Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 6, Issue 8; July-September, 2019, pp. 480-484

http://www.krishisanskriti.org/Publication.html

A Future Based on Nano Carbons

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Abstract—*The current technology is based on silicon, germanium, indium tin oxide, neodymium, lithium, cerium, lead etc. These are either rare earth elements or toxic chemicals. Even silicon the eighth most abundant element in the universe is rare on earth s crust and its extraction is difficult. Their capabilities are limited. So, if we want drastic changes in our technology then we must find new materials to replace them and probably we have found some carbon based materials or Nano carbons like Nano tubes, Graphene, buckyballs, carbyen etc. They can completely revolutionize our world by their promising capabilities and applications. And carbon being the fourth most abundant element in the universe we won t be running out of it any soon.*

Keywords*: Nano carbons, Graphene, buckyballs, Nano tubes, Schwarzites , Nano technology, The Graphene age, mechanical exfoliation, chemical reduction, chemical vapor deposition, plasma assisted chemical vapor deposition , Nano filtration .*

Introduction and summary

Nano carbons find huge applications in developing our current technology to a next level they can be used in industries such as bionic humans, drinkable ocean water, space elevator, super strong body armor, healthcare, super-fast recharging gadgets, flexible smartphones and other electronic gadgets, glowing wallpaper, faster supercomputers or quantum computers, Nano filtration, a no rust world .etc.[2][6][13].

Nano carbons: - The different non occurring allotropic forms of carbon atoms having different molecular arrangements and produced by Nanotechnology are called Nano carbons.

There are normally three main types of Nano carbons [1]:-

- Nano carbons with positive curvature (Nanotubes and buckyballs)
- Nano carbons with zero curvature (GRAPHENE)
- Nano carbons with negative curvature (Schwarzites)

Classifications of nano carbons

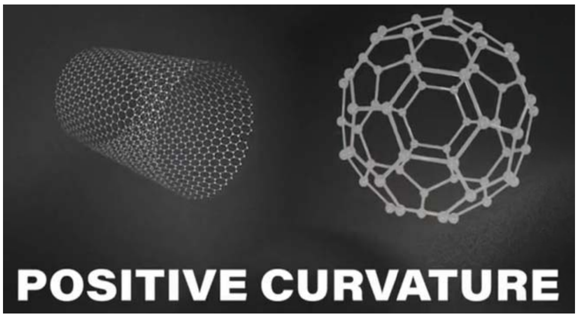
Nano carbons with positive curvature

The Nano carbons those have a positive curvature like a pipe or tubes are called Nano carbons with positive curvature like Nanotubes and buckyballs etc. [1].

Nanotubes :- Carbon nanotubes (CNT) are a class of nanomaterial s that consist of a two-dimensional hexagonal lattice of carbon atoms, bent and joined in one direction, so as to form a hollow cylinder[4].

Buckyballs: - A buckyballs is a molecule called buckminsterfullerene. Composed of 60 carbon atoms formed in the shape of a hollow ball, buckyballs have very less practical use, although they do find their application in nanotubes manufacturing [4].

Nanotubes are one of the strongest materials known to mankind capable of bearing a tensile stress of about 1.09 Tera Pascal and they can be used as semi-conductors or Conductors based on applications [5].There main properties are very high strength, high electrical conductivity, elasticity, very high thermal conductivity and electron emission.



Nano carbons with zero curvature

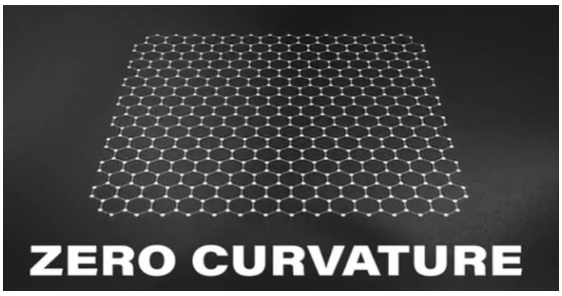
The Nano carbons those have zero curvature are called Nano carbons with zero curvature like GRAPHENE [1].

Graphene: - It is a single layer thin sheet of carbon atoms arranged in a two dimensional hexagonal lattice like honey comb. Graphene is an allotrope of carbon in which atoms are arranged in a hexagonal lattice and each atom represents a vertex of that hexagon [7][14].

