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THE PROMISING FUTURE OF GRAPHENE

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Abstract

Graphene is one of the allotropes of carbon having[1,2,3,4,5] two dimensional monoatomic layer arranged in hexagonal lattice consisting of single layer of carbon atom of thin layer of sp2 -hybridized carbon. The small overlapping between conduction band and the valence band make it similar to semimetals. Due to its exceptional thermal, electron transfer, optical, and mechanical properties, it has captured world-wide attention and has emerged as an exotic material of the 21st century.[2,3] Due to its wide application in engineering and field of science the study of graphene and graphene-based materials has extreme impact on electronics and optoelectronic devices, water filtration and purification , nanocomposites , solar cells, energy storage, supercapacitors, hydrogen storage, flexible display, and chemical sensors.[3,4] The aim of this review article is to provide a scientific progress of graphene to date on various aspects such as synthesis, functionalization, self-assembly, and some of its amazing properties along with its different applications.[1,2] Various synthesis processes of single layer graphene, chemically derived graphene, graphene nanoribbons, and graphene-based polymer and nano particle composites[3,1]. Their structural, optical, thermal, and electrical properties are discussed with their potential applications in human life.[7,8] The efficient manufacturing process such as Chemical Vapour Deposition (CVD) and thermal Exfoliation and Liquid phase reduction of graphene oxide.

Index Terms: *Graphene, Roll to Roll CVD, Graphene Exploitation and Thermal Reduction, Application and its Uses, Future Perspective,*

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INTRODUCTION:

Graphene isn't a unique or rare substance in fact it has the same carbon structure as graphite is used in pencil. It was first discovered in 2004 by Professor Andre Geim and Dr. Konstantin Novoselov in university of Manchester. Graphene is incredibly stretchable it can stretch about 25% of its length it is the hardest material people know about it's even harder than diamond the single layer of graphene atom is perfectly visible to naked eye the extraordinary properties of graphene makes it different from other elements [

1. Graphene is very light and voluminous material, nearly 1.5 kilograms of graphene sheet in a 30 gallon bag.
2. The current density of graphene is Mini million times better than that of copper.
3. Graphene expands when cool and shrink when it gets warm.
4. Graphene is a most impermeable material even Helium atom even squeeze through it.
5. Graphene have high potential to overtake many of the current materials.
6. Graphene/polymer composites have attracted a great deal of interest because of their wide applications in high-strength and conductive materials.

Manufacturing process:

ROLL-TO-ROLL CVD

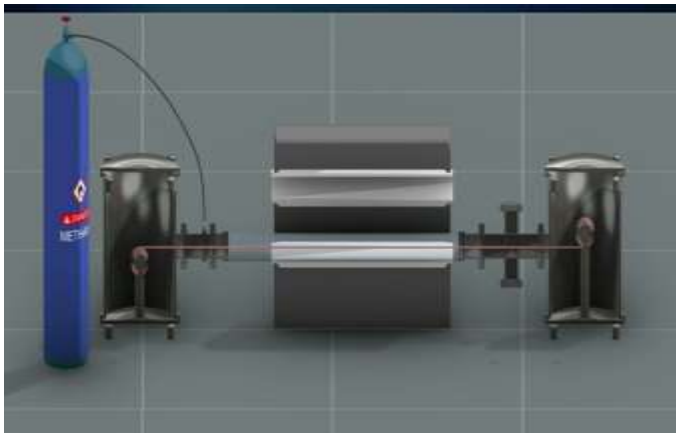

Fig-1: CVD process.

As it can be seen that it has two chambers that are connected by pipe basically these two chambers are called input and output.[8] The input chamber is where we have the beginning of the pure copper roll along with the gas is exhaust that pumps the gas into the chamber.[8] The idea is to have the sheet roll from one side to the other while gas exhaust pumps in methane on top of the copper plate while is also applied this is what called CVD or chemical vapour deposit .[8] Think of it as a molecular 3D printer, because usually they already a seed available in the role by spraying chemical on to the sheet the molecules will self-arrange and continue to create more graphene growing what was already there in a slow reaction depending upon how you start the process the seed here not really necessary because the copper has some properties to facilitate the formation of graphene however the presence of the seed would make things much easier there are more technical parts just like optimum temperature ,amount of chemicals being spread on to the sheet ,rolling speed, distance from the roller and so on [8].

[8 To keep things simple we need optimum temperature to make the reaction happen at a constant rate , to hot and the vapour molecules will not go on to the sheet and to cold they won't bind properly creating impurities in the sheet also the methane gas has to be at a highest purity or else we will get gapes that disturb the natural pattern of the hexagonal shape of graphene next is the rolling speed , again too fast and the vapour won't bind and too slow and it will create undesired layers and lastly we have the distance this is important because you need keep the temperature at a certain level that won't change the process while increasing the length so this would be the challenge of scaling production [8].

GRAPHENE EXFOLIATION AND THERMAL REDUCTION

Graphite is a layer structure in which each layer are stacked together by Van der Waals force of attraction.[7] When we remove a layer of graphite it is called graphene and when the single layer of graphite which is rich in oxygen functional group then it is called graphene oxide (GO).

[7] If we exfoliate the graphite i.e we increase the inner planar distance then it is called exfoliated graphite . EXFOLIATION means separation of the carbon sheet is used to create single layer graphene nano-sheets [7].

A related method is the graphite oxide route in which graphite pellets are firstly oxidize and then ultrasonically exfoliation in an aqueous solution [7].

Ultrasonication is method to produce graphene layers which are mono-,bi-, and few layer graphene which are obtain from graphite flakes or particles.

