iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 3 **Issue:** IX **Month of publication:** September 2015

DOI:

Volume 3 Issue IX, September 2015
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Graphene Nano Ribbons

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Abstract— This paper gives an introduction to graphene nano ribbons. Graphene nanoribbons possess ultra-thin width and offers potential applications in various devices and systems. It has many novel properties which vary according to their synthesis. The most important advantage of opening band gap in gnr makes it more desirable material than graphene in logic applications. Thus, this paper gives a brief review on the synthesis, types and applications of this material.
Keywords— graphene nano ribbon, band energy gap, electronics, armchair, zigzag

I. INTRODUCTION

Graphene is a 2 dimensional honeycomb crystal lattice. It is a zero band gap material. It possess various novel properties such as electrical, mechanical, electronic, thermal etc. Apart from these novel properties, grapheme suffers from a major limitation of zero band gap i.e. the conduction and the valence band interact at a point which is called as the dirac point. The zero band gap in grapheme does not allow the device to switch off. Hence all time it consumes power and thus not preferred for switching logic circuits. Hence it is very important to open a band gap in grapheme. There are various ways to open a band gap in grapheme. The ways can be biasing a bilayer grapheme, applying strain on grapheme, chemical modifications on grapheme sheet and forming grapheme nanoribbons.These are called as the Graphene nanoribbons. These are the strips in a graphene sheet. Its width is very small. It is about <50nm. The electronic structure of GNRs depends on their edges. These GNRs are produced by many ways and one of the common way is the unzipping of the carbon nanotubes. Like graphene they also possess novel properties but suffers from a major limitation of edge defects. It is very important to get controlled edges and proper alignments of this structures.GNRs offer various potential applications in the fields of electrical, electronic and many other areas. The opening of band gap is very essential for logic applications in electronics. Band gap in GNRS make the curve parabolic. This further leads to a disadvantage of lowering of the mobility of the carrier.

In this paper some fundamentals regarding graphene nanoribbons is given so as to gain an insight towards the various openings of applications of this material. Also this paper gives a brief review of these GNR structures which includes their classification, its types and the potential applications that can be performed.

II. PRODUCTION OF GNRS

In order to enhance the performance of future electronic industry by the use of GNRs, it is important to produce GNRs with the required semiconducting properties. Also as the GNRS suffer from edge defects, hence it is very important that the GNRs that are produced should have smooth edges so that the losses due to it should be minimum. So, there are some techniques for their production. GNRs, which are produced by different methods, show difference in their properties that is the method of production also changes their electronic properties. There are many ways to produce this carbon based material. Some important methods include:

Electron Beam Lithography [3,5],

Chemical Methods: It produces a poor edge quality GNRs [1],

Unzipping of Carbon Nanotubes.

The technique unzipping of the carbon nanotube is one of the most common method and gives two major advantages over other methods of production. These are the low cost of the technique and the other is the production of GNRs in bulk. Also, producing GNRs by unzipping CNTs gives GNRs with controlled widths, well defined edge structures, proper alignment which is important for devices [2]. Structurally the CNTs are very similar to the GNRs. If we are able to produce CNTs accurately then well-defined GNRs can be produced.

Another way to make GNRs is by top-down plasma etching: It is the technique in which etching is performed. Etching is done by masking with photo resists, metals or nanowires and then plasma etches away the exposed graphene regions. GNRs with less than 20nm have been produced with this technique. The plasma etching approach not always requires a mask for etching process. In fact it can also start from the defects/edges of graphene, and go along the crystallographic directions so that the required structure is produced. Other method is block copolymer lithography which makes a grapheme nanomesh. It is basically an array of GNRs [6].So, these are some of the ways by which GNRs can be made. These GNRs then can be used in various electronic applications.

III. CLASSIFICATION OF GNRS

Graphene nanoribbons has ultra thin width, which is less than 50nm. It is made by cutting the graphene sheet which is a two-dimentional structure. This introduces quantum confinement effect in these structures and based on this effect these can be classified into two types. Armchair and Zigzag