Graphene is a wonder material it has 200times the strength of the steal. It conducts electricity 140 times faster than silicon and heat 10 times faster than copper. It is 97% transparent [6].

Important properties of Graphene:-

- High electrical and thermal conductivity.
- High elasticity and mechanical strength.
- Highly transparent with bio compatibility.



Nano carbons with negative curvature

The Nano carbons those have a negative curvature are called Nano carbons with negative curvature like Schwarzites [1].

Schwarzites: - It is a three dimensional lattice of carbon atoms having negative curvature. It is an amorphous form of carbon atoms which finds its applications in high energy density battery technology and advanced super capacitors etc.

NOTE: - Graphene is the basic material which arranges it to form different Nano carbons illustrated in this paper.

DISCOVERY OF GRAPHENE

Graphene was theoretically predicted by phillip R. Wallace in his work named The band theory of graphite , published in physical review in 1947. Graphene was discovered in 2003 by Andre geim and kostya novoselov at the University of Manchester, and results were published in 2004. For their revolutionary discovery they have been awarded Nobel Prize in 2010. Graphene was successfully grown on various single-crystal substrates since the 1970s. It wasn t until 2003 that Graphene was finally isolated in free form. It is interesting to know that they used ordinary sticky tape to produce small quantities of Graphene. This is very significant, because the electrical and physical properties of Graphene are considerably different when it is in free-form state as opposed to being bound to a supporting crystal structure[18].

How to make graphene

The simplest DIY method to make Graphene is to use a lead pencil to deposit a thick layer of graphite onto a paper. Then use ordinary sticky tae to peel off a layer of graphite from the paper. Use another piece of sticky tape to remove a layer of graphite from the first sticky tape. Then, use a third piece of unused sticky tape, and so on. Eventually, the graphite layer will get thinner, and you will end up with Graphene, which is single layer graphite in the strict sense, or bi-layer or few layer graphite (which acts almost like Graphene in certain uses). Even though this way of making Graphene is only a proof of-concept, the sticky tape method works. It takes patience and time, but it s the DIY method which the Manchester group used in 2004. And remember as illustrated earlier, they actually won a noble prize for their work [11].

The age of graphene

Historical period or ancient civilizations have been characterized on the bases of the materials humans could harness or use at that time for example we had Stone Age, Bronze Age and Iron Age etc. And now probably we are living in silicon age because all the technology that we have is based on silicon for example transistors, IC s, SCR, computers, microprocessors etc. But a few years from now the age of silicon will be the case of past because new technology is being invented for Graphene fabrication and if we replace silicon from Graphene in our current technology than the performance of every gadget or technology will improve 3-5 times.

Professional methods to produce graphene

The production of Graphene is very expensive and difficult due to the fact that it uses techniques like aggressive oxidation, high energy mixing, and sonication. The most common ways to produce Graphene are mechanical exfoliation, chemical reduction, chemical vapor deposition and P.E.C.V.D (plasma assisted chemical vapor deposition) [12] [13][18].

Mechanical exfoliation

It is a labor intensive process in which we extract Graphene from graphite by physical process like striping of the sticky tape. This method is very uneconomical and can t be used for industrial scale production[18].

Chemical reduction

This process of producing Graphene evolves heavy oxidation and dangerous chemicals and produces huge amounts of chemical waste. That s why this process can t be used for large scale production [12].

Chemical vapor deposition

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Plasma assisted chemical vapor deposition

The process is similar to the chemical vapor deposition it involves hydrogen plasma shinnied radicals for guiding the formation of Graphene[18].

Graphene based batteries super capacitors and solar cells

Batteries

The current batteries we have needs a lot of time to get completely charged and discharges very soon, but if we develop a battery technology which will be based on Graphene then, the charging time of a battery can be decreased from few hours to few minutes. And battery life can be improved a lot. A lot of research has been done in this field big tech giants like Samsung has invented a prototype of Graphene based batteries in phones and significantly reduced the charging time from 1 hour to 12 minutes [18][17].

Super Capacitors

The reason why capacitors cannot replace batteries is that their energy density is very low. But if we can replace porous activated carbon used in the manufacturing of super capacitors by Graphene then, the electric field density of the capacitor will increase and the energy density will also increase. Super capacitors can be charged in seconds if used in phones and in few minutes if used in electric cars [18][16].

