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CARBON NANO TUBES-A BOON IN NANOTECHNOLOGY

Garima Goswami[1], Karuna Solanki[2], Kanika Yadav[3]

[1,2,3]Department of Applied Sciences (Chemistry), JIET Universe, NH-62, Mogra, Pali Road, JODHPUR (Rajasthan), (India)

ABSTRACT

Nanoscience is related to the designing, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape to the nanometre scale (atomic, molecular, and macromolecular scale). It results in production of structures, devices, and systems with at least one novel or superior characteristic or property. In this paper the concentration is on the study of different parameters of carbon nano tubes is taken up for study like its production methods, its unique and interesting properties and applications based on properties. The Carbon nano tubes have remarkable functions that have been used by the whole world. Due to their unusual electronic, thermal conductivity and mechanical properties these carbon nano tubes have huge application, which ranges from green technology to medicine and clothing.

"Carbon has this genius of making a chemically stable, two-dimensional, one-atom-thick membrane in a three-dimensional world. And that, I believe, is going to be very important in the future of chemistry and technology in general." - Richard Smalley

Keywords: Carbon Nano Tubes, Fullerene, Graphite, Nanotechnology, Small.

I. INTRODUCTION

Nano science and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

Richard Feynman described it as a process in which scientists would be able to manipulate and control individual atoms and molecules. The scanning tunnelling microscope made it possible to "see" individual atoms, and then the modern nanotechnology began. Few illustrative examples are as follows an inch has 25,400,000 nanometres; a sheet of newspaper is about 100,000 nanometres thick, etc. On a comparative scale, if a marble were a nanometre, then one meter would be the size of the Earth.

1.1 Third Allotroph of Carbon- Spherical Fullerene

Today we know there is a whole new family of carbon allotrope, known as fullerene. The first to be discovered was the hollow, cage-like buckminsterfullerene molecule or the C60 fullerene - also known as the Bucky ball, as in this spherical molecule carbon atoms are arranged in a soccer ball Shape.

