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CARBON NANOTUBES AND ITS APPLICATIONS: A REVIEW

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Abstract- **Carbon nanotubes (CNTs) are allotropes of carbon with a nanostructure that can have a length-to-diameter ratio greater than 1,000,000. These cylindrical carbon molecules have novel properties that make them potentially useful in many applications in nanotechnology. Their unique surface area, stiffness, strength and resilience have led to much excitement in the field of pharmacy. Nanotubes are categorized as single-walled nanotubes and multiple walled nanotubes. Nanotubes have a wide range of unexplored potential applications in various technological areas such as aerospace, energy, automobile, medicine, or chemical industry, in which they can be used as gas adsorbents, templates, actuators, composite reinforcements, catalyst supports, probes, chemical sensors, nanopipes, nano-reactors etc.**

Index Terms- **Carbon nanotubes, Single and multiple walled nanotubes.**

I. INTRODUCTION

Carbon nanotubes are one of the most commonly mentioned building blocks of nanotechnology. With one hundred times the tensile strength of steel, thermal conductivity better than all but the purest diamond, and electrical conductivity similar to copper, but with the ability to carry much higher currents, they seem to be a wonder material. However, when we hear of some companies planning to produce hundreds of tons per year, while others seem to have extreme difficulty in producing grams, there is clearly more to this material than meets the eye.

Carbon nanotubes are often referred to in the press, including the scientific press, as if they were one consistent item. They are in fact a hugely varied range of structures, with similarly huge variations in properties and ease of production. Adding to the confusion is the existence of long, thin, and often hollow, carbon fibers that have been called carbon nanotubes but have a quite different make-up from that of the nanotubes that scientists generally refer to. To distinguish these we will refer to them as carbon nanofibers.

II. HISTORY

EARLIER In 1952 Radushkevich and Lukyanovich published clear images of 50 nM diameter tubes made of carboN in the Soviet Journal of Physical Chemistry . A paper by Oberlin, Endo, and Koyama published in 1976 clearly showed hollow carbon fibres with nanometer-scale diameters using a vapor-growth technique3. Furthermore, in 1979, John Abrahamson presented evidence of carbon nanotubes at the 14th Biennial Conference of Carbon at Penn State University. Theconference paper described carbonnanotubes as carbon fibers which wereproduced on THE carbon anodes during arc discharge4. In 1981 a group of Soviet scientists published the results of chemical and structural characterization of carbon nanoparticles produced by a thermocatalytical disproportionation of carbon monoxide. Using TEM images and XRD patterns, the authors suggested that their “Carbon multi-layer tubular crystals”were formed by rolling graphene layers into cylinders.

