"DEVELOPMENT OF AMINE FUNCTIONALIZED GRAPHENE OXIDE FOR SUPER CAPACITOR APPLICATION"

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Abstract
In the present research, we are planning to synthesize the graphene oxide (GO), reduce graphene oxide (rGO), and graphene-based (amine- GOs) nanocomposites (GNCs) inconsecutive manner. The functionalization of the graphene oxide will be with aromatic and non-aromatic amines (amine-GOs) i.e. graphene oxide with 4-hydroxybenzylamine, 4-dimethylaminobenzylamine, 1-pyrenemethylamine hydrochloride and 2-aminofluorene etc. The expected final material will be characterized by different characterization technique of XRD, FTIR, ^{13}C NMR, Raman spectroscopy, UV-Visible, XPS, SEM, TEM for imaging and thermogravimetric analysis (TGA). The synthesized material will have plethora applications in various field but, in the present research we are planning to utilize for the substantial application in super capacitors. The significant improvement in GO's electrochemical properties through amine functionalization, will be investigated by cyclic voltammetry analysis and electrochemical impedance analysis.

Keywords: supercapacitor; materials; application of supercapacitors; amine functionalized graphene oxide; performance of supercapacitors

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INTRODUCTION

Graphene is a material made of carbon atoms that are bonded together in a repeating pattern of hexagons. Graphene is among the allotropes of carbon; its carbon atoms are arranged in a single layer. These carbon atoms are organized in a honeycomb lattice with a two- dimensional arrangement. It has flat honeycomb pattern gives it many extraordinary characteristics, such as being the strongest material in the world, as well as one of the lightest, most conductive and transparent.

Graphene has endless potential applications, in almost every industry (like electronics, medicine and much more). Presently, graphene is widely researched worldwide because of its unique properties such as zero band gap, remarkable electron mobility at room temperature, high thermal conductivity and stiffness, large surface area, impermeability to gases, etc. It is charge carrier exhibits core mobility, massless, and moves a few micrometers distance maintaining its structure at room temperature.

Graphene synthesis means any process of fabricating or extracting graphene from graphite. The method to be chosen is governed by the desired size, quantity and purity.

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As graphene is expensive and relatively hard to produce, great efforts are made to find effective yet in expensive ways to make and use graphene derivatives or related materials. Graphene oxide (GO) is one of those materials - it is a single-atomic layered material, made by the powerful oxidation of graphite, which is cheap and abundant. It has a single mono molecular layer containing oxygen functionalities such as carboxyl, carbonyl, epoxide, or hydroxyl groups. These added functionalities expand the separation between the layers and make the material hydrophilic (meaning that they can be dispersed in water). GO is a single-layered material made of carbon, hydrogen and oxygen molecules, which ultimately becomes in expensive yet abundant. However, due to the disruption of its sp^2 hybridization, GO tends to be described as an electrical insulator rather than a conductor.

LITERATURE REVIEW

An inclusionary literature survey has been carried out through some research paper as well as published research journals index formation.

An elaborate review of literature is as follows-

To counter act this disruption, GO can be reduced to form reduced graphene oxide (rGO) to retrieve its hexagonal lattice structure and produce graphene-like sheets by removing a large portion of oxygen groups to closely resemble graphene. Reducing GO by using chemical reduction is very scalable but unfortunately, the quality of the produced rGO is typically poor. Thermally reducing GO requires temperatures as high 1000 °C or more which damages the structure of the graphene platelets. However, the overall quality of the produced rGO is quite good. Electrochemical methods have been shown to produce very high-quality rGO, almost identical to pristine graphene. However, the method still suffers from scalability issues. Once reduced graphene oxide has been produced, there are numerous ways that can be used to functionalize it. This will enhance the properties of the rGO film to be used in various applications.

