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Carbon Nanotubes: A Review Article

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Abstract: ***In the field of nanotechnology, carbon nanotubes are the one of the most unique invention and carbon nanotubes are significant material for future. It has been discovered in 1991, because of its huge production they have attracted many industries and companies towards itself. Carbon nanotubes are used in nanotechnology, membranes, capacitors, polymers, metallic surfaces, ceramics, nanomedicine etc. The main motive of this paper is to highlight synthesis, properties and toxic effects of carbon nanotube.***

Keywords: ***Nanotechnology, carbon nanotubes, nanomedicine, SWCNTs, MWCNTs etc.***

I. INTRODUCTION

Carbon containing sp^2hybridisation having different structures. graphite is well known example of it but now beside graphite, carbon can form closed and open cages with honeycomb arrangement[1]. Graphene is known as 2D single layer of graphite in the list of carbon nanomaterials. graphene is stronger material than diamond because it contain sp^2 hybridisation which is stronger than the sp^3 hybridisation in diamond[2]. in recent decades carbon nanotubes are the most exciting areas of research[3]. Carbon nanotubes are made up of carbon and it is a tube shaped material. its diameter is too small and is measured by nanoscale[4]. Graphenes are rolled up into cylinder that forms carbon nanotubes[2].

A. Structure of Carbon Nanotubes

Carbon nanotubes are buckytubes, in carbon nanotubes carbon molecules are in cylinderical shape and have unique properties that make carbon nanotubes used in different areas. they have properties like thermal, electrical and mechanical properties[5]. carbon nanotubes have fullerene like structure and having graphene sheets which contain sp^2 hybridisation of each carbon atom[6].

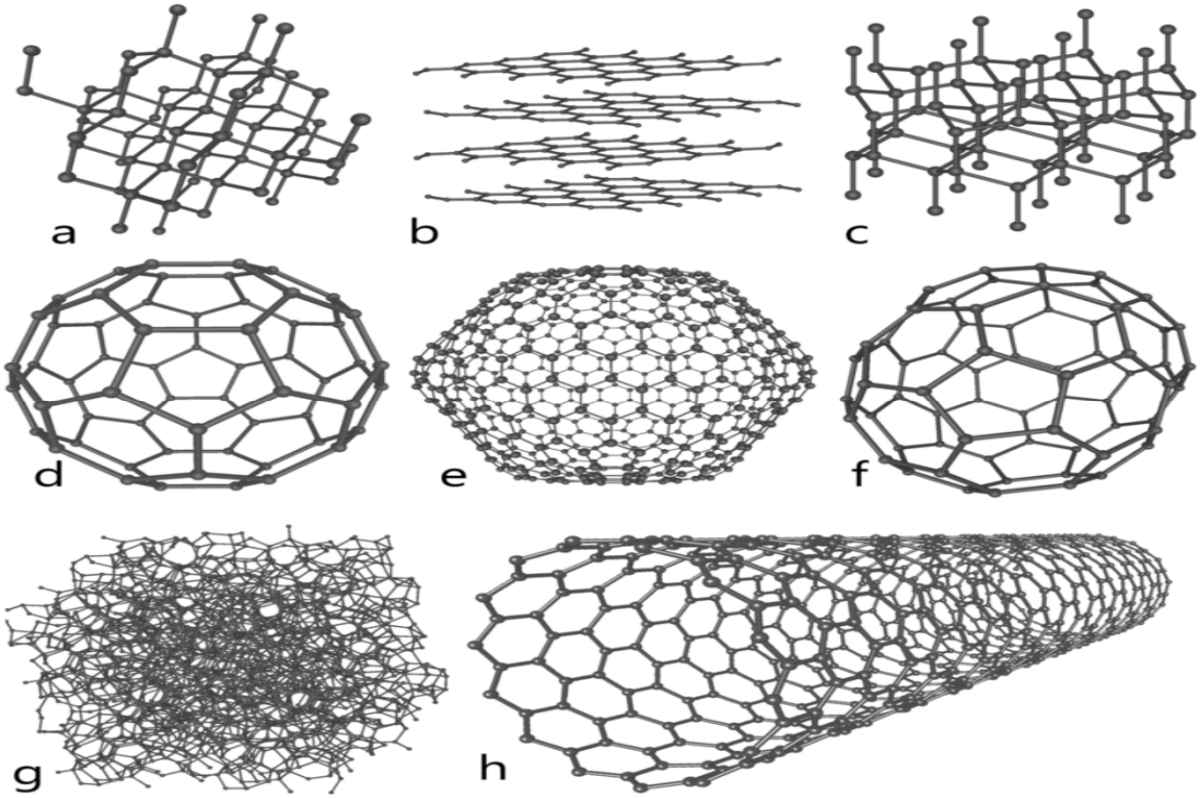

Fig.1. Eight allotropes of carbon a) a) diamond, b) graphite, c) lonsdaleite, d) C_{60} buckminsterfullerene, e) C_{540}, Fullerite f) C70, g) amorphous carbon, and h) single-walled carbon nanotube[7].

