A Study on Graphite, Graphene, Graphene Oxide (GO) and Reduced Graphene Oxide (rGO) for Practical Utilization

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I. Abstract

The conversion of graphene to graphane is of high importance from a technological and scientific point of view. This article is a review is a article.It has been collected different informations from the different articles. From the review we found here a scalable method for the hydrogenation of graphene based on thermal exfoliation of graphite oxide in a hydrogen atmosphere under high pressure (60–150 bar) and temperature (200–500°C). This method does not require a plasma source and is able to produce gram quantities of the material.Graphite, archaically referred to as plumbago, is a crystalline form of the element carbon with its atoms arranged in a hexagonal structure. It occurs naturally in this form and is the most stable form of carbon under standard conditions. Under high pressures and temperatures it converts to diamond. Graphite is used in pencils and lubricants. It is a good conductor of heat and electricity. Its high conductivity makes it useful in electronic products such as electrodes, batteries, and solar panels. Graphene is an allotrope of carbon consisting of a single layer of atoms arranged in a two-dimensional honeycomb lattice. The name is a portmanteau of "graphite" and the suffix -ene, reflecting the fact that the graphite allotrope of carbon consists of stacked graphene layers. Graphene oxide (GO) is a unique material that can be viewed as a single monomolecular layer of graphite with various oxygen-containing functionalities such as epoxide, carbonyl, carboxyl, and hydroxyl groups. Reduced graphene oxide (RGO) is the form of GO that is processed by chemical, thermal and other methods in order to reduce the oxygen content, while graphite oxide is a material produced by oxidation of graphite which leads to increased interlayer spacing and functionalization of the basal planes of graphite.

Key Words: Graphite, Graphene, Graphene Oxide (GO), Reduced Graphene Oxide (rGO), Electrodes, Electrochemical cell.

II. Introduction

Graphite has a giant covalent structure in which: each carbon atom is joined to three other carbon atoms by covalent bonds. the carbon atoms form layers with a hexagonal arrangement of atoms. the layers have weak forces between them. Graphene is a super light material with a planar density of 0.77 mg/m^2. The unit structure of graphene is a hexagonal carbon ring with an area of 0.052 nm^2. Such a ring only consists of two carbon atoms since each atom at vertex is shared by three unit rings. With respect to electrical conductivity, graphene oxide functions as an electrical insulator, because of the disturbance of its sp2 bonding networks. It is important to reduce the graphene oxide so as to recover the honeycomb hexagonal lattice of graphene, in order to restore electrical conductivity. As rGO considered as stacked layers of GO sheets upon reduction and consist of a few functional groups with wrinkle-free structure, the Ven der Waals forces between the closely packed rGO layers (during high content of filler loading) are very prominent resulting in filler aggregation and thus lowering the Tc .

III. Methods of preparation of Graphite, Graphene, Graphene Oxide (GO), Reduced Graphene Oxide (rGO).

III A. Properties of Reduced Graphite

The physical properties of graphite
has a high melting point, similar to that of diamond. …
has a soft, slippery feel, and is used in pencils and as a dry lubricant for things like locks. …
has a lower density than diamond. …
is insoluble in water and organic solvents – for the same reason that diamond is insoluble.

III B. Properties of Graphene

The most outstanding properties of 422rapheme are:

High thermal conductivity.
High electrical conductivity.
High elasticity and flexibility.
High hardness.
High resistance.
Ionizing radiation is not affected.
Able to generate electricity by exposure to sunlight.
Transparent material.

III C. Properties of Graphene Oxide

Graphene is an atomically-thin, 2-dimensional (2D) sheet of sp2 carbon atoms in a honeycomb structure. It has been shown to have many desirable properties such as high mechanical strength [1], electrical conductivity [2], molecular barrier abilities [3] and other remarkable properties.

III D. Properties of Reduced Graphene Oxide

The Properties of rGO are as follows:
Reduction method: Chemically reduced
Color: Black
Form: Powder
Odor: Odorless
Sheet dimension: Variable
Solubility: Insoluble
Density: 1.91g/cm^3
Dispersability: It can be dispersed at low concentrations of less than 0.1mg/mL in DMSO, NMP, DMF
Electrical conductivity: 666,7 S/m
Humidity (Karl Fisher, TGA): 3.7 - 4.2%
BET surface area: 422.69 – 499.85m2/g

IV Elemental Analysis Graphite, Graphene, Graphene Oxide (GO), Reduced Graphene Oxide (rGO).