Currently, GO can be synthesized in different ways such as the Modified Hummer's method and Staudenmaier method. Both methods involve the oxidation of graphite but differ in mineral acids, oxidizing agents, preparation time and type of washing/drying processes. In the original Hummers method, GO was synthesized by using $KMnO_4$ and $NaNO_3$ in concentrated H_2SO_4. Typically, for the Modified Hummer's method, Hummer's reagent with the addition of $NaNO_3$ was used. GO is produced from pure graphite powder that has been gradually added (along with $NaNO_3$) into a hot concentration of H_2SO_4 solution that would be cooled in an ice bath. $KMnO_4$ has to be slowly added to keep the reaction temperature under 20°C to prevent overheating and explosions. To complete the reaction with $KMnO_4$, the suspension would then be treated with an H_2O_2 solution and washed with HCl and H_2O. After filtration and drying, GO sheets would be obtained. This modified method happens to be very common and reliable when producing high yields of GO. The difference between graphite oxide and GO are based on their different structures but chemical composition remain alike.

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- The fabrication of GO based biosensing materials and the formation of electronic devices by controlled modification and reduction of GO and some other developmental techniques will have used to develop devices with high selectivity, sensitivity, reliability with maintaining the cost is the big challenge to researchers. Sekhar. C. Ray (2015) have studied the application in medical field of graphene oxide and reduced graphene oxide, he found that in the mechanism of in vitro bio toxicity caused by graphene are related to oxidative stress reaction and damaging of cell membrane. Further study extended to the development of suitable chemical synthesis and fictionalization approaches for precise control over size, size distribution, morphology, structural defects, and oxygen-containing groups of GO is urgently needed, because these are closely correlated to the performance of the GO-based nanomaterials for biomedical applications and safety issues.

-) Examines the Amino pyrene functionalized reduced graphene oxide as a supercapacitor electrode Ellie Yi Lih Teo, Hong Ngee Lim, Rajan Jose, Kwok Feng Chong RSC Advances 5 (48), 38111- 38116, (2015) Report on the structural and electrochemical properties of aminopyrine functionalized reduced graphene oxide (Ap-rGO) for its suitability as a supercapacitor electrode. Spectroscopy studies reveal the successful functionalization of amino pyrine onto Ap-rGO through π–π interactions. Electrochemical analyses of Ap-rGO show a substantial increase in the specific capacitance for Ap-rGO (160 F g^{-1} at 5 mV s^{-1})

The Ap-rGO is prepared by sonicating a suspension of rGO with aminopyrine and the filtered sediment is subjected to spectroscopy studies and electrochemical studies.
The Ap-rGO has desirable charge storage properties such as low series resistance (0.4 Ω) and superior cycling stability (85% after 5000 cycles) and the Ap-rGO has 1.5 fold higher energy density than the non-functionalized rGO electrode, thereby making it suitable as a deployable supercapacitor electrode.

The enhancement is shown to be the pseudo capacitance arising from the electron donating effect of the amine group and the electron accepting effect of rGO, which enable facile electron transfer between the surface-bound amine group and rGO.

- Graphene and its derivatives have attracted great research interest due to their many exciting properties leading to a number of potential applications. However, for many practical applications including reinforcement in epoxy resin matrices, chemical functionalization of graphene is often a necessary requirement

Herein Souvik chakraborty, Saikat Saha, V. R. Dhanak, Michel Barbezat (Royal Society of Chemistry,
View Journal), (2016) report a simple temperature-assisted reflux method to synthesize graphene oxide (GO) functionalized with n-butylamine in high yield without the use of toxic chemicals.

Made their study on high yield synthesis of amine functionalized graphene oxide and its surface properties.
According to their work- A facile one-step method for high yield synthesis of functionalized graphene (GO-ButA) with short chain alkyl amine has been reported without the use of toxic chemicals such as thionyl/acyl chlorides.
The attachment of amine functionalities to the GO nanosheets has been confirmed by EDX analysis by the presence of nitrogen.

- Functionalized and fully characterized graphene-based lubricant additives are potential 2D materials for energy-efficient tribological applications in machine elements, especially at macroscopic contacts. Two different reduced graphene oxide (rGO) derivatives, terminated by hydroxyl and epoxy hydroxyl groups, were prepared and blended with two different molecular weights of polyethylene glycol (PEG) for tribological investigation. **Bhavana Gupta, Niranjan Kumar, Kalpataru Panda, Vigneshwaran Kanan, Shailesh Joshi & Iris Visoly-Fisher (Scientific Reports 2016-2017 www.nature.com/scientificreports)** In this study- Two different reduced graphene oxide (rGO) derivatives were prepared for tribological investigation and blended with two different molecular weights of polyethylene glycol (PEG). Chemical and structural characterization indicated that rGO1 is mostly made of graphene sheets functionalized by hydroxyl groups at their edges facilitating inter-plane interactions.

