



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 Issue: IV Month of publication: April 2018

DOI: <http://doi.org/10.22214/ijraset.2018.4827>

www.ijraset.com

Call: ☎ 08813907089

E-mail ID: ijraset@gmail.com

Carbon Nanotubes: A Review Article

Rajwant Kaur¹, Pooja Vatta², Mandeep Kaur³

^{1, 2, 3}Post graduate department of chemistry, R.S.D College, ferozepur city, punjab, india, 152002

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^2 hybridisation 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 cylindrical 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].

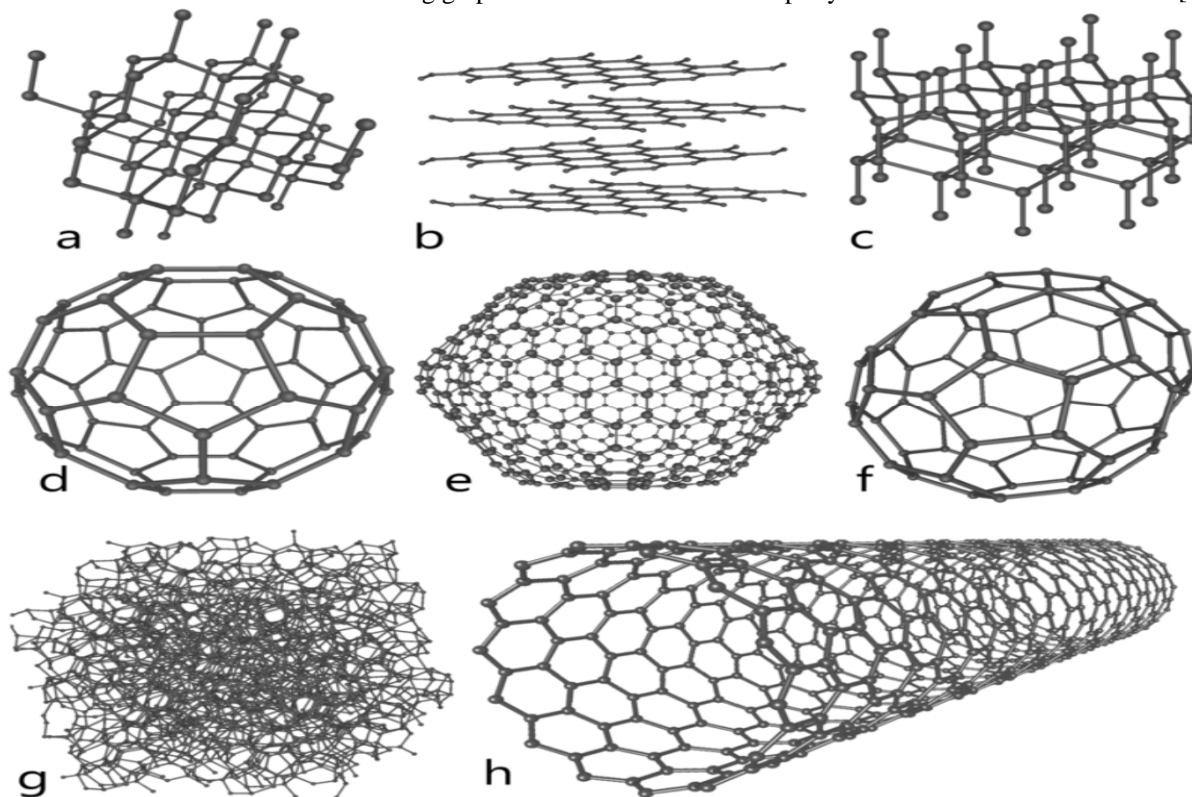


Fig.1. Eight allotropes of carbon a) a) diamond, b) graphite, c) lonsdaleite, d) C₆₀ buckminsterfullerene, e) C₅₄₀, Fullerite f) C₇₀, g) amorphous carbon, and h) single-walled carbon nanotube[7].

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].