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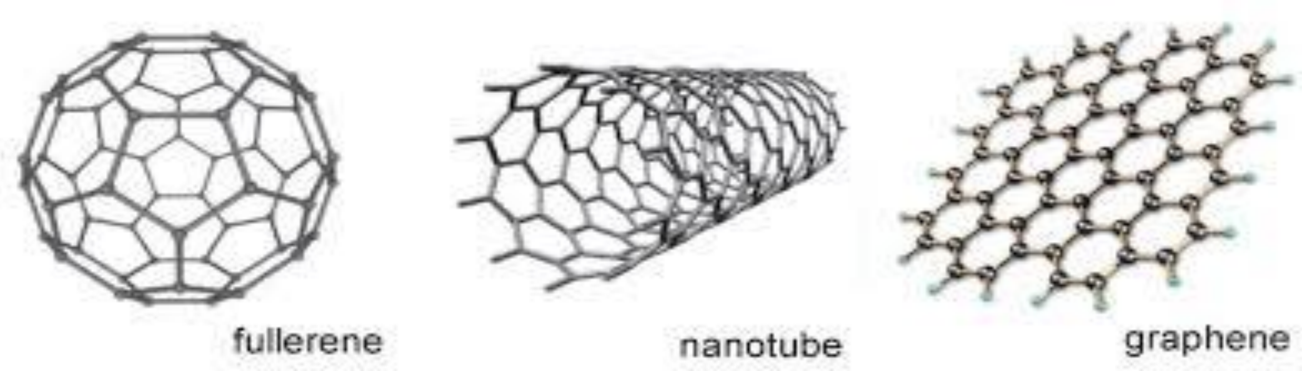
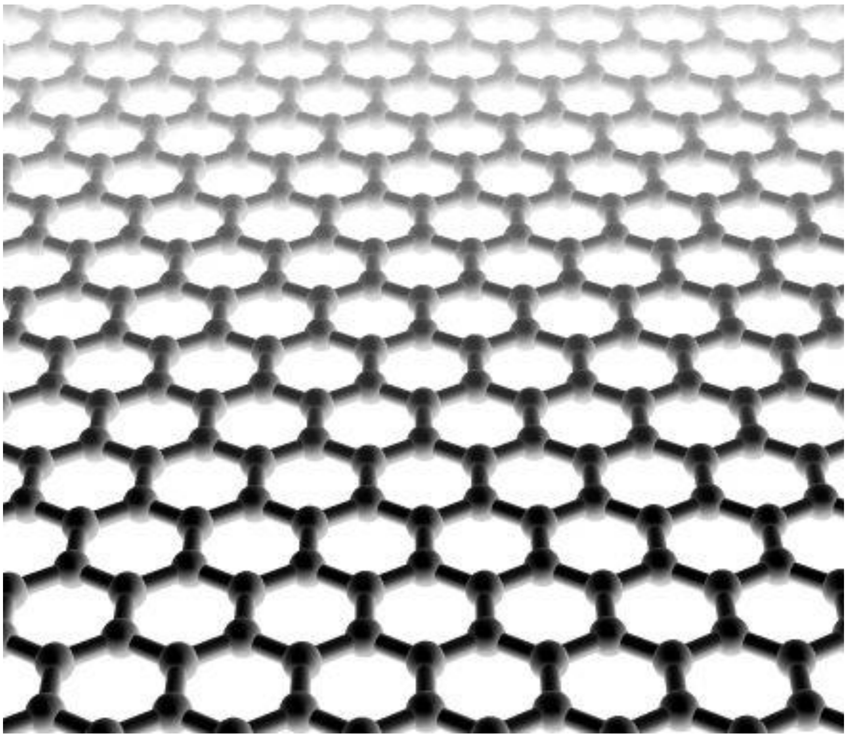
In C60 structure there are 60 carbon atoms and a number of six-member rings are isolated by five-membered rings. There are a large number of other potential structures containing different or the same number of carbon atoms. Their particular shapes depend on whether five-member rings are isolated or not, or whether seven-membered rings are present.



1.2 Layered Fullerene- Graphene

Graphene is the second type of fullerene which is a layered structure and is one-atom-thick planar sheet of carbon atoms, which resembles honeycomb shaped crystal lattice. Graphene looks like atomic-scale chicken wire made up of carbon atoms and their bonds.



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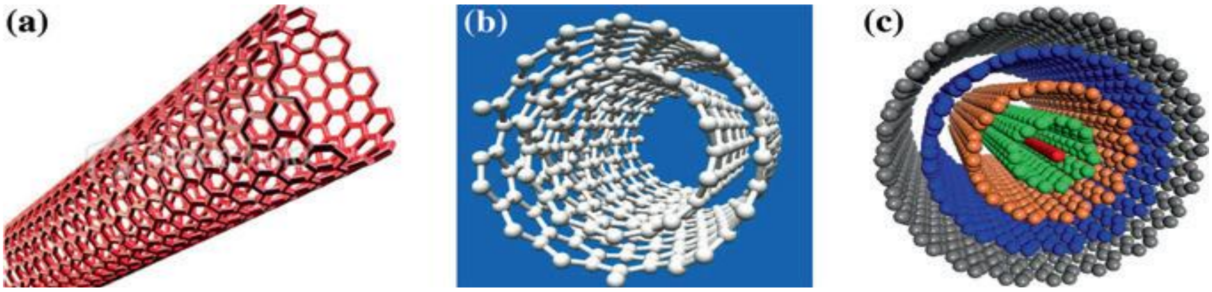
1.3 Carbon Nanotubes



Single Walled CNTs **Double Walled CNTs** **Multi walled CNTs**

Carbon nano tube is a tube-moulded material, made of carbon, the holding between the particles is exceptionally solid and the tubes can have extraordinary viewpoint proportions. A carbon nano tube can be as thin as a couple of nanometres yet are the length of several microns.