Weaker interactions were found for PEG600 with both rGO types compared to PEG200 due to the smaller hydroxyl content and larger inter-chain dispersive interactions in PEG600. When blended with rGO1, PEG molecules interact only with the graphene plane edges via hydrogen bonding with the hydroxyl groups there.

rGO2 is characterized by a larger density of oxygen-related functional groups, with many of them being epoxides residing on the graphene basal planes, in addition to hydroxyl groups, due to the harsher oxidizing conditions used in the synthesis of rGO2.

The friction and wear properties of PEG with two different molecular weights, namely PEG200 and PEG600, were compared in steel-steel contact interfaces. The higher molecular weight of PEG600 showed a lower friction coefficient, explained by the longer methylene-chain unit and enhanced anti- wetting properties, indicating effective boundary film lubrication.

- The rapid development of the electronics industry and growing concerns about environmental issues has led to the research and development of materials for energy storage devices with high efficiency and performance. **C. C. Caliman, A. F. Mesquita, D. F. Cipriano, J. C. C. Freitas, A. A. C. Cotta, W. A. A. Macedo and A. O. Porto (Royal Society Of Chemistry), View Journal,(2017- 2018)** Carried out research on One-pot synthesis of amine-functionalized graphene oxide by microwave-assisted reactions, an outstanding alternative for supporting materials in supercapacitors. TGA results indicate a higher relative weight loss for the amine-functionalized materials than for the non-functionalized graphene oxide, indicating that much of the mass of the functionalized materials may be grafted with amines adsorbed onto the materials, which even after successive washes and drying processes were not removed.

The analysis of the produced materials showed that the four different amines are covalently attached to the graphene oxide structure, even though their interlayer distances have not been increased during the synthesis.

All synthesized amine-GO materials presented a good electrochemical behavior with long life cycle stability and reaching specific capacitance values of up to 290 F g-1 and 260 F g-1 for GO-PA and GO-
DPA.

- Carbon based nanostructures (CNTs, graphene, fullerenes, and others) and their nanocomposites have received considerable attention in these days. It has tunable physical and chemical properties in the nanoregime compared to their bulk. These materials have significantly high promise in the diverse fields including science and technology, industry, medicine, energy and environment because of its high tunable surface area, electrical and thermal conductivity, good chemical stability. Literature reflects that, surface modification by functional molecules is an effective strategy to tailor and fine tune its surface structure and further to develops their intrinsic properties So far **Vijay S. Sapner, Parag P. Chavan, Renuka V. Digraskar, Shankar S.**

Narwade, Balaji B. Mulik, Shivsharan M. Mali, and Bhaskar R. Sathe (Chem Electro Chem 2018) Challenge to paid numerous efforts to prepare metal free surface functionalized graphene has conducted a study on tyramine Functionalized Graphene: Metal-Free Electrochemical
Non Enzymatic Biosensing of Hydrogen Peroxide. On the basis of their conducted study some results was found to be- The synthesized novel metal free T- GO based electrocatalytic system and their further utility as a cathode material towards H_2O_2 reduction in PBS (pH-7) solution.

The available active surface of the metal free T-GO improves the electron transfer capabilities towards H_2O_2 reduction reaction.

The metal free carbon-based nanomaterials functionalized with biomolecules is hybrid material is cheap and cost effective, unique ability to manipulate the surface properties for detection and quantification of biomolecules as compared to other biosensors.

As-synthesized metal free T-GO is having high surface area and aromatic hydroxy groups of tyramine to enhance the electron reach centers for reductive detection of H_2O_2 is better than GO.SEM, XRD, UV-Vis, FTIR, XPS and Raman spectroscopic results reflects multistep functionalization followed by anchoring of Tyramine on GO surface.

- By the study on Synthesis of amino pyrene-tetraone modified reduced graphene oxide as an electrode material for high-performance supercapacitors according to the journal of ACS Sustainable Chemistry & Engineering 6 (4), 4729-4738, **2018** by **Jianqiao Shi, Zhipeng Zhao, Jichuang Wu, Yibo Yu, Zhikun Peng, Baojun Li, Yushan Liu, Hongwei Kang, Zhongyi Liu,** 2-aminopyrene-3,4,9,10tetraone (PYT-NH2), a small organic molecule, onto graphene oxide (GO) and then further chemically reduced it to obtain PYT-NH2/reduced graphene oxide (rGO).

