Endo and Koyama published their paper which simply showed hollow fibres of carbon with diameter in nanometer. In 1979, John Abrahamson used arc discharge technique to produce carbon fibres on carbon anodes at the 14th Biennial Conference of Carbon at Penn State University. It was not yet over. Again in 1981 a group of Soviet scientists suggested that "carbon multi-layer tubular crystals" were produced by rolling graphite sheets or graphene layers into cylinders. In 1987, Howard G. Tennent of Hyperion Catalysis produced a tube of 70 nm. A large and improved amount of work was continuously carried out in labs in this field. Lastly in the year 1991, a Japanese researcher Sumio Iijima carried out the hollow, nanometer sized tube of graphitic carbon at Nippon Electric Company (NEC) by arc discharge method.

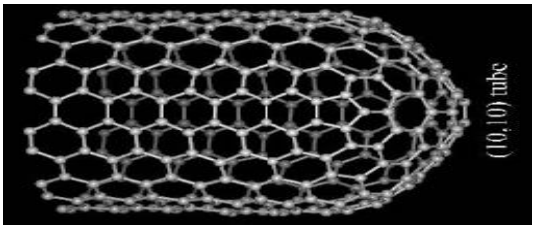

Fig.5. Nanotube

III. CLASSIFICATION

The graphite sheet can be rolled in more than one way and hence forms various types of CNTs. Thus they can be classified as: single-walled nanotube (SWNT) and multi-walled nanotube (MWNT).

SINGLE-WALLED NANOTUBE:
Single-walled nanotube (SWNT) is made from a single thick layer of graphite rolled into a seamless cylindrical tube like structure. Its diameter is close to longer length.

For the synthesis of SWNT, catalyst is needed and its purity is poor. During functionalization, a chance of defect is more and it can be easily turned and twisted. Its characterisation and evaluation is easy. It has a band gap of 0-2 eV.

MULTI-WALLED NANOTUBE:
Multiple layers of graphene are rolled onto each other. The interlayer distance in MWNT is approximately close to 3.4 Å. The two models which can clearly describe the MWNT are Russian Doll Model and Parchment Model.

The multi-walled nanotube can be produced without any catalyst. It has a very complicated structure and cannot be easily twisted. Its purity is high and defects chance is less. But once the chance of defect is occurred it is tough to avoid.

IV. IMPORTANCE OF CARBON NANOTUBES

Here is the importance of CNTs:

1. Because of less power consumption, increased performance, high aspect ratio, high tensile strength, low mass density, high heat conductivity, large surface area, and a versatile electronic behavior, including high electron conductivity, carbon nanotubes are rapid in growth.
2. The helicity of carbon nanotubes along with the diameter introduces significant changes in the electronic density of states, and hence provides a unique electronic character.
3. The other factor of importance is when individual layers are closed on to themselves, certain properties of graphite disappear, making the structure remarkably different from graphite.
4. The combination of size, structure and topology endows nanotubes with important mechanical properties (e.g., high stability, strength and stiffness, combined with low density and elastic deformability) and with special surface properties (selectivity, surface chemistry).

V. PROPERTIES OF CNTs

Carbon nanotubes have very interesting and unique properties such as high thermal conductivity, high electrical conductivity, high mechanical strength, has ultra light weight, high aspect ratio, high surface area, it has both metallic and semi-metallic behaviour, is harder than diamond (152 GPa).

VI. APPLICATIONS

CNTs have huge applications in various different fields. Recent applications of CNTs are-

1. Hydrogen storage
2. As a catalyst
3. As a diagnostic tool
4. As a preservative
5. In biomedical applications
6. Genetic engineering
7. Chemical sensors
8. In pharmacy as a carrier for drug delivery
9. Artificial implants
10. Paper batteries

Application in Medical field And Communication
Today technology is increasing day by day and moving ahead without any stoppage. The new tools are introduced in the market which help in creating excellent devices and are much more advanced than earlier one.

These devices in one or the other way serves as a helping hand in technology which is becoming advanced each day. Carbon nanotubes is a unique creativity in the field of micro technology. It also has its application in communication area. They are commonly used in optical and electronic communication. Due to high tensile strength nanotubes are possibly used in flywheels, space

elevators and in bridges. Can be used in fire resistive products because it resists high temperature quality like for examples bucky paper. Today techniques used in LCDs and touch screens are replaced b nanotube electrically transparent films. This is now used in displays for computers, cell phones and other electronic devices. Since they are electrically transparent they are used to create photocurrent in solar cells. These are also treated as superconductors and efficient capacitors for storing energy. Also worn as antennas for various EM devices.

Carbon nanotubes are also highly prevalent and researched in medical field. It has vast applications in pharmacy. Nanotubes have now become an advantage in drug delivery and cancer therapy. Some of the main applications of CNTs are in gene delivery to cells or organs, in tissue regeneration and biosensor diagnostic and analysis. CNTs also finds the solution and act as a resistance of infectious agents such as various antiviral and antibacterial problems in the body. Many other functionalized SWNTs or MWNTs have been used successfully as a delivery systems for treating neurode generative diseases or brain tumors (neuroscience). Also as an antioxidant.

VII. ADVANTAGES

Following are the advantages of nanotubes:

1. Extremely small and lightweight.
2. Are resistant to temperature changes.
3. Less power consumption.
4. Resources required to produce it is in plenty and many can be made in small amount of material.
5. Long life.
6. Enable multi-tasking.
7. Highly energy efficient.

VIII. LIMITATIONS

1. Have low shear strength. Can be easily torn.
2. The techniques and setups used in the production of carbon nanotubes are very expensive and very less efficient. These are:

(i). Arc discharge
(ii). Chemical Vapour Deposition (CVD)
(iii). Electrolysis
(iv). Laser Ablation

3. When inhaled, causes serious hazardous to human health.

IX. CHALLENGES

Even today there are some challenges which are being faced by carbon nanotube. Such as:

1. Lack of solubility in most solvents.
2. The production of structurally and chemically reproducible batches of CNTs with identical characteristics.
3. Difficulty in maintaining high quality and minimal impurities.
4. Have low shear strength.
5. The techniques and setups used in production of carbon nanotubes are very expensive and very less efficient.
6. When inhaled they may cause serious health hazard in human body.
7. Toxicity
8. Crystallographic defects.

X. CONCLUSION

The history of nanotube has only just begun. The properties and characteristics of carbon nanotubes are still being researched heavily by researchers. Single walled and multi walled nanotubes have proven themselves effective and safer in pharmacy or drug delivery field. Carbon nanotubes have been the focus of a lot of research work for nearly two decades now. Considering this investment of time and money, relatively few nanotube applications have reached the market yet. This may remind some of the disappointments associated with fullerene research, originally believed to be so promising, but which has resulted in no significant application after twenty years. However, nanotubes exhibit an extraordinary diversity of morphologies, textures, structures and nanotextures, far beyond that provided by fullerenes. Indeed, the properties of nanotubes are yet to be fully identified.

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