Research on preparation and performance of graphene

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ABSTRACT
Graphene has recently attracted much interest in material field due to its unique two-dimensional structure and outstanding properties. Graphene oxide (GO) was prepared by the Hummers method. Raman spectrum, X ray photoelectron spectroscopy and infrared spectroscopy were used to characterize the chemical structure of Graphene, especially in introducing outstanding performances of graphene on physical and chemistry.

Key words: Graphene; preparation; properties

INTRODUCTION
Zero-dimensional (0D) buckminsterfullerene, discovered by Kroto, Curl and Smalley[1], in 1985, ignited significant interest in nanoscale carbonaceous materials. After that Iijima[2] found further improved studies of carbon-nanoparticles. One-D CNTs, highlighted shortly thereafter by further increased enthusiasm in carbon-based nanoparticle research. While both fullerenes and CNTs are proposed to have been derived from the two-D graphenesheet. This delay in discovery can be partially attributed to the single-atom-thick nature of the graphene sheet, which was initially thought to be thermo-dynamically unstable. However, graphene is not only stable but also exhibits impressive electronic and mechanical proper-ties. Importantly, graphene can be made in bulk quantities and in a wide range of processable forms using simple mechanical and chemical processes.

Graphene has generated great excitement in the last few years because of its novel properties with potential applications. Graphene exhibits an ambipolar electric field effect, ballistic conduction of charge carriers, and the quantum hall effect at room temperature. Some of the other interesting characteristics of graphene include high transparency toward visible light, high elasticity and thermal conductivity, unusual magnetic properties, and charge transfer interactions with molecules. Although the study of graphene began recently, scientists have begun to conduct extensive research on its synthesis and properties of modification. Grapheneoxide and graphene occupy the interface of macromolecules and nanoscale objects. As such, they can bemodified readily using a plethora of chemical reactions, chemically modified graphene(CMG) has been studied in the context of many applications, such as polymer composites, energy-related materials, sensors, ‘paper’-like materials, field-effect transistors (FET), and biomedical applications, due to its excellent electrical, chemical, and thermal properties.

This review prepared e oxidation of graphite by the method of Hummersth, hydrazine hydrate as a reducing agent, and was characterized by XRD, FT-IR and EM. Application performance was discussed on physical and chemistry.

EXPERIMENTAL SECTION

1.1 Reagents
Natural flake graphite; concentrated sulfuric acid, AR; hydrogen peroxide, AR; potassium permanganate; AR, etc.

1.2 Reaction Mechanism
In anhydrous concentrated acid system, natural graphite powder as raw materials reacts with strong oxidizer (such as
KMnO	extsubscript{4}) to form graphite oxide with redox process method. The reaction generate some functional groups containing oxygen, such as C - O - C, C = O, - COOH and – OH.

Joining an appropriate amount of solution and adjusting the pH in the range of 9 to 11, which formulated as a suspension concentration. Hydrazine hydrate as a reducing agent reacts with some functional groups containing oxygen to form graphene dispersion.

**1.3 Preparation of graphite oxide**

In anhydrous concentrated acid system, natural graphite powder as raw materials reacts with strong oxidizer (such as KMnO	extsubscript{4}) to form graphite oxide with Hummers redox process method. The temperature was raised to 98 ℃ using gradient method and 30% H	extsubscript{2}O	extsubscript{2} solution was added.

**1.4 Preparation of graphene**

The NaOH solution was joined in the graphite oxide with hydrazine hydrate as reductant, graphene oxide was dispersed. The graphite oxide powders were exfoliated via ultrasonic vibration to produce GO nanoplatelets.