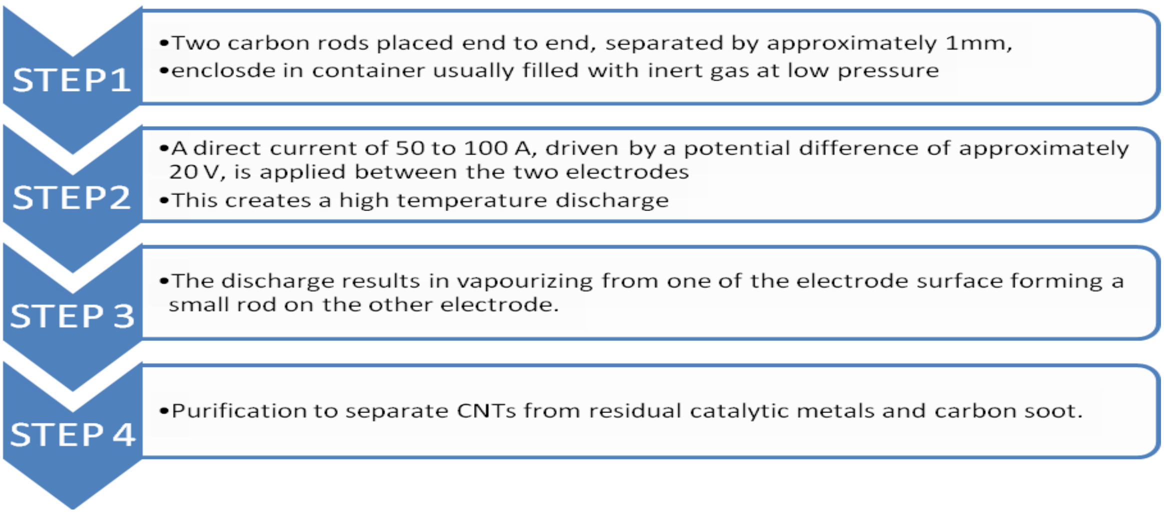
The key reality for nanotechnology is that valuable dopant atoms can be incorporated inside the empty fullerene ball. Particles contained inside the fullerene are said to be endohedral. Obviously they can even be attached to fullerenes outside the ball as salts, if the fullerene picks up electrons.

The electrical conductivity is maximum for endohedral metal particles. Frameworks containing suitable materials inside the fullerene ball are directing and are quite enthralling in light of the fact that they could be stored to create dot like conducting circuits. Fortifying endohedral doped structures with non-doped structures changes the genuine organization of a fullerene wire in a solitary wire; protecting and leading areas might be absolutely characterized.

1.4 Production Method

Ach method and Electric arc discharge method are the two principle methods for obtaining small quantities of CNTs.