As an electrode material for high-performance supercapacitor application, PYT-NH2/rGO exhibited higher capability and smaller charge transfer resistance in comparison with PYT-NH2/GO, rGO, and PYT-NH2.

For the fabricated hybrid capacitor, the capacitance retention of 25 000 cycles was nearly 100% at 5 A g–1, thus manifesting excellent electrochemical stability and signaling promising potential in energy storage applications.

- Electrochemically active organic materials are one of the best choices for replacing metal-based electrode materials in energy storage devices for their advantages of low cost, high capacitance, high safety performance and abundant reserves According to Chemical Engineering Journal 361, 189-198, **2019** by **Weiyang Zhang, Hongwei Kang, Huili Liu, Baocheng Yang, Yaxuan Liu, Mengke Yuan, Zhikun Li**, gives their some opinion for the work on 1-Aminopyrene/rGO nanocomposites for electrochemical energy storage with improved performance. In this case study, 1-aminopyrene and reduced graphene oxide nanosheets composites are successfully synthesized via solvothermal method.

The as-obtained AprC2 electrode displays a capacitance as high as 381.48 F g−1 at 0.6 A g−1 and an superior rate performance.

As electrochemically active organic material, it demonstrates that the nanocomposites electrodes show high capacitances with wonderful super-long cycle stabilities under the synergistic effect of various components.

- Carbon fibre -reinforced polymers(CFRPs) are widely used in the aerospace industry due to their outstanding strength-to-weight ratios[1, 2]. Nevertheless, the fact that CFRPs are made by staking fibre plies and held by a resin matrix makes these materials highly anisotropic, showing poor conductivity and poor mechanical properties in the direction perpendicular to the fibres, leading to delamination, brittle failure and poor damage resistance.

Great efforts from **Verónica Rodríguez-García1,2 , Julio Gómez3 , Francesco Cristiano4 and María R Gude(2020)** the European Community are being invested in developing scalable procedures in science to transfer them to the industry [6, 15, 40, 41]. Within this framework, and considering the potential industrial benefits of the introduction of GRM in CFRPs for the aerospace industry, this study aims to produce multiscale CFRPs laminates with commercial materials, involving industrial partners and using industrial procedures in every step of the process: from the production of GRMs to the final manufacturing of multiscale laminates

A complete characterization has been performed to evaluate the multiscale laminates and different behavior could be observed. In general terms, the multiscale laminates containing GNPs have shown detriments regarding to the mechanical performance in comparison to the non-filled CFRP laminate, probably caused by a bad dispersion of the nanoparticles causing aggregates.

Electrical conductivity along the thickness direction is improved for CFRP-GNP laminates a 227%. On the other hand, the CFRP-rGO laminates seem to have lightly enhanced the matrix-fibre interface but probably a bad distribution of the nanoparticles impeded obtaining higher improvements.
Finally, GO seem to be better integrated resulting in an improvement of the matrix and therefore in-plane shear properties and delamination resistance.

In this case study, multiscale CFRP composites containing different GRMs have been manufactured following standard procedures currently used in the aerospace industry with the aim to evaluate its potential application.

Multiscale CFRPs, with epoxy matrix and aeronautical grade carbon fibre, containing three different GRMs have been successfully manufactured by prepreg hand lay-up and autoclave curing using standard procedures implemented in the industry in every step of the procedure: from the production of GRMs to the final laminates.

 Biocompatible reduced graphene oxide (rGO) could deliver drugs for synergistically stimulating stem cells directed differentiation with influences on specific cellular activities

Here, **Delong Jiao, Jing Wang, Wenting Yu, Ning Zhang, Ke Zhang, Yuxing Bai (2021)** prepared a biodegradable gelatin reduced graphene oxide (rGO@Ge) to evaluate its functions in promoting rat adipose derived mesenchymal stem cells (ADSCs) chondrogenic differentiation through delivering kartogenin (KGN) into the stem cell efficient. All the results show that rGO@Ge as a biocompatible nanocarrier can deliver KGN into ADSCs for exerting a pro-chondrogenic effect and assist the drug to promote ADSCs chondrogenesis synergistically through modification of the autophagy in vitro, which promised its further application in repairing cartilage defect in vivo.