III. CLASSIFICATION OF CARBON NANOTUBES

Carbon nanotubes are classified in following two types,

• SWNTs- Single walled carbon nanotubes• MWNTs- Multiple walled carbon Nanotubes

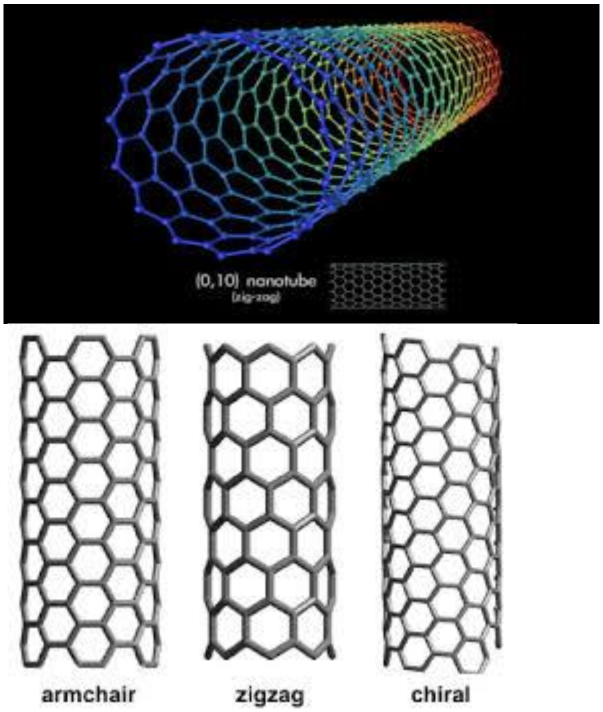

Table 1- Comparison between SWNT and MWNT

Sr. No.SWNTMWNT

1. Single layer of graphene. Multiple layer of grapheneCatalyst is required for synthesis.Can be produced without catalyst.
2. Bulk synthesis is difficult as it requires Bulk synthesis is easy.

proper control over growth and
atmospheric condition.

3. Purity is poor. Purity is high.
4. A chance of defect is more during A chance of defect is less but

functionalization. Once occurred is difficult to

6. Less accumulation in body. More accumulation in body.

IV. METHODS OF PRODUCTIONS OF CNTs:

A. Arc Discharge Method

Arc Discharge method has been reported for producing carbon nanotubes. In this method, as shown in FIG 1 nanotubes are produced through arcvaporization of two carbon rods placed end to end with a distance of 1mm in an environment of inert gas such as helium,
argon at pressure between 50 to 700 mbar. Carbon rods are evaporated by a direct
current of 50 to 100 amps driven by 20V which will create high temperature discharge between two electrodes. Due to this, anode will get evaporated and rod shaped tubes will be deposited on cathode. Bulk production of CNTs depends on uniformity of plasma arc and temperature
of deposition.

B. Laser Ablation Method

In 1996, Smalley and coworkers produced high yields (>70%) of SWNT by laserablation
(vaporization) of graphite rods with small amounts7 of Ni and Co at 1200 0C (see figure 4). The tube grows until too many catalyst atoms aggregate on the end of the nanotube. The large
particles either detach or become over-coated with sufficient carbon to poison the catalysis. This allows the tube to terminate with a fullerene-like tip or with a catalyst particle. Both arc-discharge and laser-ablation techniques have the advantage of high (>70%) yields of SWNT and the drawback that (1) they rely on evaporation of carbon atoms from solid targets at temperatures >3000 0C, and (2) the nanotubes are tangled which makes difficult the purification and application of the

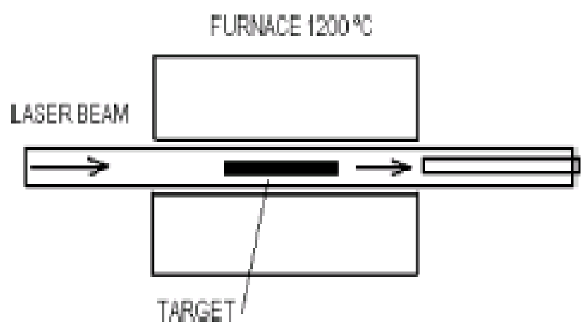

Figure 2:Laser-ablation scheme: Laser beam vaporizes target of a mixture of graphite and metal catalyst (Co, Ni) in a horizontal tube in a flow of inert gas at controlled pressure and in a tube furnace at 1200 0C. The nanotubes are deposited on a water-cooled collector outside the furnace.

D. Flame Synthesis Method:

SWNTs are formed in controlled flame environment from hydrocarbon fuels and small aerosol metal catalyst Single-walled nanotubes have been observed in the post-flame region of a premixed acetylene/oxygen/argon flame operated at 50 Torr (6.7 kPa) with iron pentacarbonyl vapor used as a source of metallic catalyst. Between 40 and 70 mm heights above burner (~30 milliseconds), nanotubes are observed to form and coalesce into clusters.