Liquid phase Reduction of graphite is based on exposing the material to a solvents with a surface tension favours an increasing in total area of graphite crystallites. A surfactant is used to reduce its surface tension because solvent is typically non aqueous. Hence graphite can also be splited in two platelets by sonication method

[7] Now after the exfoliation and reduction of graphite the suspension of graphite oxide is processed and can be deposited on thin film on any surface and reduced back to parent graphite state

The exfoliation is done under the muffle furnance adjusted to the 500 °C. and it is carried under air atmosphere about 4 minutes. Then it's is cooled under atmosphere air to the required temperature

[7] According to recent review by Rouff group in 2013 on chemistry of graphene they said clearly that in graphite oxide the oxygen atoms occupy the edges mostly. So graphene is conducting and it is totally depend on amout of functional group present and of course the conjugation produced by oxygen atoms [7].

APPLICATION AND USES

The various applications and property of graphene make it a precious and useful material for future.

1. Drinkable Ocean Water
   The membrane made from graphene will be able to make water pass through while filtering out salt at the same time. This would be revolution in De-Salination Technology. Such membrane can also purify dirty water .

2. Super Strong Body Armor
   A single layer of Graphene is actually very strong, it can be imagined what can be achieved with double or

two layers of graphene used as incredibly strong protective material.

3 Healthcare
Scientists at the University of Illinois have determined that Graphene can assist in detecting cancerous cells in the body. Researchers have invented temporary tattoos that are based on graphene.

4 Reacharging Gadgets
New batteries based on Graphene will be able to recharge incredibly quickly it would be possible for them to go empty to full just in 15 minutes ,also they can be charged more than 3500 times [6] .

5 Flexible Smartphone Display [6]
In gadgets manufacturing if producers starts to use graphene we might be able to see new and innovative flexible smartphones which can be folded and bended in any direction.

6 Running Shoes
In labs of University of Manchester such shoes have been already tested as they are different from other running shoes that lies in the fact their rubber outsoles are made with the addition of Graphene they are more stretchier and stronger as a results they would last more longer than simple materials [6].

7 Glowing Wallpapers
Graphene may be the reason why light bulbs become a thing of past. Thin wallpapers which glow with graphene-based electrode technology will provide pleasant and adjustable light such lighting will also be much more energy-efficient [6].

8 Rust-free Material
Graphene being impermeable one coating of graphene-based paint would be enough to prevent corrosion [6].

FUTURE PERSPECTIVES OF GRAPHENE

It has been proved that the extra-ordinary, unexpected and unusual properties of graphene (including electrical, thermal, mechanical, optical, and long electron mean free paths) made it enthralling and captivating for various engineering applications. A large number of research publications in past years signifies the importance of graphene that might surpass silicon research in the development of microelectronics and nanomaterial technology.

Graphene nanoribbons and bilayer graphene are the results of such modification that leads to a suitable band gap and allows the applications in FET. Graphene as a new material still faces many challenges and problems ranging from synthesis and characterization to the final device fabrication. The exceptional and extra-ordinary properties were observed in the defect free pristine graphene prepared by graphite exfoliation using scotch tape method which is not appropriate for any large mass device manufacturing. The alternative methods have progressed to CVD and grown single, bilayer and few-layer graphene.

The emergence of graphene is opening new horizons for the investigation of materials sciences; however, research towards the applications of graphene-based materials in electrochemistry is still in its infancy.

CONCLUSION:

According to many physicist graphene is considered as a perfect 2D lattice of carbon atom. Graphene is used for many purposes and for each purpose the number of graphene layers required are different. But even less than perfect graphene layers can be used for many applications.

As the applications of graphene in current world market is driven by the production of graphene , there is a clear sign of how soon this application will reach the user or consumer. The material which require highest electronic quality grades or biocompatibility may takes decades to develop, the material use the lowest grade, most available and cheapest material will first manufacture the recent development in last few years are so rapid in prospective of graphene and continue to improve as the days passes . The properties of grahpene will be replaced only if the other material having same properties come into existence .

The extra ordinary properties of graphene and various applications in the field of engineering, medical science, Defence and research sector , etc

REFERENCES

1]Virendra Singh, Daeha Joung ,Lei Zhai, Soumen Das, Saiful I.Khondaker, Sudipta Seal, Progress in material science, Graphene based material:Past,Presnt and Future

2] Slonczewski JC, Weiss PR. Band structure of graphite. Phys Rev 1958;109:272.

3] Zhang YB, Tan YW, Stormer HL, Kim P. Experimental observation of the quantum Hall effect and Berry's phase in graphene. Nature 2005;438:201.

4] Novoselov KS, Jiang Z, Zhang Y, Morozov SV, Stormer HL, Zeitler U, et al. Room-temperature quantum Hall effect in graphene. Science 2007;315:1379.

5] Novoselov KS, Geim AK, Morozov SV, Jiang D, Katsnelson MI, Grigorieva IV, et al. Two-dimensional gas of massless Dirac fermions in graphene. Nature 2005;438:197.

6] https://goo.gl/rQTJZz (Bright Side)

7]K.S.Novoselov, V.I Fall, A roadmap for graphene,doi:10.1038/nature11458

8] https://youtu.be/K309K-DFqpE (Subject Zero Science)

9] S. Akca, A. Foroughi, D. Frochtzwajg, H.W.C. Postma ,Competing in Dna assembly on graphene

10] Y. Wang, Y. Li, L. Tang, J. Lu, J. Li,Application of graphene modified electrode, Electrochem. Commun., 11 (2009), pp. 889-892

11] S. He, B. Song, D. Li, C. Zhu, W. Qi, A graphene nano-probe for rapid selection, Adv. Funct. Mater., 20 (2010), pp. 453-459

12] C.-H. Lu, J. Li, J.-J. Liu, H.-H. Yang, X. Chen, G.-N. Chen,increasing the sensitivity and single mismatch molecular by go.