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Research Article

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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 bepartially 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, grapheme 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 effcet 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. Grapheneoxideand graphene occupy the interface of macromolecules and nanoscale objects. As such, they can bemodified readily using a plethora of chemical reactions,chemically modified grapheme(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

KMnO4)to from 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 somefunctional groups containing oxygen to form grapheme dispersion.

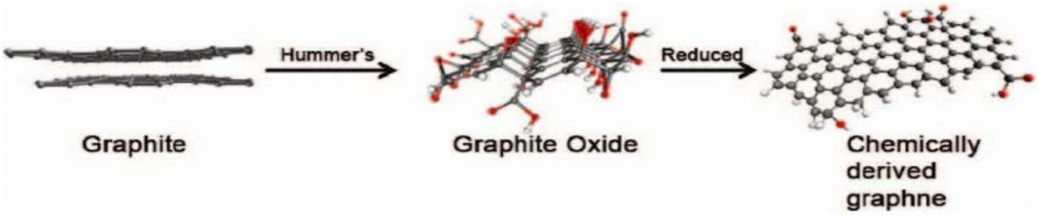
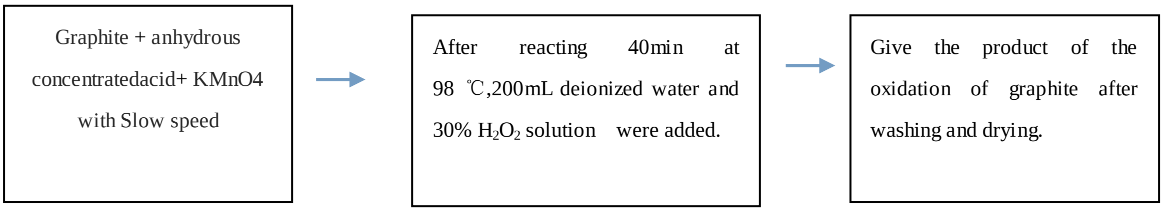


Fig.1 The schematic of preparation of graphene by Hummers method

1.3 Preparation of graphite oxide

In anhydrous concentrated acid system, natural graphite powder as raw materials reacts with strong oxidizer (such as KMnO4)to from graphite oxide with Hummers redox processmethod . he temperature was raised to 98 ℃using gradient method and 30% H2O2 solutionwas added.



Graphite + anhydrous concentratedacid+ KMnO4 with Slow speed

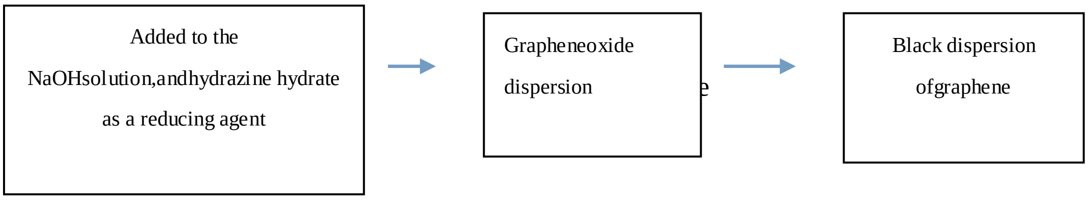
After reacting 40min at 98 ℃,200mL deionized water and 30% H_2O_2 solution were added.

Give the product of the oxidation of graphite after washing and drying.

Fig.2 process flow diagram of preparation of graphite oxide

1.4 Preparation of grapheme

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 ultrasonicvibration to produce GO nanoplatelets.



Added to the NaOHsolution,andhydrazine hydrate as a reducing agent

Grapheneoxide dispersion

Black dispersion ofgraphene

Fig 3 The process flow diagram of preparation of grapheme

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. in1359.1cm-1. The grapheme has a D and G peak in 1343.7cm-1 and 1590.1cm-1. Ratio of ID and IG of grapheme increases than graphite oxide. Suggesting thatthe area of sp2 hybridization carbon atoms of grapheme is reduced and quantityincreased. What reason that a part of SP3 hybrid structure generated in the stru-cture. 2D band of graphenecan also be observedby 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-laye grapheme.