Solar Cell

The Solar panels we use today are made of Poly-crystalline, mono-crystalline and Amorphous form of semiconductors like silicon, germanium etc. While manufacturing these solar panels a lot of toxic compounds are used and after their service life of 15-25 years they cannot be recycled. hence making them less environment friendly. But if we make solar cells using Graphene and Indium Tin Oxide then solar panels can be made transparent, the efficiency of the solar cell will also improve significantly and as we know that Graphene is made of Carbon it will certainly be environment friendly [18][15].

Future applications and scope of Nano carbons (Graphene)

1. Graphene based aerogels those constitute 99.8% air and only 0.2% carbon but will be stronger than steel [6].
2. It can be used to manufacture impenetrable body armor [3].
3. It can be used for making flexible or foldable as well as transparent electronic gadgets like smart phones, tablets, laptops etc. [6].
4. They can be used in bio medical applications like implants, BCI (brain computer interface and cell grafts etc. [6].
5. Due to hydrophobic properties of Graphene it can be used to make clothing [6].
6. It can be used to make an energy vibration harvester because it supports Brownian motion [6].
7. It can be also used to make super conductors at room temperature because of its properties like tetra vacancy and SP2 Hybridization [6][14].
8. It can make optical computing a reality by replacing silicon in transistors and processors [6].
9. It can be used to make advance super capacitors and batteries those can charge in minutes and last for days [1].
10. It also finds its application in making quantum computers a reality because its capability to become super conductor when combined with a few other elements [2][6].
11. It can be used for making glowing wallpapers [3][1].

12. They can be used to make space elevator because of they are the strongest materials known to mankind [6].
13. Graphene filtration: - Graphene naturally repels water, but when narrow pores are made in it, rapid water permeation is allowed. This sparked ideas regarding the use of Graphene for water filtration and desalination [6] [10].

It has been observed in laboratories that thin membranes made out of Graphene oxide are impermeable to all gases and vapors besides water, and further research revealed that an accurate mesh can be made to allow ultra-fast separation of atomic species that are very similar in size enabling super-efficient filtering of water, gold, xenon etc. this opens the door to the possibility of using seawater as a drinking water resource, in a fast and relatively special and simple way [10] [14].

Nano filtration based on Graphene can also be used to extract different materials like xenon for space exploration and laser technology, gold worth of 20 trillion dollars from ocean water etc.

The key to the future without ageing, pollution, and drought is not impossible after all it was inside your pencil.

Acknowledgment

Firstly i would like to acknowledge the support and assistance provided to me by my teacher, mentor and guide Dr. Mayank pande. Throughout the preparation of this paper, he has been a source of encouragement for me and kept on providing valuable inputs for the completion of this research paper.

I am also thankful to our HOD Shri. Jagvir Singh and rest of college staff for providing necessary facility and environment to carry out my research successfully.

The co-authors helped me to carry out my research by giving their time, energy, valuable inputs and encouragement.

References

[1] Is This New Super Carbon Better Than Graphene? [Internet]. YouTube. 2019 [cited 11 September 2019]. Available from: https://www.youtube.com/watch?v=FWENEXM5S3E

[2] What's Graphene And Why It'll Soon Take Over The World [Internet]. YouTube. 2019 [cited 11 September 2019]. Available from: https://www.youtube.com/watch?v=dQCJpYR0og8

[3] Why graphene hasn t taken over the world...yet [Internet]. YouTube. 2019 [cited 11 September 2019]. Available from: https://www.youtube.com/watch?v=IesIsKMjB4Y

[4] Carbon nanotube [Internet]. En.wikipedia.org. 2019 [cited 11 September 2019]. Available from: https://en.wikipedia.org/wiki/Carbon_nanotube

[5] WooCommerce B. Carbon Nanotubes Properties and Applications | Cheap Tubes [Internet]. Cheap Tubes. 2019 [cited 11 September 2019]. Available from: https://www.cheaptubes.com/carbon-nanotubes-properties-and-applications/

[6] WHATEVER HAPPENED TO GRAPHENE? (UPDATE) [Internet]. YouTube. 2019 [cited 11 September 2019]. Available from: https://www.youtube.com/watch?v=yUTHA-2LF0w

[7] Fuente J. [Internet]. Graphenea. 2019 [cited 11 September 2019]. Available from: https://www.graphenea.com/pages/graphene-properties#.XVleEugzaUk