IV A. Elemental Analysis of Graphite

In contrast to graphite oxide, the chemically modified graphene sheets are not heavily oxygenated that is confirmed not only by elemental analysis and IR spectroscopy, but also by XRD. XRD of the acid-treated graphene showed a broad and weak diffraction peak (002).

IV B. Elemental Analysis of Graphene

The properties of the resultant hydrogenated graphene were studied by scanning and transmission electron microscopy, Raman spectroscopy, X-ray photoelectron spectroscopy, infrared spectroscopy and combustible elemental analysis techniques. Sheet and specific resistance of the graphene and hydrogenated graphene were measured. This scalable synthesis method has great potential to serve as a pathway towards the mass production of graphane.

IV C. Elemental Analysis of GO

Graphene oxide (GO) can be successfully prepared by a modified Hummer's method. The reduction effect and mechanism of the as-prepared GO reduced with hydrazine hydrate at different temperatures and time were characterized by x-ray photoelectron spectroscopy (XPS), Fourier transform infrared spectroscopy (FTIR), elemental analysis (EA), X-Ray diffractions (XRD), Raman spectroscopy and thermo-gravimetric analysis (TGA).From the review results showed that the reduction effect of GO mainly depended on treatment temperature instead of treatment time. Desirable reduction of GO can only be obtained at high treatment temperature. Reduced at 95 °C for 3 h, the C/O atomic ratio of GO increased from 3.1 to 15.1, which was impossible to obtain at low temperatures, such as 80, 60 or 15 °C, even for longer reduction time. XPS, 13C NMR and FTIR results show that most of the epoxide groups bonded to graphite during the oxidation were removed from GO and form the sp2 structure after being reduced by hydrazine hydrate at high temperature (>60 °C), leading to the electric conductivity of GO increasing from 1.5×10^{-6} to 5 S cm^{-1}, while the hydroxyls on the surface of GO were not removed by hydrazine hydrate even at high temperature. Additionally, the FTIR, XRD and Raman spectrum indicate that the GO reduced by hydrazine hydrate can not be entirely restored to the pristine graphite structures. XPS and FTIR data also suggest that carbonyl and carboxyl groups can be reduced by hydrazine hydrate and possibly form hydrazone, but not a C = C structure.

IV D. Elemental Analysis of rGO

The constituent elements of rGO are given below:
Oxygen (%): 13 – 22%
Hydrogen (%): 0 – 1%

Nitrogen (%): 0 – 1%
Carbon (%): 77 – 87%
Sulfur (%): 0

V. Applications of Graphite, Graphene, Graphene Oxide (GO), Reduced Graphene Oxide (rGO).

V A. Applications of Graphite

Real and potential applications of graphite intercalation compounds in electrochemical processes are critically surveyed. Special attention is given to the fields of' batteries' and' chemically modified carbon electrodes'.

V B. Applications of Graphene

Graphene has unique mechanical, electronic, and optical properties, which researchers have used to develop novel electronic materials including transparent conductors and ultrafast transistors.

V C. Applications of GO

Graphene oxide and graphene quantum dots are attractive fluorophores that are inexpensive, nontoxic, photostable, water-soluble, biocompatible, and environmentally friendly. The present study reports a novel, simple, economic and ecofriendly method to synthesize Titanium dioxide (TiO_2) nanoparticles using green alga Chlorella pyrenoidosa.

V D. Applications of rGO

The rGO is used in the following applications:

- Graphene research
- Batteries
- Biomedical
- Supercapacitors
- Printable graphene electronics

VI Conclusions

In this review article, the preparation, properties, and applications of graphite and graphene-based materials have been reviewed.

Preparation of high quality graphene materials in a cost-effective manner and on the desired scale is essential for many applications. CVD growth on metal foils has exceptional potential for, ultimately, the production of endless lengths of graphene/n-layer graphene of desired widths (‘graphene foil’) that could then be picked up by roll-to-roll processing. Further improvement of the quality along with development of a clean transfer process for such foils will help to realize many applications including graphene-based electronic devices, for thermal management, for transparent conductive electrodes, and others. The preparation of graphene materials via ‘chemical’ processing routes (e.g., oxidation of graphite followed by reduction of the graphene oxide platelets obtained by exfoliation) may be able to produce fairly large amounts of ‘graphene’ cost effectively; however, the chemical details (e.g., oxidation/reduction mechanisms and detailed chemical structures) need to be more fully understood. Future efforts for graphene and n-layer graphene such as achieving desired surface functionalization, and, e.g., the ‘cutting’ or preparation into desired shapes, could generate novel structures having many applications.

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