Recent Progress on Graphene/Polyaniline Composites for High-performance Supercapacitors

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Electrode materials	**C_m (F g^{-1})**	**C_A (mF cm^{-2})**	**C_V (F cm^{-3})**	**Cycle life**
graphene/PANI electrode	480 (0.1 A g^{-1}) 3-electrode			
rGO-PANI electrode	286 (5 mV s^{-1}) 3-electrode			94% capacitance after 2000 cycles (50 mV s^{-1})
GO/PG/PANI ternary composite	793.7 (1 A g^{-1}) 3-electrode			80% capacitance after 1000 cycles (100 mV s^{-1})
GQDs-PANI composites	1044 (1 A g^{-1}) 3-electrode			80.1% capacitance after 3000 cycles (1A g^{-1})
Microspherical polyaniline/graphene (PANI/GMS)	338 (20 mV s^{-1}) 2-electrode			87.4% capacitance after 10000 cycles (3A g^{-1})
PANI/G-MS	596.2 (0.5 A g^{-1}) 447.5 (20 A g^{-1}) 3-electrode			83.7% capacitance after 1500 cycles (2A g^{-1})
PANI/GO composite	475 (5 A g^{-1}) 3-electrode			90% capacitance after 2000 cycles (10A g^{-1})
PANI-GS composite	863.2 (0.2 A g^{-1}) 3-electrode			85.6% capacitance after 1000 cycles (1A g^{-1})
sulfur functionalized PANI/FrGO composite films	692 (1 A g-1) 3-electrode 324.4 (1 A g-1) 2-electrode			83.3% capacitance after 1000 cycles (10A g-1)
PANI-STGNS10	1225 (1 A g-1) 3-electrode			85.7% capacitance after 1500 cycles (100 mV s-1)
Flexible rGO/PANI nanocomposite film		920 2-electrode	1314.3	80% capacitance after 2000 cycles (7 mA/cm2)
Porous PANI-RGO composite	630 (0.5 A g-1) 3-electrode			81% capacitance after 5000 cycles
Flexible paper-like film of PANI nanofibers (PANI- NFs) and chemically converted graphene (CCG)	210 (0.3 A g-1) 2-electrode			21% loss after 800 cycles (3A g-1)
OGH-PANI composite film	530 (0.5A g-1) 2-electrode			80% capacitance after 10000 cycles (10A g-1)
Core-shell structured CB@CNF/PANI membrane	501.6 (0.5 A g-1) 3-electrode			91% capacitance after 5000 cycles
UGA/PANI composites	538 (1 A g^{-1}) 3-electrode			74% capacitance after 1000 cycles (3 A g^{-1})

3D-G/PANI composite	567 (1 A g^{-1}) 3-electrode (77.8 Wh Kg^{-1}) 2-electrode		720 3-electrode	100% after 10000 cycles5 A g^{-1}, 3-electrode 95.6% for 10,000 cycles 2- electrode
Graphene/PANI composite nanosheets	665 (1 A g^{-1}). 2-electrode		847	86% capacitance after 1000 cycles (20 A g^{-1})
3D RGO/S-PANI aerogel	480 (1 A g^{-1}) 2-electrode			96.14% after 10,000 cycles (10 A g^{-1})
RGO/PANI/RGO hybrid paper	581 (1 A g^{-1})			85% capacitance after 10000 cycles (10A g^{-1})
GH-PANI/GP	864 (1 A g^{-1}) 2-electrode	190.6 (0.5 mA cm^{-2})		85.6% capacitance after 5000 cycles (8 A g^{-1})
PANI/rGO electrodes		1329 2-electrode		75% capacitance after 1000 cycles 50 mA cm^{-2}
Graphene/sulfonated PANI (rG/SP)		3.31	16.55 2-electrode	85.4% capacitance after 10000 cycles

RESEARCH GAP

As per the Literature survey discussed earlier, that there is no composite material derived from 4-hydroxibenzylamine,4-dimethylaminobenzylamine,1-pyrenemethylamine hydrochloride and 2-aminofluorene with graphene oxide (GO) and reduce graphene oxide (rGO).