[8] Schwarzites: Long-sought carbon structure joins graphene, fullerene family [Internet]. Phys.org. 2019 [cited 11 September 2019]. Available from: https://phys.org/news/2018-08-schwarzites-long-sought-carbon-graphene-fullerene.html

[9] Graphene and water treatment: introduction and market status | Graphene-Info [Internet]. Graphene-info.com. 2019 [cited 11 September 2019]. Available from: https://www.graphene-info.com/graphene-water-treatment

[10] Mrmak N. 4 Great Methods to Make Graphene At Home, along with Graphene Basics [Internet]. Graphene-battery.net. 2019 [cited 11 September 2019]. Available from: http://www.graphene-battery.net/graphene.htm

[11] El-Kady M, Shao Y, Kaner R. Graphene for batteries, supercapacitors and beyond. Nature Reviews Materials [Internet]. 2016 [cited 11 September 2019];1(7). Available from: https://www.nature.com/articles/natrevmats201633

[12] Xu H, Ma L, Jin Z. Nitrogen-doped graphene: Synthesis, characterizations and energy applications. Journal of Energy Chemistry [Internet]. 2018 [cited 11 September 2019];27(1):146-160. Available from: https://www.sciencedirect.com/science/article/abs/pii/S2095495617310616

[13] Geim A. Graphene: Status and Prospects. Science [Internet]. 2009 [cited 11 September 2019];324(5934):1530-1534. Available from: https://science.sciencemag.org/content/324/5934/1530

[14] Ferrari A, Meyer J, Scardaci V, Casiraghi C, Lazzeri M, Mauri F et al. Raman Spectrum of Graphene and Graphene Layers. Physical Review Letters [Internet]. 2006 [cited 11 September 2019];97(18). Available from: https://scholar.google.com/citations?hl=en&user=ucXN1nQAAAAJ

[15] Dutta, M., Sarkar, S., Ghosh, T. and Basak, D. (2012). ZnO/Graphene Quantum Dot Solid-State Solar Cell. The Journal of Physical Chemistry C, [online] 116(38), pp.20127-20131. Available at: https://s3.amazonaws.com/academia.edu.documents/43349019/ZnOGraphene_Quantum_Dot_Solid-State_Sola20160304-3354-150gdpj.pdf?response-content-disposition=inline%3B%20filename%3DZnO_Graphene_Quantum_Dot_Solid-State_Sol.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20190929%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20190929T113726Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=daf40f6461bc2357804414edcd363694c69296d55bb00fddbe41b7857b7ae70f [Accessed 29 Sep. 2019].

[16] Le, L., Ervin, M., Qiu, H., Fuchs, B. and Lee, W. (2011). Graphene supercapacitor electrodes fabricated by inkjet printing and thermal reduction of graphene oxide. Electrochemistry Communications, [online] 13(4), pp.355-358. Available at: https://s3.amazonaws.com/academia.edu.documents/46896287/

Graphene_supercapacitor_electrodes_fabri20160629-15913-13g1msw.pdf?response-content-disposition=inline%3B%20filename%3DGraphene_supercapacitor_electrodes_fabri.pdf&X-Amz-Algorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWOWYYGZ2Y53UL3A%2F20190929%2Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20190929T114003Z&X-Amz-Expires=3600&X-Amz-SignedHeaders=host&X-Amz-Signature=af3c50d4ade117391fe589ddc88c404a68202771d7ade0a8d33e97e181c86fc8 [Accessed 29 Sep. 2019].

[17] Luo, J., Zhao, X., Wu, J., Jang, H., Kung, H. and Huang, J. (2012). Crumpled Graphene-Encapsulated Si Nanoparticles for Lithium Ion Battery Anodes. The Journal of Physical Chemistry Letters, [online] 3(13), pp.1824-1829. Available at: http://Crumpled Graphene-Encapsulated Si Nanoparticles for Lithium Ion Battery Anodes. [Accessed 29 Sep. 2019].

[18] MERTENS, R. (2019). GRAPHENE HANDBOOK (2019 EDITION). [S.l.]: LULU COM.

[19] News.samsung.com. (2019). Samsung Develops Battery Material with 5x Faster Charging Speed. [online] Available at: https://news.samsung.com/global/samsung-develops-battery-material-with-5x-faster-charging-speed [Accessed 29 Sep. 2019].