1.5 Arc Method- Specific Method To Produce C60 Bucky Balls.



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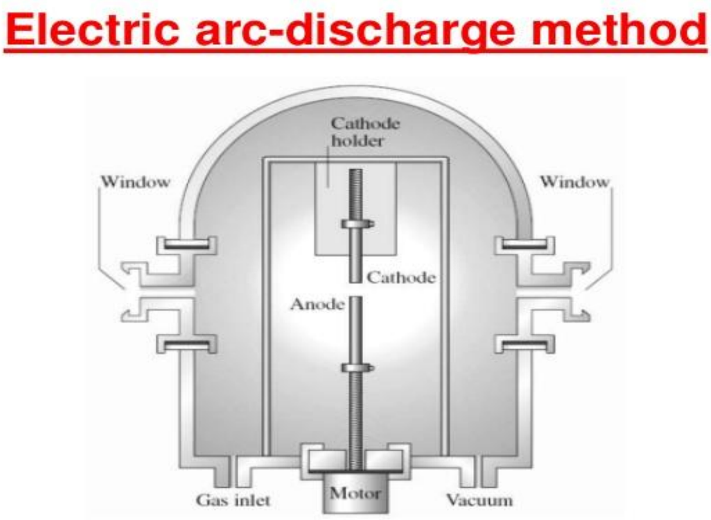
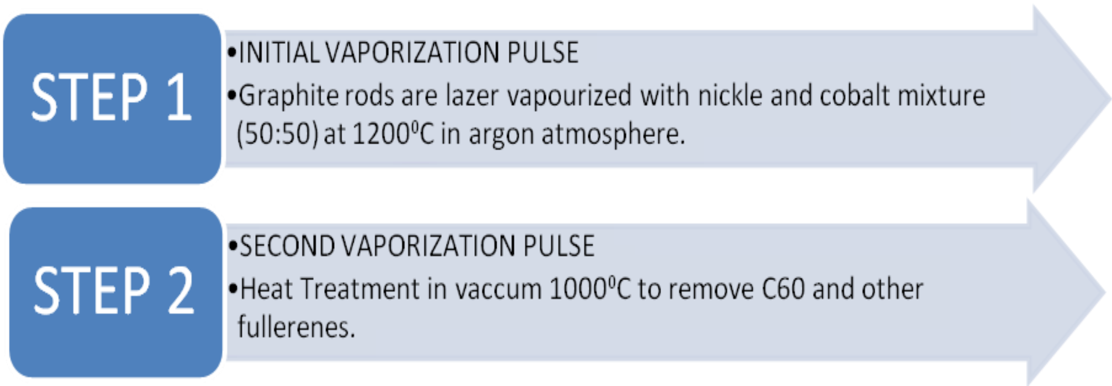
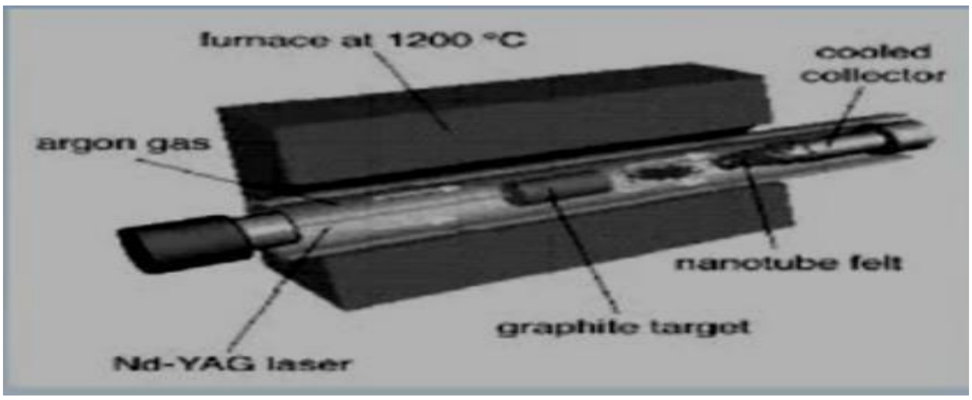
Producing CNTs in high yield depends on the uniformity of the plasma arc, and the temperature of the deposit forming on the carbon electrode.



1.6 Laser Method



The use of two successive laser pulses minimizes the amount of carbon deposited as soot. The second laser pulse breaks up the larger particles ablated by the first one, and feeds them into the growing nano tube structure. The resultant material produced appears as a mat of “ropes”. The average nano tube diameter and size distribution depend on following factors: the growth temperature, the catalyst composition, and other process parameters, Arc-discharge and laser vaporization are currently the principal methods for obtaining small quantities of high quality CNTs.