It is planned to synthesize the composites. The application of the synthesized material is expected in various fields like super capacitor, batteries, solar cells, biological systems and water desalination.

In our research it is planned to study the application of the developing composites through cyclic voltammetry analysis and electrochemical impedance analysis for super capacitor.

STATEMENT OF THE PROBLEM

Graphene and graphene oxide (GO) materials have unique two-dimensional honey comb structures, high surface areas and high optical and electrical conductivity. The extra advantage of graphene oxide is presence of large number of oxygen functional groups likes hydroxyl, epoxy and carboxyl acid groups both on the basal planes and the edges. The aliphatic or aromatic amino group can be easily attached to different oxygen containing graphene oxide through covalent linkage. The covalent modification increases the stability of materials, and such types of stable functional materials are widely used in both in chemical industry and pharmaceuticals as catalysts, sensors, and adsorbents. The functional groups present in the surface of GO not only make GO dispersible in aqueous solution with highest adsorption capacity, but also provide the reactive sites for chemical conjugation or covalent or non-covalent functionalization's with a mine groups. In the present research we are planning to utilized synthesized composite material for the super capacitors

The intercalation of GO with amine group composite improves the efficiency of the materials in order to modulate the electrode properties. Furthermore, GO has substantial band gap due to the presence of a more amount of sp^3 hybridized carbon, which allows making unique GO-based composite materials.

Although the organic moieties such as 4-hydroxy benzylamine, 4-(dimethylamino) benzylamine, 1-pyrenemethylamine hydrochloride and 2-amino fluorene etc. Functionalized GO prepared by grafting method has been well documented; its usefulness in super capacitors is very limited though oxygen functional groups seem to enhance the wettability and capacitance value. Due to the difference in electro negativity, the carbon center of epoxy functional group of GO has an inherent tendency to react with electron donating functional groups. Thus nucleophilic substitution reaction occurs very easy at room temperature in aqueous solution and leads to the surface functionalization by the formation of amino/imino moieties.

OBJECTIVES OF THE STUDY

The objectives of proposed work are as follows:

Synthetization of graphene oxide from graphite using modified Hummers' method.

1. Fabrication of different composite materials from graphene oxide with amino groups containing aliphatic and aromatic compounds.
2. Conformation of synthesized composites with various characterization techniques.
3. Analyze and compare the developed composites for the application of super capacitor with existed results.

SCOPE

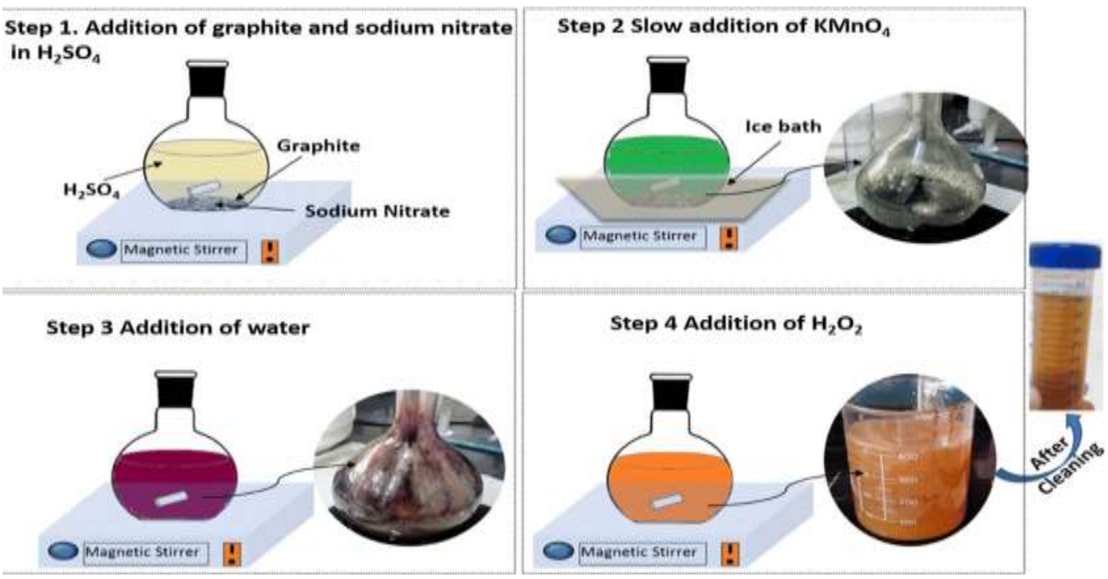
The developed composite material can be used in filters of IC engines to remove lead.