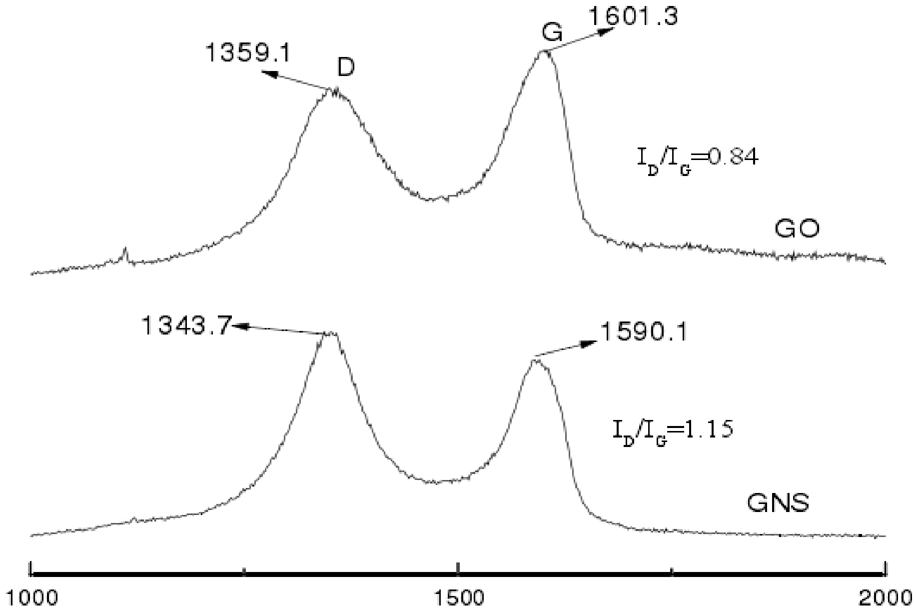


Fig.4 Raman spectra of and graphen

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 unstableunder electron beam bombardment. After a few minutesof exposure to the electron beam during the TEM observation, theGO nanosheets were found to be broken up, which was possiblycaused by the evaporation of the oxygen- and hydrogen-containing functionalized groups.After chemical reduction.Graphite oxide were reduced to graphene sheetsand restored to an ordered crystal structure. This is evidencedby the appearance of the (002) peak ofgrapheneat 11.8 ° .

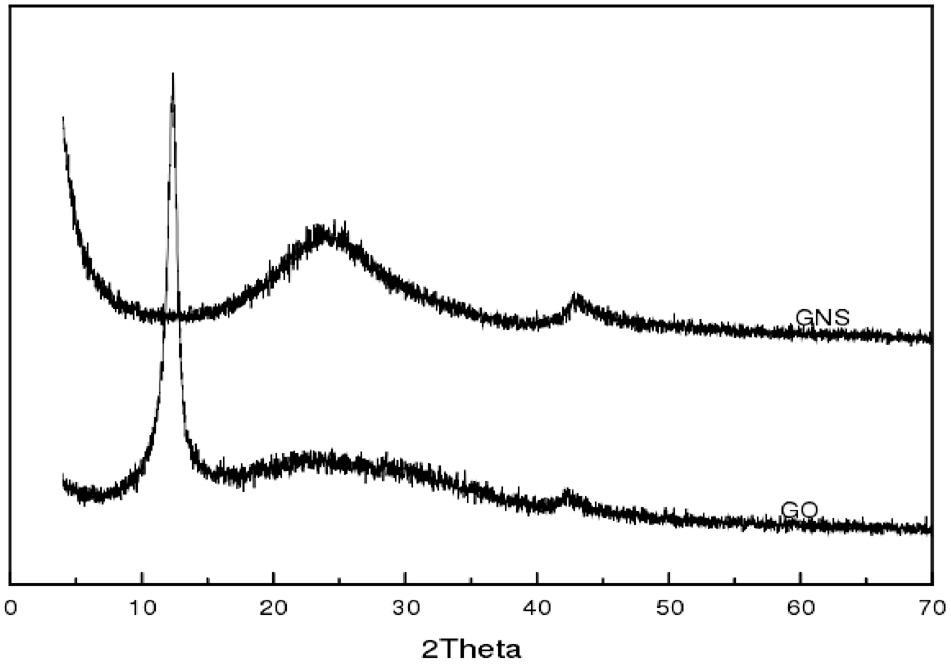


Fig.5 XRD patterns of graphite oxide and graphene

2.3 Infrared analysis

The biggest difference places between two products of the infrared spectrogram is in the range of 3000-3700cm-1.There has strong O-H stretching vibration peak of graphite oxide, this peak almost disappeared in grapheme. Indicating that the oxidation reaction is complete proceed. Also, the two products have the same absorption peaks, in the range of 051-1059cm-1 and 1221-1225cm-1, respectively Appear stretching vibration of C-O-C and C-OH.