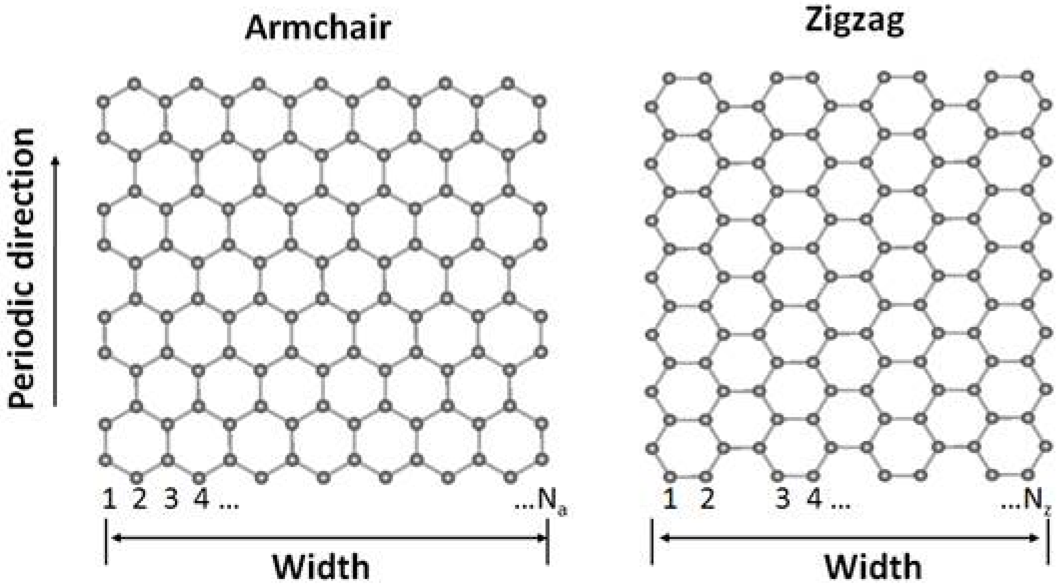

Fig. 1 Structures of Armchair and Zigzag GNRs [4]

A. Armchair GNRs

Armchair GNRs can be either metallic or semiconducting. These nanoribbons are semiconducting and give an energy bandgap which increases with decreasing GNR width. An energy bandgap up to 0.5 eV in a 2.5 nm wide armchair ribbon is reported.

B. Zigzag GNRs

Zigzag GNRs are always metallic .But these Zigzag nanoribbons are also semiconducting as their band gap opens due to antiferromagnetic coupling between the magnetic moments at opposite edge carbon atoms. The band gap of zigzag GNR is inversely proportional to the electron/hole concentration.

IV. APPLICATIONS OF GNRS

GNR have attracted much attention as carbon based nanomaterial. It is a desirable candidate for nanotechnology and is replacing silicon in many applications. GNRs have use in numerous applications such as transistors, energy storage devices, electrical machinery windings, transparent conducting electrodes, biosensors and interconnect, optoelectronic application. One of the major applications is in the field of electronics.

V. GNR IN ELECTRONICS

GNRs are a substitute to graphene in many electronic applications such as transistors, photodetectors and sensors. Field effect transistors based on GNR are well suited for logic electronic applications. The most common switching application can be done through GNRFET [7]. In these graphene nano ribbon field effect transistors (GNRFET), the silicon channel of the conventional FET is replaced by GNR channel. Graphene based FET have been used in many applications of transistors. But the limitation in digital applications is removed by GNRFET. GNRFET with very narrow GNRs less than 10 nm wide are generally suitable for digital applications that require high I_{ON} /$_{IOF F}$ ratio. But the edge roughness defects reduces the performance of these GNR-FETs. Hence, it is important to synthesise GNRs with proper technique so as to get smooth edges and minimum defects