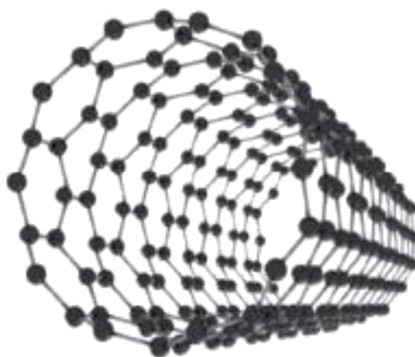


Fig2. Single walled carbon nanotubes[9].

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

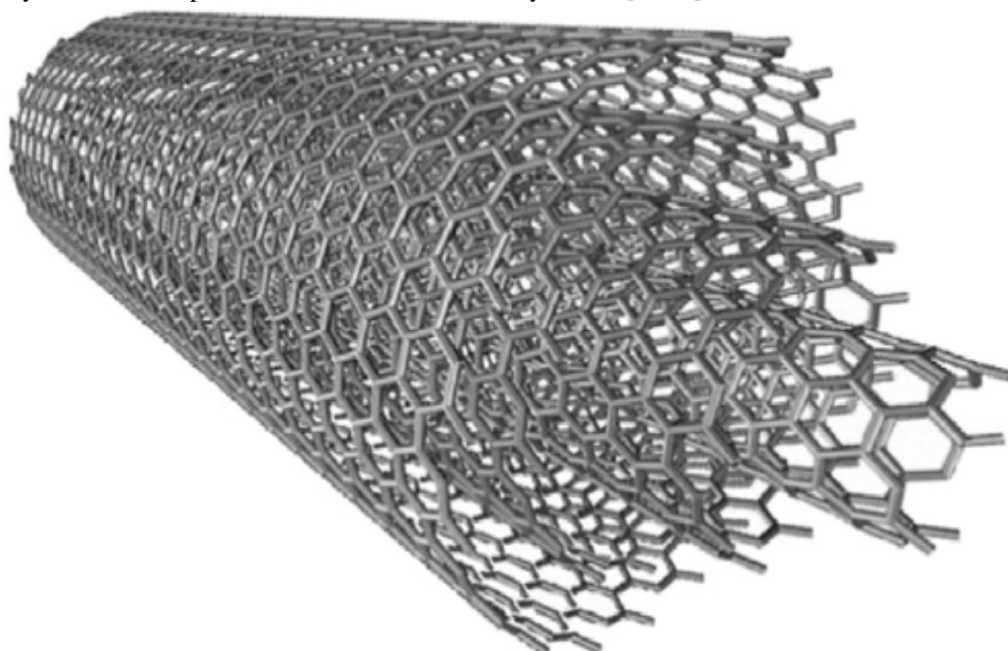


Fig3. Multiwalled carbon nanotubes[9].

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].