- the oxidation and reduction combined with a deep understanding of graphene structure may allow us to realize good control of the attaching and elimination of functional groups to some specific locations on the carbon plane.
- the controllable oxidation and reduction of graphene may facilitate the applications of graphene as semi-conductors used in transistor and photoelectronic devices.
- Functionalized graphene biosystems with unique properties have been achieved to build biological platforms, biosensors, and biodevices.
- GO and rGO have an extremely high surface area; therefore, these materials are considered for usage as electrode materials in batteries and double-layered capacitors, as well as fuel cells and solar cells.

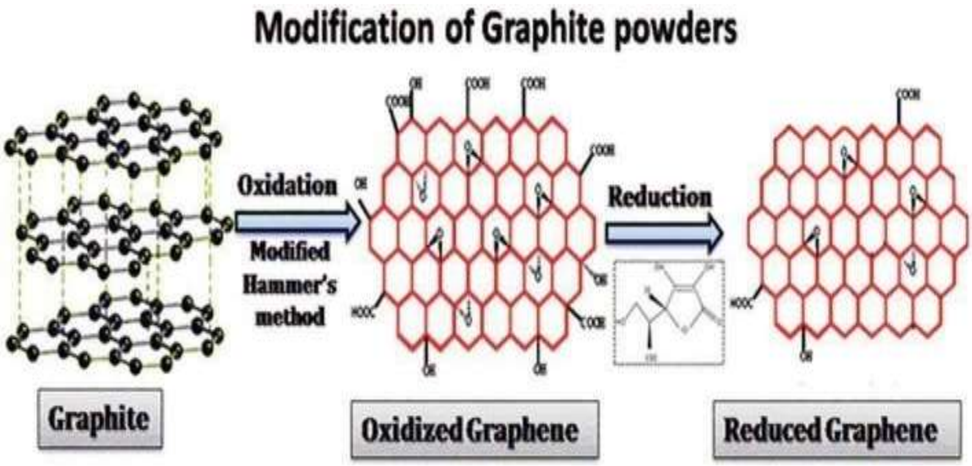
RESEARCH METHODOLOGY, TOOLS AND TECHNIQUES

The proposed work is planned to be carried out in the following manner

1. Graphene oxide will be prepared by modified hummers method from graphite
2. Reduced Graphene oxide will be prepared from the synthesized graphene oxide by heating to optimal temperature.
3. The structural formation of graphene oxide is ought to be confirmed from Raman spectroscopy and XRD techniques.
4. Developing a graphene with the aliphatic and aromatic amine composites by different methods like in-situ polymerization, oxidation reduction, microwave irradiation etc.
5. The purified composite material will be confirmed by different characterization techniques like XRD, FTIR, ^{13}CNMR, Raman spectroscopy, UV-Visible and XPS.
6. SEM, TEM analysis is used further for determining surface topography and particle size of the designed composite material.
7. Thermal stability of composite material will be performed by thermogravimetric analysis (TGA) in order to analyze the application of super capacitors.
8. Apply the developed composite material for the designing of super capacitors and DSSC applications.



Modified Hummer's method



Conclusions

In the present research we are planning to synthesize the graphene oxide (GO), reduce graphene oxide (rGO), and graphene-based (amine-GOs) nanocomposites (GNCs) in consecutive manner. The functionalization of the graphene oxide will be with aromatic and non-aromatic amines (amine-GOs) i.e .graphene oxide with 4-hydroxy benzylamine, 4- (Dimethylamino) benzylamine, 1pyrenemethylamine hydrochloride and 2-aminofluorene etc. The expected final material will be characterized by different characterization technique of XRD, FTIR, ^{13}CNMR, Raman spectroscopy, UV-Visible, XPS, SEM, TEM for imaging and thermogravimetric analysis(TGA). The synthesized material will have plethora applications in various field but, in the present research we are planning to utilize for the super capacitors. The significant improvement in GO's electrochemical properties through amine functionalization, will be investigated by cyclic voltammetry analysis and electrochemical impedance analysis.

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