**CHARACTERIZATION OF GRAPHENE**

**2.1 Raman spectroscopy**

Figure 4 exhibits a high magnification TEM image of a GO nanosheet showing a strong G peak of graphite oxide in 1359.1 cm\(^{-1}\). The graphene has a D and G peak in 1343.7 cm\(^{-1}\) and 1590.1 cm\(^{-1}\). Ratio of ID and IG of graphene increases than graphite oxide. Suggesting that the area of sp\(^2\) hybridization carbon atoms of graphene is reduced and quantity increased. What reason that a part of SP\(^3\) hybrid structure generated in the structure. 2D band of graphene can also be observed by TEM. This is mainly because in the multi-layer graphene, the shape of 2D band is pretty much different from that in the single-layer graphene. The 2D band in the single-layer graphene is much more intense and sharper as compared to the 2D band in multi-layer graphene.
2.2 X-ray photoelectron spectroscopy analysis
Contrast diffraction peaks between graphite and graphene oxide: the 001 strong peaks of graphite oxide disappear in the graphene structure. We also found that the GO nanosheets were unstable under electron beam bombardment. After a few minutes of exposure to the electron beam during the TEM observation, the GO nanosheets were found to be broken up, which was possibly caused by the evaporation of the oxygen- and hydrogen-containing functionalized groups. After chemical reduction, graphite oxide were reduced to graphene sheets and restored to an ordered crystal structure. This is evidenced by the appearance of the (002) peak of graphene at 11.8°.
2.3 Infrared analysis
The biggest difference places between two products of the infrared spectrogram is in the range of 3000-3700 cm\(^{-1}\). There has strong O-H stretching vibration peak of graphite oxide, this peak almost disappeared in graphene. Indicating that the oxidation reaction is complete proceed. Also, the two products have the same absorption peaks, in the range of 051-1059 cm\(^{-1}\) and 1221-1225 cm\(^{-1}\), respectively. Appear stretching vibration of C-O-C and C-OH.

![FT-IR spectra of graphite oxide and graphene](image)

PROPERTIES OF GRAPHENE
As a new carbon nano-material, graphene has the special physical and chemical properties. Chemical properties of high surface area, high electrical conductivity, high mechanical strength, and easy modification. Meanwhile, graphene has advantages in price, known as the "silicon after age" of potential new materials.

3.1 The performance of the application in physics
3.1.1 Mechanics application
The connection between the carbon atoms of graphene is very flexible. Arranged in form of SP2 hybridization structure, elastic extension can reach 20%, given the excellent mechanical properties of graphene. Graphene is the thinnest and strongest two-dimensional nanomaterials at this stage.

Hu mingRen test the mechanical behavior of graphene by electronic universal testing machine. The Cycle tests were used to testing the initial position of the contact, a fixed compression displacement, and returning to the initial position. It can still return to the initial position without residual strain after 300 cycles. This is mainly related to the existence state of the graphene sheets. Using scanning electron microscopy shows between sheets support each other and porous honeycomb structure. Graphene also has the high elasticity under minimal stress.

3.1.2 Electrical Application
Graphene has a very high specific surface area, if the surface has been effectively utilized, can gain will much the capacitance than porous carbon [3-4]. The good surface conductivity and electrode material is good for forming with Electrode material/Electrolyte electric double layer interface, to ensure efficient use of the material surface [5]. Yan [6] produced of supercapacitor by graphene. It have 11 kw/kg of power density, 28.5 Wh/kg of energy density, 205F/g of specific capacity, and specific capacity still maintain more than 90% of capacity after 1200 charge-discharge cycles. Graphene is two-dimensional semiconductor, which energy gap is close to zero. In the sub-micron movement, anti-interference ability is very strong and without the aid of the carrier. Graphene is the smallest resistivity materials. Graphene sheet has a band of zero-energy states localized at the surface. The most studied such states are those localized near graphene zigzag edge. Along a zigzag edge there is one localized state per three lattice units. This implies that a precursor structure for localized states at the Dirac energy can be found in ribbons or
constrictions of small lengths. Single-layer graphene can be considered a zero gap semiconductor, which leads to the possibility of mid gap states. Further, graphene can change the chemical potential in the electric field. Mainly graphene has a hole carriers half-integer quantum Hall effect.

And the quantum Hall effect of graphene has been proved by Novoselov [7] in the experiment.

3.1.3 Optical Application
Owing the accurate chemical structure, graphene have the quality of light transmittance, and its layers increase linearly with the changes of the number [8]. This feature has been proved by Gusynin[9] et al in the way of the experiment. In the ZnO solar cell system, the ZnO thin films are deposited on the surface of the graphene oxide transparent electrode. Combining with Au, PEDOT/PSS together. The highest energy conversion rate of battery can reach 0.31%. Kamat Produced of TiO2 composite materials by graphene. The results showed: with the addition of graphene, TiO2 optical response performances enhanced and broaden the range of light response. The graphene was applied in transparent electrode and light absorption agent[10-12]. In addition, graphene composites started as a manufacturing dye-sensitised cell [13].