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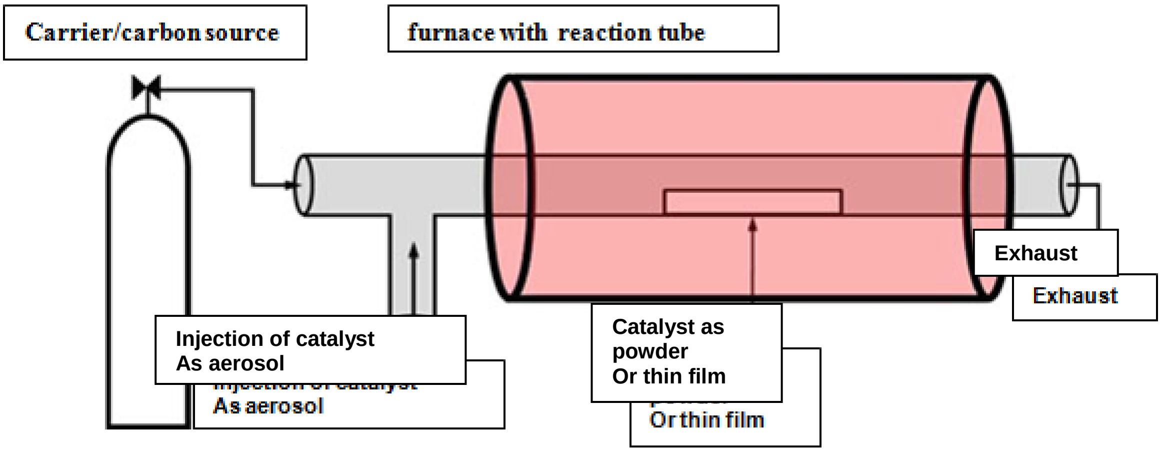
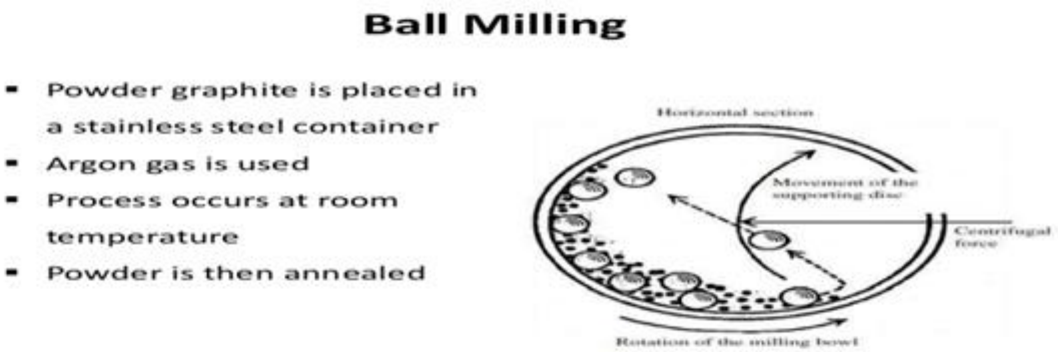
1.7 Chemical Vapour Deposition

Carbon Nano tubes can be prepared at large scale by catalytic chemical vapour deposition technique using acetylene in presence of cobalt and iron as catalysts supported on silica or zeolite. Temperatures are maintained at 545°C for Nickel-catalysed CVD, and 900°C for an uncatalyzed process. The resultant carbon nanostructures have open ends, with no caps. Alternatively high yields of single walled nano tubes can also be obtained by catalytic decomposition of mixture of an H_2/CH_4 in the presence of metals such as Cobalt, Nickel, and Iron on magnesium oxide at 1000°C.





II. PROPERTIES

- Electrical Conductivity - High
- Tensile Strength- Very High
- Flexibility- High, can be bent considerably without damage.
- Elasticity- High, ~18% elongation to failure.
- Thermal Conductivity - High
- Thermal Expansion Coefficient – Low

2.1 Electrical Conductivity

High conducting nature of CNTs makes it act like as a good metal. High conductivity is a function of their chirality, the degree of twist as well as their diameter. CNTs can be both metallic in their electrical behaviour as

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in single-walled nanotubes , there is no change in current across its different parts, or semi-conducting in their electrical behaviour as when in single walled nanotubesthe transport current changes abruptly at various positions on the CNTs.

