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Sugar AssistedGraphene: A Green Synthesis Approach

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Abstract: Graphene, being a boon to scientific industry has varied applications. There are a number of methods to synthesize graphene. One amongst them is chemical reduction of grapheme oxide (GO).We synthesised reduced Graphene oxide (rGO) using glucose as reducing agent and the reducing effect of glucose was no less than hydrazine. Reaction is safe to carry and by-products formed are less hazardous. Characterization of rGO was done using Raman spectroscopy, Atomic Force Microscopy, Fourier Transform Infra-red Spectroscopy and Vibrating Sample Magnetometer.

Keywords: Grapheneoxide; reduced graphene oxide; glucose.

Introduction and Experimental:

Graphene, a superlative material has engaged many brains, learning its unique properties and its skilful applications. Graphene is a 2D lamella of sp^2carbon atoms, arranging themselves in a honeycomb lattice structure. The honeycomb structure can be thought of as a merge of two triangular sub-lattices, thus each unit of honeycomb contains atoms from different sub-lattices. The basisofgraphene contains two atoms per unit cell. Graphene can be considered as a basic unit for other graphitic materials such as:0Dfullerenes, 1D nanotubes and 3D graphite. Novoselov *et.al* observed that quasi-particles in graphene obey linear dispersion relation $E = \hbar k v_F$ and the conductivity of graphene never falls below a minimum value of quantum unit of conductance even when charge carriers tend to be absent. The charge carriers in graphene mimic relativistic particles with zero rest mass and have an effective speed of light, $v \approx 10^6$ ms^{-1}[1].

Based on utility, there are different methods of preparation of graphene, each having their own merits and demerits. First, in 2004, Andre Geim and Kostya Novoselov extracted single layer crystallite from graphite using a simple scotch tape. This method is micromechanical cleavage. On other hand graphene films can be grown on SiC and electrically insulating surfaces. Chemical vapour depositionis another technique, yielding high quality graphene films. But these methods are not economic. Cost effective methods include chemical reduction of GO and liquid phase exfoliation. In chemical synthesis, GO is obtained from graphite by oxidising, reducing and centrifuging. Most commonly used reducing agent is hydrazine. For large scale production, toxicity of hydrazine is a major concern, to overcome this, numerous other reducing agents have been used in literature, one amongst them is reducing sugars, which is environmental friendly. We synthesised reduced Graphene oxide (rGO) using glucose as reducing agent [2].

In the present study, graphite oxide was prepared from graphite powder based on Hummer's method described in the literature [3]. Here40 mg glucose as reducing agent was added in 25 ml of dispersed GO FFFFFF and stirred for 30 minutes. Then, 20 µl of ammonia solution was added to the resulting dispersion and was followed by stirring for 60 min. at 95 °C. Resulting stable black dispersion was centrifuged(4000 rpm) and washed with double distilled water for several times, decanting away the supplement each time. The solid obtained after the centrifuge was vacuum-dried at 50 °C for 48 hours. Then the resultant rGO was collected and used for the characterization.

Results and Discussion:

FT-IR spectroscopy served as an aid to confirm the reduction of GO based on molecular vibrations. In the Fig.1, major peaks were observed at 3443 cm^{-1}, 2024 cm^{-1}, 1626 cm^{-1}, 1403 cm^{-1} and 1060 cm^{-1}, corresponding to –OH stretch hydroxy group, C≡C skeletal vibration, organic nitrate, carboxylate and primary amine CN stretch[4]. Study of transmittance from the Figure.1 depicts that, in case of rGO transmittance increases, validating the removal of oxygen functionalities from GO on reduction with glucose.

Raman spectroscopy is a handy and non-destructive tool to analyse materials. Electronic properties and microstructure are the two parameters for which Raman spectroscopy is widely used. In Figure. 2, D and G bands are very prominent, respectively at 1347 cm^{-1} and 1604 cm^{-1}.D band corresponds to symmetry A_{1g} mode and G band is for E_{2g} mode of sp^2 carbon atoms. D/G intensity ratio increased for rGO in comparison to GO. This confirms reduction of GO [4].

AFM gives the definite identifications of the number of layers in graphene samples. Figure. 3 shows the AFM image of the rGO with high profile. The average thickness of the rGO, measured from the height profile of AFM image, is about 5 nm. The increased thickness of rGO is due to the tendency of graphene layers to restack in the absence of stabilizing molecules[2].

