A Review on Device quality graphene from crude sources
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Abstract
Herein, we have discuss the overview of characterization and synthesis of Graphene oxide and thin film on wafer by using different methods. Graphene has amazing and unique band structure material with the highest characteristic mobility known to exist at room temperature. In this paper, we have review a comprehensive litera time survey of graphene with emphasis on the material, growth, process and the application of the same. The different properties and characteristics techniques have been discussed as well that is based on the corresponding literature survey. The paper points out the inevitability of the study of possibility of growing high purity graphene by using easily attainable organic materials via cost effective chemical route.

Introduction
Graphene is an attractive two-dimensional (2D) material with an atomically thick honeycomb structure [1-3]. It is an analog of graphite (carbon) content with exceptional characteristics obtained by the bonding properties of the C bonding sheets. Due to its extraordinary electrical [4], mechanical [5], thermal [6] and spintronic [7] properties, graphene has the potential to be applied in nano electronic devices [8, 9] and in nanocomposites [10, 11].

In some previous years, numerous researchers have adopted the production of graphene, such as exfoliation, chemical methods, and chemical vapor deposition (CVD), have appeared in the literature. For the exfoliation methods, researchers originally used adhesive tape to mechanically peel away the graphite crystals into few-layer or monolayer graphene [1, 4]. In present scenario, easily available and less expensive carbon sources, such as food, insects, and waste, can be used without purification to grow high-quality monolayer graphene directly with various method. In this study, we have reviewed the recent literature on the synthesis and characterization of graphene. Several researchers have growing a high-quality graphene from carbon sources opens a new way to convert the waste carbon into a commercial product, as graphene is one of the most expensive materials in the world. Graphene material is a very promising and innovate materials science research with their numerous remarkable properties [1-7]. In spite of the enormous research efforts accumulated thus far, it is still considered that many novel properties of graphene-based materials
are yet to be discovered. This review article highlights the characterization and synthesis of the graphene material by using carbon waste. In this paper, we have reviewed remarkable paper recent progress in the novel applications of graphene.

**Review of literature**

Hui lin Guo et al (2009) [12] have reported a green and fast approach in their study to synthesis high quality graphene in large quantity. They claim to have opened a pathway for fabrication of large area sheet defect free graphite. The synthesis process was chemical route, where the GO has been reduced to form graphene. The resulting film characterized using following characterization methods. Raman spectroscopy: The Raman spectroscopy is to distinguish order and disorder in the crystal structure. In this paper, authors demonstrated that the intensity of D band showed inclination in the Raman spectra of GO (fig 1 a). Which describes the defect in ERGO, CRGO (Chemically reduced graphene oxide).

**FTIR spectra:** The FTIR spectra of GO, ERGO, CRGO are complicated rather than FTIR of GO, CRGO, ERGO (fig 1 b) they claimed that the functional group (containing oxygen), peak is decreasing which show that the eviction of oxygen.

**AFM:** AFM is a method to identify the crystal structure. As shown in figure 2 the exfoliated GO and ERGO are flat.

![Figure 1: (a) FTIR OF GO, ERGO, CRGO [12], (b) Raman spectra of GO, ERGO, CRGO.](image-url)
From TEM images (figure 3) of graphene nano sheet, derived by electrochemical reduction they analyzed that Graphene sheets are transparent and exhibits stable nature under electron beam.

All the above characterization technique reinforced the fabrication discussed in paper. However, the drawbacks of the method have been discussed and it resulted in a graphene which had defect because of residual chemicals. The author claims that this defect can be avoided by further electrochemical synthesis at high temperature and annealing the product. The applications suggested for the graphene in this paper was for biosensors.

Chun Hua Lu et al (2009) [13] in his study synthesized high quality graphene sheets in large quantity. To synthesis Graphene oxide from natural graphite by using Hummer’s method. Atomic force microscopy (AFM) was used by the author to characterise the complex of P1-GO
and GO, also shown in figure 4. The DNA might have led to the white areas over the surfaces of GO. Authors analyzed the platform to illustrate the generality of the above method. Forward to this, Authors also acclaim that GO, alike other carbon nanotubes, may be used as a platform for the fast biomolecules detection. However, when comparing it with carbon nanotubes, the inexpensiveness and large scale of production of GO makes it a material worth promising for devising biosensors.

![Figure 4](image)

**Figure 4.** AFM height image of GO sheets deposited on mica substrates (left); AFM height image of DNA-GO complex (right) [13].