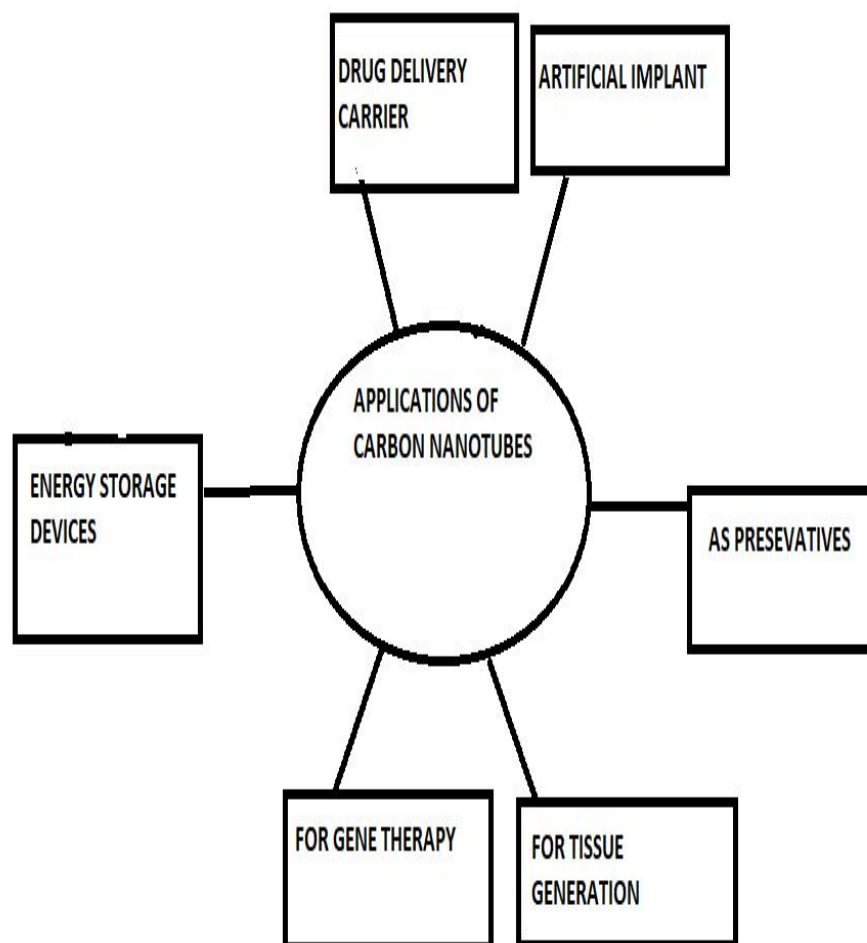
- 2) *Laser Method*: in 1996 Laser was used for production of carbon nanotubes with 70% purity. Presently this method is used for production of carbon nanotubes. This process consist of graphite rods and it contain 50:50 catalyst mixture of Co and Ni at 1200°C and argon is flowing through it for sample 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°C 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°C 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°C and one atmospheric pressure.
Conditions	Low pressure inert gas(helium)	Argon gas at 1200°C.	700-900°C 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 strength 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 cause harmful 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.

REFERENCES

- [1] Valentin N. Popov "Carbon nanotubes: properties and application" Materials Science and Engineering R 43 (2004) 61–102
- [2] B.K. Kaushik and M.K. Majumder, Carbon Nanotube Based VLSI Interconnects, SpringerBriefs in Applied Sciences and Technology, DOI 10.1007/978-81-322-2047-3_2
- [3] Peter J.F. Harris " Carbon nanotubes science : Synthesis, properties and applications" www.cambridge.org/9780521828956. p.no. 3
- [4] Kalpna Varshney "Carbon Nanotubes: A Review on Synthesis, Properties and Applications" International Journal of Engineering Research and General Science Volume 2, Issue 4, June-July, 2014 ISSN 2091-2730