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B. Classifications of Carbon Nanotubes

carbon nanotubes are of two types

1) *Single Walled Carbon Nanotubes:* it consist of single layer of graphene. it requires catalyst for its synthesis. SWCTs are of poor purity and doesn't have any complex structure. It can easily be twisted [8].

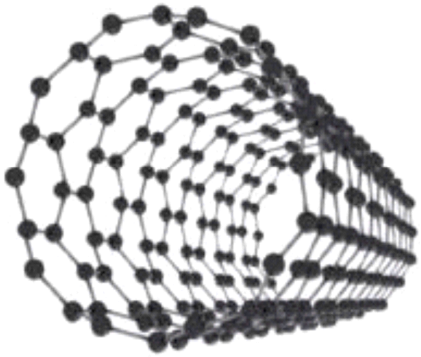


Fig2. Single walled carbon nanotubes[9].

2) *Multi walled Carbon Nanotubes:* it consist of multi layer of graphene. it doesnot require any catalyst for its synthesis. MWCTs are of high purity and have complex structure. it cannot be easily twisted[10,11]

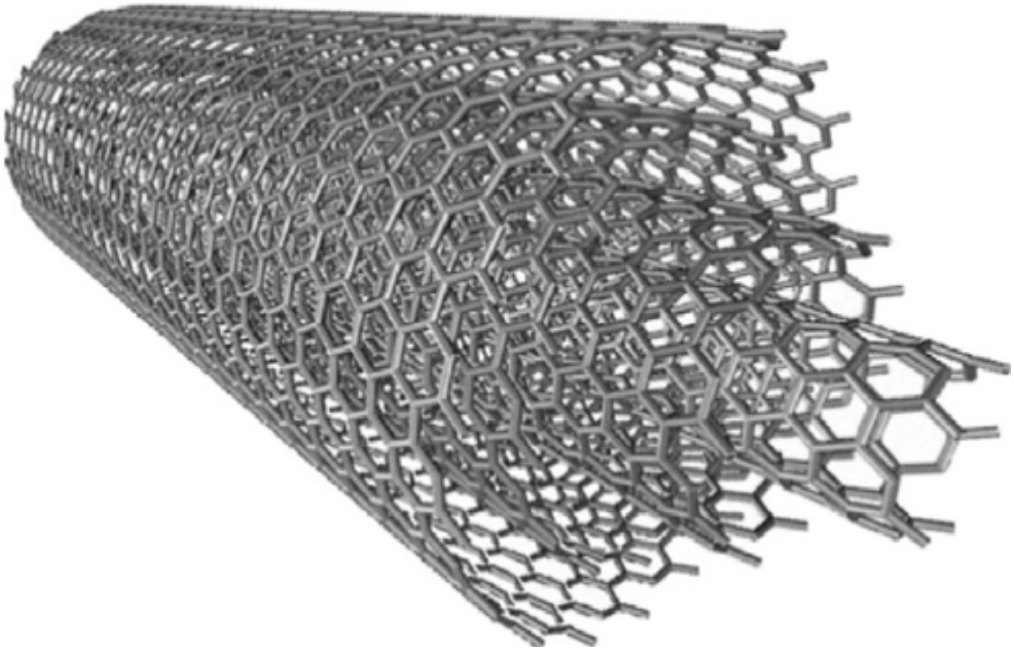


Fig3. Multiwalled carbon nanotubes[9].

C. Method of Preparation Carbon Nanotubes

1) *Plasma based synthesis method (arc discharge method):* For best quality of nanotubes plasma based methos or arc discharge method can be used. it involves two graphite electrode in presence of helium and a current of 50 ampere is passed through two graphite electrodes. it causes vapourization of graphite; some part of it condense on reaction vessel and some of it condense on cathode. The part which is deposit on cathode carbon nanotube. if we want single walled carbon nanotubes then Co, Ni metals can be introduced in anode[4-12-13].

2) *Laser Method:* in 1996 Laser was used for production of carbon nanotubes with 70% purity. Presently this method is used for production of carbon nanotubes. This process consist of graphite rods and it contain 50:50 catalyst mixture of Co and Ni at 1200^0C and argon is flowing through it for sample preparation (Ahmed 2010)[14]. in this method metal catalyze the growth of single walled carbon nanotubes and also many side products are formed. We can get nanotubes by cooling vaporized species [15]

3) *Chemical vapour deposition:* In the above methods, there are two major problems i.e. ordered synthesis and large scale production [16]. In 1996, chemical vapour deposition method was used for production of carbon nanotubes[17]. This method is used to produced large amount nanotubes. in this process reaction chamber contain mixture of nitrogen, ethylene and acetylene. during this temperature of reaction chamber was 700-900^0C and one atmospheric pressure[18]. This method is employed on lower temperature and we get the well organized carbon nanotubes[19].