Single walled nanotube ropes are the most conductive carbon fibres known as the resistivity of the single walled nanotubes ropes was found to be of the order of 10–4 ohm-cm at 27°C.

2.2 Tensile Strength

The basal plane elastic modulus of graphite is one of the largest of any known material. A planar honeycomb lattice in an individual (graphene) sheet of graphite, consisting of a carbon atom form a strong chemical bond to three neighbouring atoms. For this reason, CNTs are said to exist as the ultimate high-strength fibres. These bonds are more than 300 times more robust than steel and are lighter and more durable. The CNTs are applicable where no other metal of the world can work. Single walled nanotubes are more rigid than steel, and are very difficult to damage on physical force application. The tip of a nano tube on pressing will bend or tip will misshape without damaging the tip. Original shape of the tip is regained on removing the force This property makes CNTs very useful as probe tips for very high-resolution scanning probe microscopy.

2.3 Thermal Conductivity and Expansion

CNTs apart from behaving like conductors and semiconductors have also shown to exhibit superconductivity below 20°K (aprox. - 253°C). The strong in-plane graphitic carbon - carbon bonds make them exceptionally strong and stiff against axial strains. The almost zero in-plane thermal expansion but large inter-plane expansion of single walled nanotubes implies strong in-plane coupling and high flexibility against non-axial strains.

2.4 Field Emission

The small diameter and high aspect ratio of CNTs is very favourable for field emission. Even for moderate voltages, a strong electric field develops at the free end of supported CNTs because of their sharpness. These field emitters must be superior to conventional electron sources and might find their way into all kind of applications, most importantly flat-panel displays. It is remarkable that after only five years Samsung actually realized a very bright colour display, which will be shortly commercialized using this technology.

III. APPLICATIONS

1. The high tensile strength and resistance to breakage make CNTs suitable to be used in bridges, space elevators and flywheels.
2. Fire Resistant or high temperature resistant property of CNTs find their use in making fire resistant materials as thick layers of carbon fibres are present.
3. CNTs due to their transparency are used to replace the LCDs and touch screen displays with their electric conducting mono films.
4. CNTs find their use in solar cells as are capable of producing photocurrent . As these are electrically transparent they allow light to pass through them. When light passes through the top layer of carbon nanotube films it produces photocurrent.

5. Brushes of electric motors can be made of CNTs instead of carbon black, as are less brittle ,more strong and easily mouldable. It act as suitable lubricant for electric motor.
6. These can act as superconductors and efficient capacitors for storing energy.
7. Used as antennas for various electromagnetic devices.
8. Used as antennas for various electromagnetic devices.
9. The Carbon nanotubes play important role in restructuring of damaged bones. These are powerful, light weight, can be moulded according to requirement. CNTs contribute in reducing the swelling in the broken bones also.
10. CNTs also hold promise for cleaning up polluted environments. Nanotubes are very effective at absorbing chemicals from their surroundings and have possible applications in water filtration and in air filters, such as smokestacks.
11. In the Conductive plastics
12. Used for Gas storage
13. Used for Antifouling paint
14. Used for Micro- and nano-electronics
15. Used in the coating of Radar-absorbing
16. Used in Technical textiles
17. Used for Atomic Force Microscope tips
18. Used as Bio sensors for the damaging gases
19. Used as the additional strong fibers
20. Customized carbon nanotubes carry drugs or remove the surplus genes by entering the body cells.

IV. CONCLUSION

With the advent of Nanotechnology , world is progressing from huge to small, from room sized computers to finger tip sized computers. Carbon nanotubes are one of the latest invention and has a high contributing part in the fields of electronics, aircraft’s components, corrosion control

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