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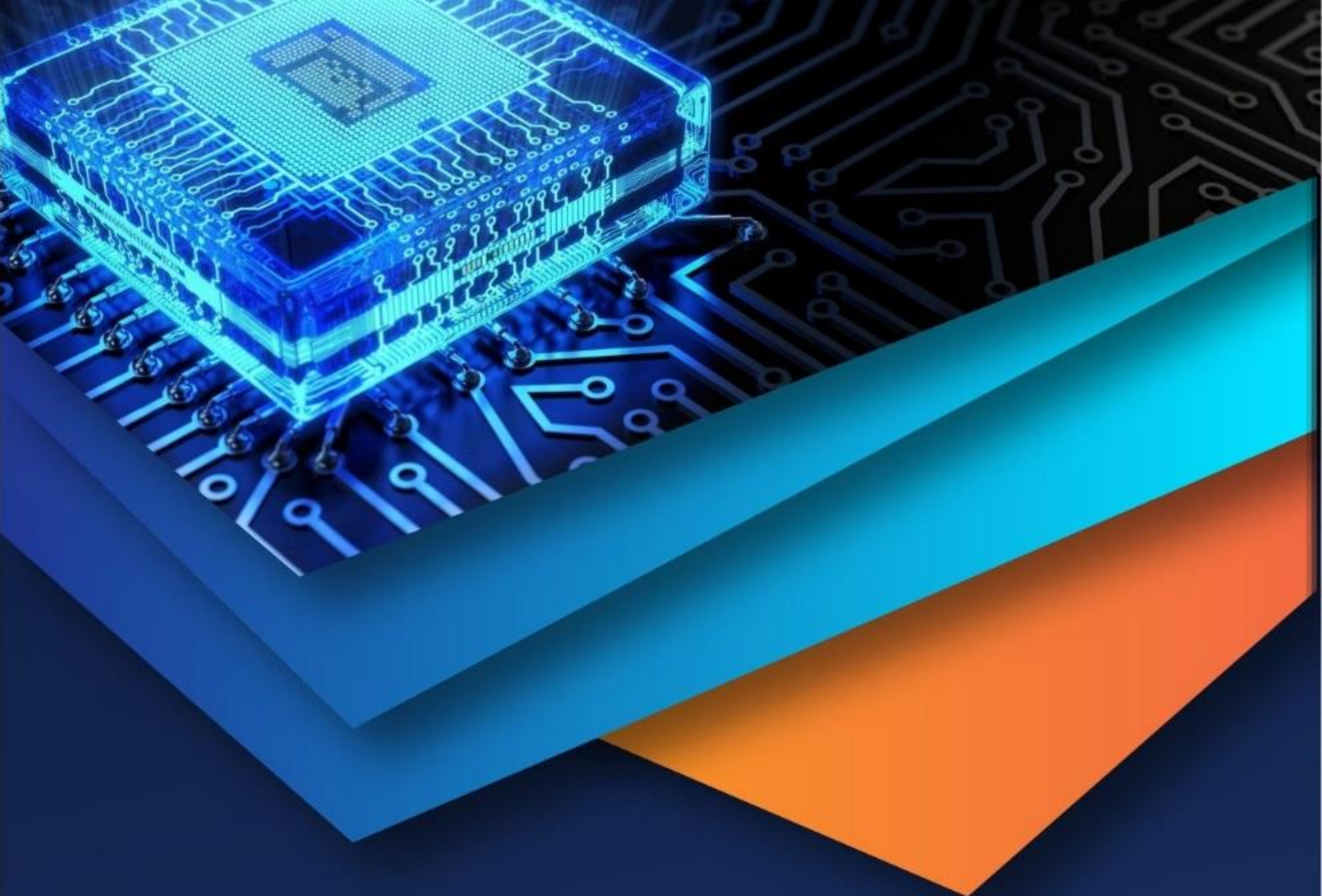
VI. CONCLUSION

This paper gives a basic fundamentals about GNRs It includes production techniques, types and application of GNRs There are three different ways of producing GNRs. Out of these three techniques unzipping of carbon nanotubes is the most preferred one. Based on quantum confinement of structures GNRs are classified into two types i.e. armchair and zigzag. Armchair GNRs can be semiconducting or metallic. But zigzag GNRs are always metallic. It also discuss the use of GNRs in electronic applications.

REFERENCES

[1] Jiao, L, Wang, X., Diankov, G., Wang, H. and Dai, H.," Facile synthesis of high-quality graphene nanoribbons.", Nature Nanotechnology, Vol.5, No.5, pp. 321-325,2010.
[2] Jiao, L, Wang, X., Diankov, G., Wang, H. and Dai, H.,"Narrow graphene nanoribbons from carbon nanotubes.", Nature, Vol. 458,No.7240, pp. 877-880,2009.
[3] Qi, Z. J., Rodríguez-Manzo, J. A., Hong, S. J., Park, Y. W., Stach, E. A., Drndić, M. and Johnson, A. C.," Direct electron beam patterning of sub-5nm monolayer graphene interconnects.", In SPIE Advanced Lithography, pp. 86802-86810,2013.
[4] Delibozov, N. ,"Analysis of Graphene Nanoribbons Passivated with Gold, Copper and Indium.", International Journal of Theoretical and Applied, 2013.
[5] Nemes-Incze, P, Levente Tapasztó, G. et al, "Graphene nanoribbons with zigzag and armchair edges prepared by scanning tunneling microscope lithography on gold substrates.",Applied Surface Science, Vol. 291,pp. 48-52,2014.
[6] Wang, X. and Shi, Y., " Fabrication Techniques of Graphene Nanostructures.", 2014.
[7] Xin-Ran, W., Yi, S. and Rong, Z., "Field-effect transistors based on two-dimensional materials for logic applications.", Chinese Physics B, Vol. 22, No.9, 2013.



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