TABLE 1. A Summary of the synthesis of carbon nanotubes

Method	Arc discharge method	Laser method	Chemical vaporization method
Process	it involves two graphite electrode in presence of helium and a current of 50 ampere is passed through two graphite electrodes	this process consist of graphite rods and it contain 50:50 catalyst mixture of Co and Ni at 1200^0C and argon is flowing through it	in this process reaction chamber contain mixture of nitrogen, ethylene and acetylene. during this temperature of reaction chamber was 700-900^0C and one atmospheric pressure.
Conditions	Low pressure inert gas(helium)	Argon gas at 1200^0C.	700-900^0C temp at one atmospheric pressure
Yield	32-91%	Up to 70%	Up to 100%
SWCNT	Short tubes with diameter .6-1.4nm	Long tubes with diameter 1-2nm	Long tubes with diameter .6-4nm
MWCNT	Short tubes with diameter 1-3nm	they are very expensive and not prepared but can be synthesized	Long tubes with diameter 10-240nm
CARBON SOURCE	graphite	graphite	hydrocarbon
Cost	high	high	low

D. Applications of Carbon Nanotubes

1) Carbon nanotubes are used in drug delivery carriers for treatment of cancer[20]. And they are reported for targeting of amphotericin B to cells[21].

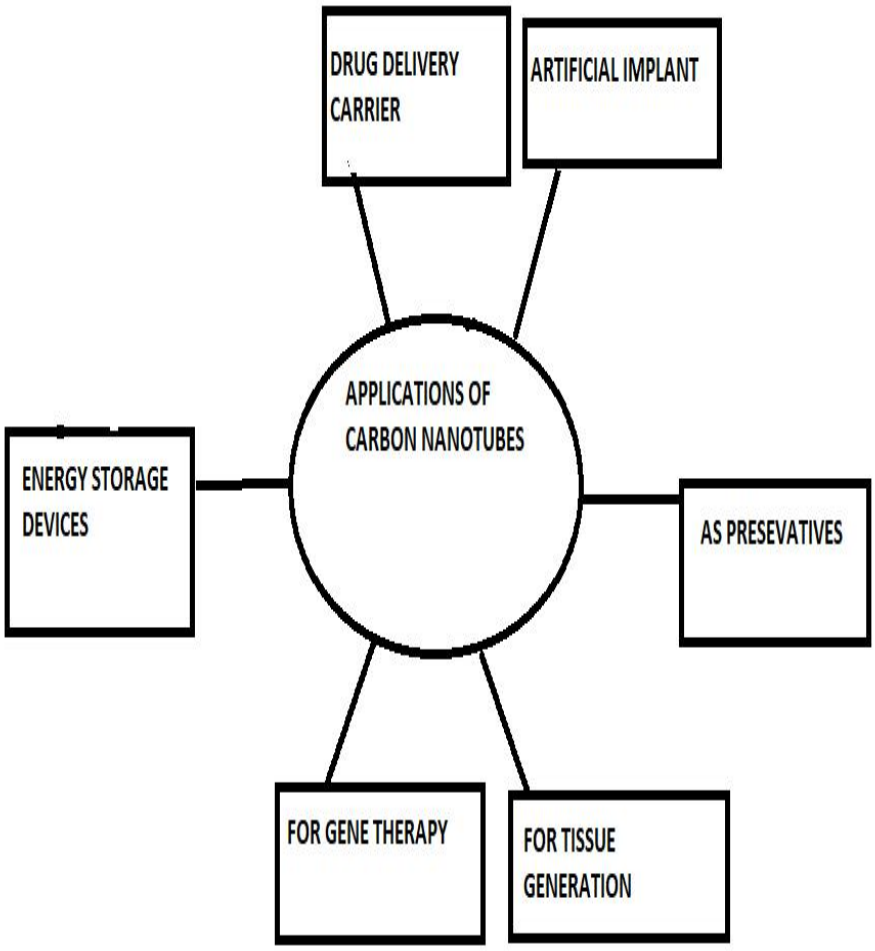
2) Carbon nanotubes are used for generation of tissue. In recent years carbon nanotubes are best for tissue generation because these are biocompatible, resistant to biodegradation and enhancing the organ generation [22].

3) Carbon nanotubes are used as energy storage devices[23].

4) Carbon nanotubes are used in artificial implants. carbon nanotubes having high tensile stregth so they are filled with calcium and arranged like a bone, so can acts as a bone substituent[4].

5) Carbon nanotubes are antioxidant in nature so they are used preserve drugs that are easily oxidised[24].