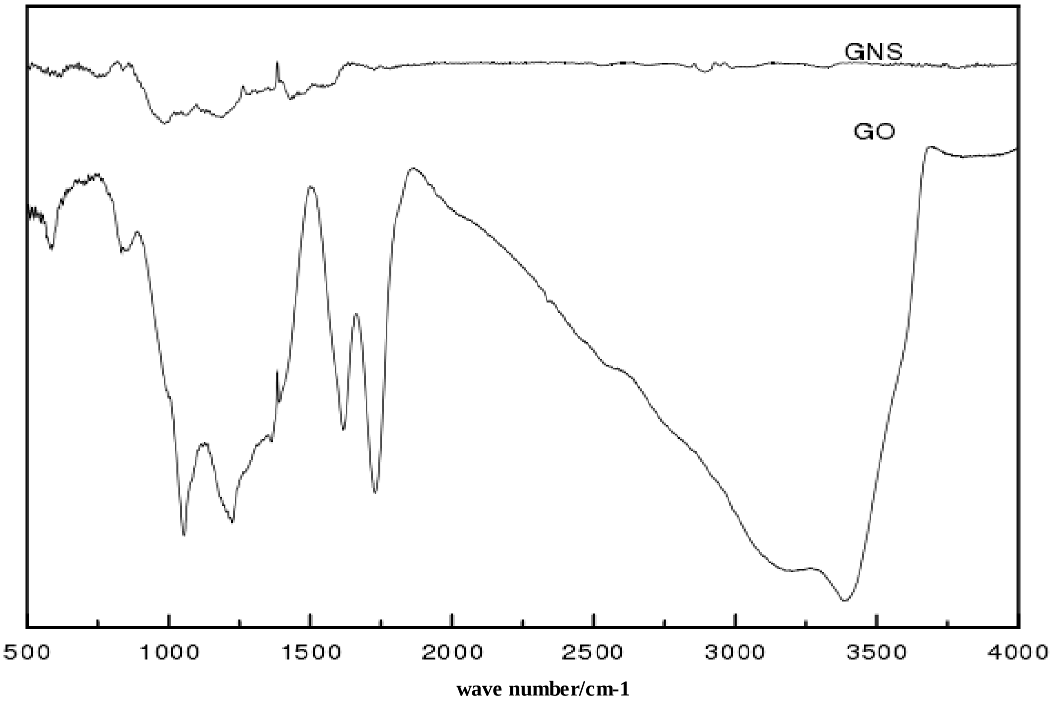


Fig.6 FT-IR spectra of graphite oxide and graphene

PROPERTIES OF GRAPHENE

As a new carbon nano-material, graphen 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

3.1.1Mechanics application

The connection between the carbon atoms of grapheme is very flexible. Arranged in form of SP2 hybridization structure, elastic extension can reach 20%, given the excellent mechanical properties of graphene. Grapheme 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, andreturning 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 grapheme.It have 11 kw/kg of power density , 28.5 Wh/kg of energy density, 205F / g of specific capacity, and pecific 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 agraphene 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 gapsemiconductor, which leads to the possibility of mid gapstates. Further, grapheme 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 changesof the number [8]. This feature has been prove-d 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. Co-mbinating 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 grapheme was applicated in transparent electrode a-nd 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 find out the corresponding relati-on between G peak frequency of the grapheme 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 thancopperand silicon.

3.2 The performance of the application in Chemistry

3.2.1Catalyst carrier

Graphene is a good template supported catalyst; primarily there is a direct relationshipwith its regular two-dimensional surface structure. Mastalir[20-21] et al fixed Pd nanoparticles on the bottom material of grapheme and synthesized Pd - graphene oxide nanocomposite catalysts. The catalysts were applicated in the hydrogenation of acetylene will show high selectivity and catalytic activity. Scheuermann[22] et al also applied in the above reaction catalyst, and comparised 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, grapheme improves effectively the electron transfer between the electrode and electroactive center. Li preparate for Pt - graphene catalysts and Pt – Vulcan catalysts, they were applicated 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 grapheme 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 electrically 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.Carbonmaterial of super capacitor. It is mainly made up of activated carbon what main unit is grapheme[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 producted 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 grapheme.

CONCLUSION

With improvements in the synthesis and processing of grapheme oxide and graphene, these highly versatile materials can be accessed by more scientists and engineers, When The graphene was applicated in the photoelectric conversion, reducing graphene sheets stacked and reunited ,adopting the new ways to dispersing of 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 DN A and cytochrome c into grapheneoxide.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 therapyor 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 has 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.

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