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Fascinating world of immerging graphene technologies

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Author's Biography

Atul Tiwari is an Associate Research Faculty at the Department of Mechanical Engineering in the University of Hawaii, USA. He has received his Master degree in Organic Chemistry and Ph.D. in Polymer Science from the Universities in India and another Master degree in Mechanical Engineering from the University in USA. He earned the Chartered Chemist and Chartered Scientist status from the Royal Society of Chemistry, UK and is a member of several other professional bodies in the UK, USA, and India. His areas of research interest include the development of silicones and graphene materials for various industrial applications. Dr. Tiwari has invented several international patents pending technologies that have been transferred to the industries. He has been actively engaged in various fields of polymer science, engineering, and technology and has published more than 50 scientific peers reviewed journal papers, book chapters and books related to material science. He is an active reviewer and acts as associate editor of international journals. Dr. Tiwari is two times winner of business plan competitions in the USA and incepted new start-up companies with major venture investment.

Dear Editor,

After decades, allots of research to exploit the unique properties of graphite resulted to a successful discovery of a new nano material called graphene. Unprecedented efforts by two Manchester University professors resulted in an extraction of a single layer of graphite in the year 2004 that earned them a Nobel Prize of physics in 2010. Several terms that are interrelated to graphene such as graphite nano platelets, graphite oxide, single layer or few layers of graphite oxide, graphene oxide, functionalized graphene sheets or functionalized nano graphene sheets, exfoliated graphene oxide and their numerous processing techniques have appeared in the last few years.

Graphene is a single layer of carbon atoms derived from relatively cheaper graphite that is naturally abundant and an anisotropic material. It has a layered structure of carbon atoms arranged in a hexagonal ring and attached through Sp^2 covalent bonds. These hexagonal rings possess high mechanical stiffness of 1060 GPa [**1**]. The layered structure is slippery in nature due to weak Vander-Waals forces between the layers. The graphene is a two dimensional sheet of carbon atoms arranged in a honeycomb lattice with neighboring carbon atoms having an interlayer spacing of 3.35Å [**2**]. A high mechanical strength of 1060 GPa, high thermal conductivity of 3000 $Wm^{-1}k^{-1}$, and high specific area of 2600 m^2/g are few unique properties of graphene nano sheets. Electrons show extremely fast mobility of 15,000 $m^2v^{-1}s^{-1}$ in the 2D graphene sheets [**3**].

The arm chair and zig-zag are two different conformations of the edges in graphene which play an important role in determining the properties of graphene especially in the case of magnetic properties in the nano-meter regime [**4**]. The graphite however is a layered crystal with a c-axis lattice constant of 0.66 nm [**5**]. The topological defects and point defects affect the vibrational and transport properties of graphite. The point defects may enhance the chemical reactivity and play a crucial role in the formation of other defects and also helps in enabling the functionalization [**6**].

The structure of graphene oxide has two regions i.e. aliphatic and aromatic. There are six membered aliphatic rings with unoxidized benzene rings whose relative amount depends on the level of oxidation in the material. The material consists of various functional groups such as large amount of hydroxyl, epoxy, carbonyl and carboxyl functionalities attached to the basal or edge plane [**7**]. The epoxy and other groups are created due to strong oxidizing reaction in graphene oxide [**8**].

The functionalized graphene oxide is now being used as nanofiller to enhance the physico-mechanical properties of the polymeric resins. The reduced graphene has displayed high electrical conductivity and now being used in flexible organic displays. Researchers are exploring the use of graphene for wide variety of industrial applications including biosensors, bioelectronics and biomedical devices. More recently, the European Union has infused one billion Euros under "graphene flagship" for the

research and development of graphene. The scientists and academicians worldwide are putting efforts towards the development of new graphene-based devices and we expect a great future ahead for this new material.

With warm regards
Atul Tiwari, Ph.D., CChem.

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