- [5] A. Aqel, K.M.M. Abou El-Nour R. A.A. Ammar ,A. Al-Warthan"Carbon nanotubes, science and technology part (I) structure, synthesis and characterisation"Arabian Journal of Chemistry (2012) 5, 1–23
- [6] Kroto HW, Heath JR, O'Brien SC, Curl RF, Smalley RE. C60: buckminsterfullerene. *Nature*, 318, 162 (1985). <http://dx.doi.org/10.1038/318162a0>
- [7] Iijima S, Ichihashi T. Single-shell carbon nanotubes of 1-nm diameter. *Nature*, 363, 603 (1993). <http://dx.doi.org/10.1038/363603a0>
- [8] A. Aqel, K.M.M. Abou El-Nour R. A.A. Ammar ,A. Al-Warthan"Carbon nanotubes, science and technology part (I) structure, synthesis and characterisation"Arabian Journal of Chemistry (2012) 5, 1–2
- [9] R. HIRLEKAR*, M. HARSHAL GARSE, M. VIJ, V. KADAM 'CARBON NANOTUBES AND ITS APPLICATIONS: A REVIEW' Asian Journal of Pharmaceutical and Clinical Research Vol.2 Issue 4, October- December 2009 ISSN 0974-244
- [10] <http://en.wikipedia.org/www/Carbon%nanotube>
- [11] <http://www.cientifica.com>
- [12] Brenner, D. —Empirical potential for hydrocarbons for use in simulating the chemical vapor deposition of diamond films. *Physical Review B* 42(15): 9458-9471, 1990
- [13] Calvert, P. —Strength in disunity. *Nature* 357: 365-366, 199
- [14] Kaushik, B.K, Majumder, M.K. "Carbon Nanotube: Properties and Applications" 2015,XI, 86 P, 57 illus., softcover. ISBN: 978-81-322-2046-6
- [15] Sinnott, S.B.; Andrews, R. Carbon Nanotubes: Synthesis, properties and applications. *Critical Reviews in Solid State Mat. Sci.* 26, 145–249, 2001.
- [16] Mamalis AG, Vogtländer LOG, Markopoulos A. Nanotechnology and nanostructured materials: trends in carbon nanotubes. *Precis Eng*, 28, 16 (2004). <http://dx.doi.org/10.1016/j.precisioneng.2002.11.002>
- [17] Li WZ, Xie SS, Qian LX, Chang BH, Zou BS, Zhou WY, Zhao RA, Wang G. Large-scale synthesis of aligned carbon nanotubes. *Science*, 274, 1701 (1996). <http://dx.doi.org/10.1126/science.274.5293.1701>.
- [18] Xie S, Li W, Pan Z, Chang B, Sun L. Carbon nanotube arrays. *Mater Sci Eng A*, 286, 11 (2000). [http://dx.doi.org/10.1016/S09215093\(00\)00657-2](http://dx.doi.org/10.1016/S09215093(00)00657-2).
- [19] Ibrahim Khan "Carbon nanotubes- Properties and Applications: A Review" Article Carbon letters. July 2013 DOI: 10.5714/CL.2013.14.3.131
- [20] W. Zhang, Z. Zhang, and Y. Zhang, "The application of carbon nanotubes in target drug delivery systems for cancer therapies," *Nanoscale Research Letters*, vol. 6, pp. 555–577, 2011
- [21] Y. Rosen and N. M. Elman, "Carbon nanotubes in drug delivery: focus on infectious diseases," *Expert Opinion on Drug Delivery*, vol. 6, no. 5, pp. 517–530, 200
- [22] Hua He, L.Ai Pham-Huy, P.Dramou, D.Xiao, Pengli Zuo, and C.Pham-Huy" Carbon Nanotubes: Applications in Pharmacy and Medicine" Hindawi Publishing Corporation BioMed Research International Volume 2013, Article ID 578290, 12 page
- [23] www.google.com
- [24] L. A. Pham-Huy, H. He, and C. Pham-Huy, "Free radicals, antioxidants in disease and health," *International Journal of Biomedical Science*, vol. 4, no. 2, pp. 89–96, 2008
- [25] E. Bekyarova, Y. Ni, E. B. Malarkey et al., "Applications of carbon nanotubes in biotechnology and biomedicine," *Journal of Biomedical Nanotechnology*, vol. 1, no. 1, pp. 3–17, 2005.
- [26] H. Liao, B. Paratala, B. Sitharaman, and Y. Wang, "Applications of carbon nanotubes in biomedical studies," *Methods in Molecular Biology*, vol. 726, pp. 223–241, 2011
- [27] R.Chavan, U.Desai, P.Mhatre, R.Chinchole "A REVIEW : CARBON NANOTUBES"Volume 13, Issue 1, March – April 2012; Article-022
- [28] N. Saifuddin, A. Z. Raziah, and A. R. Junizah "Carbon Nanotubes: A Review on Structure and Their Interaction with Proteins" Hindawi Publishing Corporation Journal of Chemistry Volume 2013, Article ID 676815, 18 pages
- [29] M.M.Ali Rafique, J.Iqbal "Production of Carbon Nanotubes by Different Routes— A Review" *Journal of Encapsulation and Adsorption Sciences*, 2011, 1, 29-34.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)