6) Carbon nanotubes are used for Gene therapy by DNA delivery. Gene therapy is a therapy to cure the gene which can causeharmful disease by introducing DNA into cells [25-26]



E. Disadvantages of Carbon Nanotubes

1) It is difficult to maintain high quality and lower impurities [27].
2) Cost of nanotechnology is very high [28].
3) In ARC DISCHARGE and LASER method huge amount of energy is required to complete the process [29].
4) It is difficult to target large amount of graphite in industrial process [29].

II. CONCLUSION

This review paper is based on properties, applications and limitations of carbon nanotubes. The aim of this paper is not only to lay stress on its unique properties but also its harmful effects that can occur during the use of metals that very toxic. In this study we notice that chemical vapour deposition is best methods for production of carbon nanotubes because it gives high purity carbon nanotubes. Researchers taking keen interest in carbon nanotubes and likely to give more advancement in coming future.

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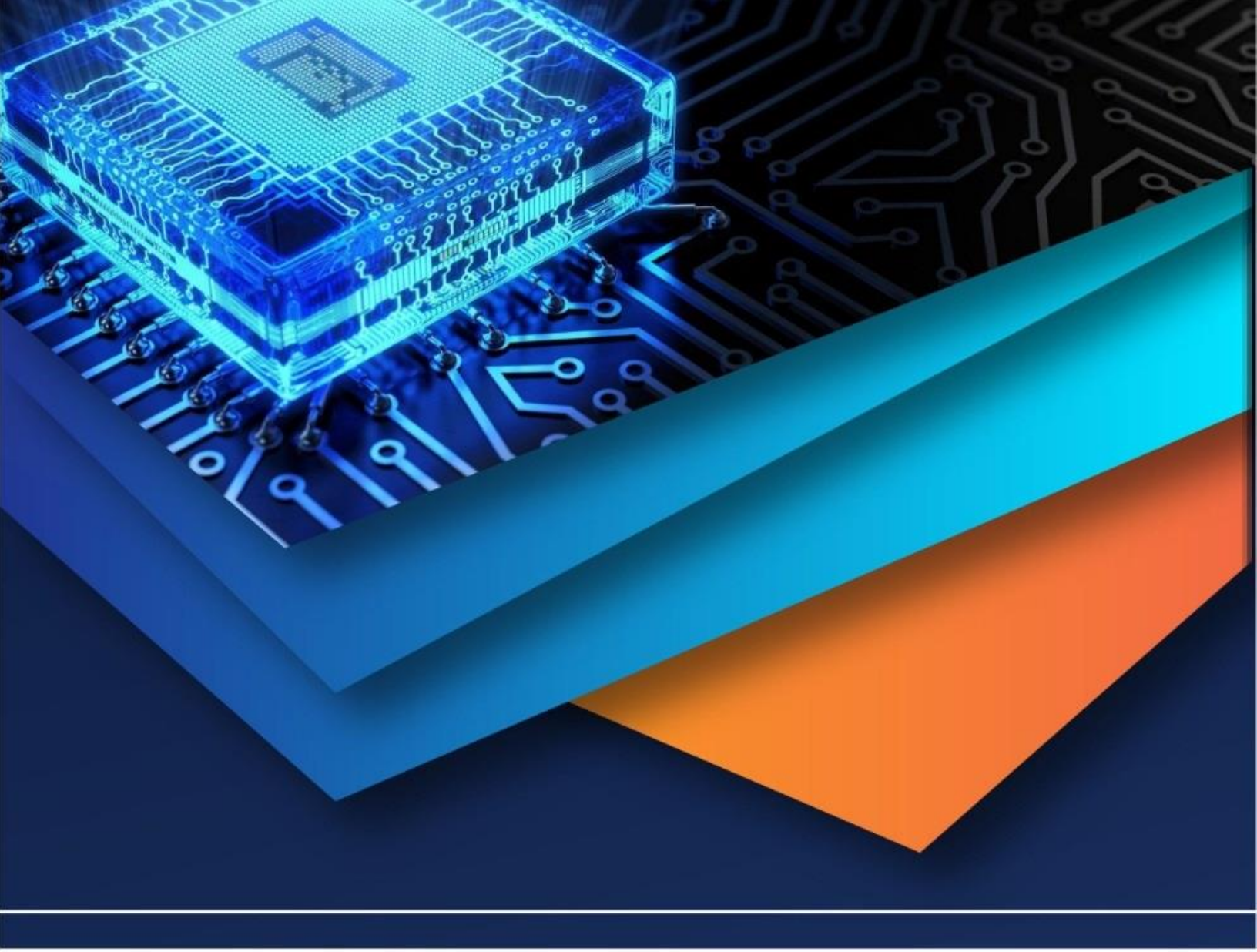

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