3.1.4 Thermal application
Graphene is the basic unit of carbon allotropes of elemental composition. In 2008, Pe-res[14] deduced theoretically this feature. Balandin[15] et al found out the corresponding relation between G peak frequency of the graphene and laser energy, shows that thermal conductivity of monolayer graphene's is up to 3000-5000 - w/mK at room temperature. Graphene were adsorbed on SiO2 by Seol[16] et al, which the thermal conductivity can still reach 600 W / (m • K). While reducing the thermal conductivity is determined by energy consumption and interface scattering of phonons through the graphene - silicon interface. Nevertheless, the thermal conductivity of graphene increase by two and fifty times than copper and silicon.

3.2 The performance of the application in Chemistry
3.2.1 Catalyst carrier
Graphene is a good template supported catalyst; primarily there is a direct relationship with its regular two-dimensional surface structure. Mastalir[20-21] et al fixed Pd nanoparticles on the bottom material of graphene and synthesized Pd - graphene oxide nanocomposite catalysts. The catalysts were applied in the hydrogenation of acetylene will show high selectivity and catalytic activity. Scheuermann[22] et al also applied in the above reaction catalyst, and compared with conventional catalyst. Graphene and its derivatives have higher catalytic activity ability. Li[23] et al demonstrated graphene and its composites exhibit fast electron transfer kinetics. In Fe (CN) / 63-4 - reduction system, graphene improves effectively the electron transfer between the electrode and electroactive center. Li prepare for Pt - graphene catalysts and Pt – Vulcan catalysts, they were applied in methanol fuel cell in order to contrasting the two performance. On the same cyclic voltammetry conditions, the catalyst Pt-graphene two times as the current density as Pt-Vulcan carbon catalyst, the catalytic performance of Pt-Vulcan carbon is much lower than the Pt - graphene catalyst.

3.2.2 Chemical Energy
High conductive properties of graphene are also used in the electrochemical luminescence. Graphene can effectively promote the electron transfer to the sensor platform and play linked channels role between the chromophore and electrode channels. Moreover, the graphene may promote porosity and surface area of the platform, this will increase the diffusion rate of the reactants [24]. Cheng yuan Deng prepared for graphene-nanocomposite by in situ electrochemical reduction method, it can overcome low the electrical chemical luminescence intensity of quantum dot itself and poor stability. The experimental results show that the electrochemical reduction of graphene oxide make increase chemical luminescence intensity of graphenenanocomposites [25-27].

The appearance of graphene brings about the application of super capacitor. Carbon material of super capacitor. It is mainly made up of activated carbon what main unit is graphene[28]. Graphene modified products act as electrode materials of super capacitor by Ruoff [29], the water phase capacitance of super-capacitor is 135 F·g-1.

3.2.3 Electrode modification
Excellent electrical conductivity of have better electrocatalytic properties for specific substrates. The larger specific surface area and biocompatibility of graphene was often used to fix biological macromolecules (such as proteins or enzymes) and produced the electrochemical- sensor. Shan[30] et al adopt polyethylene (PE) and pyrrolidone functionalized graphene electrodes, the modified product can be well dispersed in the aqueous phase, and act as a catalyst.in the reaction of O2 and H2O2. 2,2′- 2 nitrous double (3 - ethyl-benzothiazol-6 - sulfonic acid) (ABTS) was adsorbed on the surface of the graphene through electronic effect, electrochemical results showed that the ABTS
has a fast electrochemical reaction and electrochemical kinetics on the surface of the graphene.

**CONCLUSION**

With improvements in the synthesis and processing of graphene oxide and graphene, these highly versatile materials can be accessed by more scientists and engineers. When the graphene was applied in the photovoltaic conversion, reducing graphene sheets stacked and reunited, adopting the new ways to dispersing graphene and TiO2 nanoparticles, can have a good optical performance TiO2/graphene composites. Graphene drop-cast from a dispersion has recently been utilized as an ultrathin support film for TEM imaging to give unmatched atomic resolution.[31-33] Bionano composites have also been prepared recently, via intercalation of DNA and cytochrome c into graphene oxide. Graphene paper itself is biologically compatible, being able to function as a support for mouse fibroblast cells, which suggests its use in encapsulating enzymes, serving as a template for D NA-based therapy or culturing cells[34]. With such innovative applications in mind, the development of new graphene oxide- and graphene-based materials will certainly lead to many future advances in science and technology.

Although the preparation and properties of graphene have made great progress, the optimization of synthesis and performance also needs to be more research. For example: if the strong oxidant damaging its structure effectively controlled will improve its structural integrity and realize controllable synthesis process. The research of Graphene mechanism and process of phase change will control better the synthetic process of graphene.

**REFERENCES**