V. PROPERTIES OF CNTs:

Electrical properties

The Unique Electrical Properties of carbon nanotubes are to a large extent
Derived from their 1-D character . They have extremely low electrical resistance. Resistance occurs when an electron collides with some defect in the crystal structure of the material through which it is passing. The defect could be an impurity atom, a defect in the crystal structure, or an atom vibratingabout its position in the crystal. Such collisions deflect the electron from its path. But the electrons inside a carbon nanotube are not so easily scattered. Because of their very small
diameter and huge ratio of length to diameter—a ratio that can be up in the millions or even higher. In a 3-D conductor, electrons have plenty of opportunity to scatter, since they can do so at any angle. Any scattering gives rise to electrical resistance. In a 1-D conductor, however, electrons can travel only forward or backward. Under these circumstances, only backscattering (the change in electron motion from forward to backward) can lead to electrical resistance.

Mechanical properties

The carbon nanotubes are expected to have high stiffness and axial strength as a
result of the carbon–carbon sp2 bonding Nanotubes are the stiffest known fiber, with a measured
Young's modulus of 1.4 TPa. They have an expected elongation to failure of 20-30%,
which combined with the stiffness, projects to a tensile strength well above 100 GPa
(possibly higher), by far the highest known.

Thermal Properties

Prior to CNT, diamond was the best thermal conductor. CNT have now been
shown to have a thermal conductivity at least twice that of diamond. CNT have the
unique property of feeling cold to the touch, like metal, on the sides with the tube ends
exposed, but similar to wood on the other sides. The specific heat and thermal
conductivity of carbon nanotube systems are determined primarily by phonons.

VI. APPLICATIONS

Various applications of CNTs are
as follows:
1) When oxygen and hydrogen react in a fuel cell, electricity is produced and water is formed as a byproduct. If industry wants to make a hydrogen-oxygen fuel cell, scientists and engineers must find a safe way to store hydrogen gas needed for the fuel cell
2) Functionalised carbon nanotubes are reported for targeting of Amphotericin B to Cells31.
3) Cisplatin incorporated oxidized SWNHs have showed slow release of Cisplatin in aqueous environment. The released Cisplatin had been effective in terminating the growth of
human lung cancer cells, while the SWNHs alone did not show anticancer activity32.
4) Anticancer drug Polyphosphazeneplatinum given with nanotubes had enhanced permeability, distribution and retention in the brain due to controlled lipophilicity of nanotubes.
5) Antibiotic, Doxorubicin given with nanotubes is reported for enhanced intracellular penetration33.
6) The gelatin CNT mixture (hydro-gel) has been used as potential carrier system for biomedicals.
7) 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.
8) They can be used as lubricants or glidants in tablet manufacturing due tonanosize and sliding nature of graphite layers bound with van der waals forces.
9)the most important application of cnt is to be used as a water purifier because nowdays there is a lot of contaminated water ,therefore wiyh the use of cnt we can make this contaminated water useful.
10) When a nanotube is put into an electric field, it will emit electrons from the end of the nanotube like a small cannon. If those electrons are allowed to bombard a phosphor screen then an image can be created
11) A carbon nanotube can be partially filled with gallium metal. When the temperature is changed, the gallium metal expands or contracts to fill or empty the carbon nanotube. The gallium level in the carbon nanotube varies almost linearly with temperature. This new device may find use in certain
microscopies

VII. CONCLUSION

With the newer prospect of the gene therapy, cancer treatments, and innovative new answers for life-threatening diseases on the horizon, the science of nanomedicine has become an ever-growing field that has an incredible ability to bypass all barriers. Theproperties and characteristics of CNTs are still being researched heavily and scientists have barely begun to tap the full potential of these structures. Single and multiplewalled carbon nanotubes have already proven to serve as safer anda more effective alternatives to previous drug delivery methods. They can easily pass through membranes, carrying various therapeutic drugs, vaccines, and nucleic acids deep into the cell to targets previously which are unreachable. They can also serve as contaminated water purifier and a ideal non-toxic vehicles which, in some cases, increase the solubility of the drug attached, resulting in greater efficacy and safety. Overall, recent studies regarding CNTs have shown a very promising glimpse of what lies ahead in the future of medicine.

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