A Vibrating Sample Magnetometer was used to analyze the magnetic properties at room temperature (RT), in the range of -15KOe to 15kOe as shown in the Figure. 4.GO and rGO samples show the magnetic hysteresis at RT [5]. It is not possible to exactly pin down the origin of magnetism in the GO and rGO samples. However, defects and edge effects may play a major role in ferromagnetic and antiferromagnetic features in GO and rGO. The ferromagnetism, primarily the result of edge effects, and it is not surprising that From VSM data, it is evident that rGO shows the better ferromagnetic features than GO [5].

We have successfully prepared graphene by reducing GO with reducing agent glucose. FT-IR spectrum confirms the removal of oxygen functionalities from GO. Raman studies authenticates that GO was reduced as rGO. AFM confirms that the average thickness of rGO layer is in nano meter range. The ferromagnetic nature of GO and rGO was confirmed by VSM data.The synthesised rGO can be used for various applications.

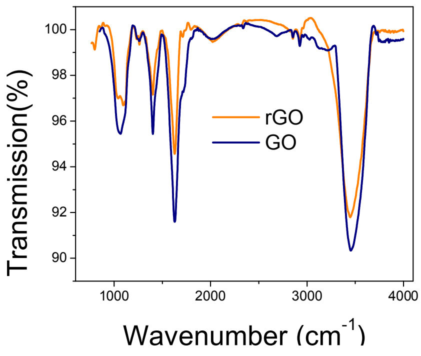

Figure 1: The FT-IR spectrum of GO and rGO

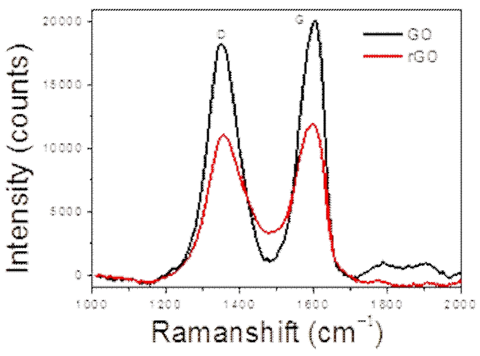

Figure 2: Raman spectra of GO and rGO

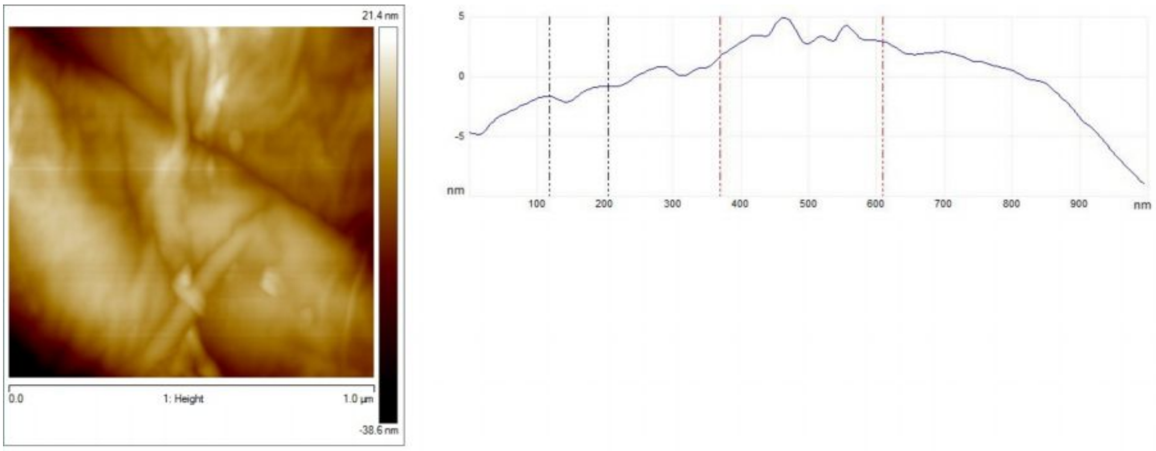

Figure 3: AFM image of rGO with the height profile

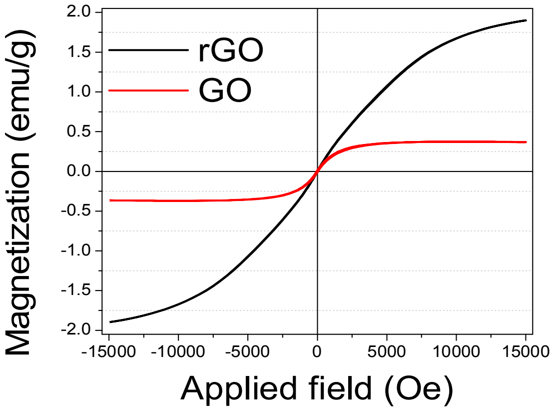

Figure 4: Magnetization versus applied magnetic field at room temperature for GO and rGO samples.

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