Young Bin Lee et al (2010) [14], have found a new pathway to synthesize wafer scale graphene and also claimed that the size of these sheets was about 1 inch. In this study authors synthesized graphene on Ni and Cu films and then transferred this wafer size graphene on arbitrary substrate through etching of metal layers. The synthesis process of graphene oxide film on a metal wafer has been shown in schematic diagram in figure 5.
**Figure 5.** Schematic illustration for synthesis, etching, and transfer of large-area graphene films. Transferring and patterning of graphene films grown on a metal/SiO$_2$/Si wafer. Graphene/metal layers supported by polymer films are mechanically separated from a SiO$_2$/Si wafer. After fast etching of metal, the graphene films can be transferred to arbitrary substrates and then patterned using conventional lithography.

For the characterization authors used Raman spectroscopy. They studied those Raman spectra of films of graphene grown on metal Cu and Ni. Authors analyzed that the red and blue colored lines in figure 6 were Raman spectra for films of graphene grown on Cu. And they claim that these spectra of graphene grown on Cu film indicated that graphene were mono or bilayer graphene. And the D band peek pointed that the quality of resultant graphene was high, and the Raman spectrum of graphene grown on Ni film, (black color) indicated the property of multilayers graphene. They also observed that after transfer, the D band peek in spectrum was not changing which demonstrates that the quality of graphene was not changing while transferred on other substrates.

**Figure 6.** Raman spectra of the large-area graphene layers grown on Cu (blue and red lines) and Ni (black line) films and transferred on PDMS substrate (green line). The excitation wavelength is 514 nm. (b) Optical transmittance of thin and thick graphene films grown on Cu (red line) and Ni (blue line) layers on SiO$_2$/Si substrates.

They also assured that this approach to synthesis of GO took little time (few minutes) for the metal layers to be extracted completely. This wafer scale graphene was transparent and highly conducting for the applications those are designate for graphene wafer is in optoelectronics, electronics and also in fabrication of field effect transistors.
Gedeng Ruan et al (2011) [15] developed a very simple and a less expensive method to grow graphene oxide. In this approach they have used carbon sources which are quite less expensive, like food products, waste products, and insects without purification. Interestingly, six raw carbon containing materials of negative value were used by them (grass, cookies, chocolate, cockroach leg, plastics, and dog feces) to grow graphene on the back side of Cu foil as shown in figure 7. In this approach firstly they put the waste material on the top of Cu foil, after that put it under vacuum after that they annealed it at 105°C for 15min. For characterization of resulted graphene, they applied Raman spectroscopy and TEM in figure 8. It is clear that Raman spectra of graphene hint at very small peak of D bands for different materials.

Figure 7. Growth of graphene from a cockroach leg. (a) One roach leg on top of the Cu foil. (b) Roach leg under vacuum. (c) Residue from the roach leg after annealing at 1050°C for 15 min. The pristine graphene grew on the bottom side of the Cu film (not shown).

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Figure 8. Raman spectra of monolayer graphene from six different carbon sources. The Raman spectra graphene were derived from (A) Girl Scout cookie; (B) chocolate; (C) grass; (D) plastic (polystyrene Petridish); (E) dog feces, and (F) a cockroach leg.

The TEM images of graphene samples were taken to determine the crystal structure of graphene samples obtained from waste material such as cookies, signal that the graphene has hexagonal diffraction pattern and monolayer edge of graphene was imaged in figure 9.

Figure 9. Diffraction pattern and TEM images of the cookie-derived graphene. (A) SAED pattern, (B) suspended graphene film on a 1 μm diameter hole, and (C) the edge of monolayer graphene.

It is evident that above discussed characterization methods reinforced that this is a less expensive approach to synthesis of high-quality graphene in high quantity.

Omid Akhavan et al (2012) [16] have developed a method to produce graphene oxide of high quality and reduced sheets of graphene oxide from various wastes containing carbon such as animal wastes (cow and bone dung), vegetational wastes (wood, bagasse, leaf, and fruit wastes), industrial waste (soot powder formed during exhaustion of diesel vehicles), and semi industrial waste (newspaper). In this work they have also developed a method of chemical exfoliation for synthesis of GO through carbonaceous materials which are quite inexpensive. In this method,
firstly carbonized the starting material at 400-500°C temperature through imperfect burning. Past this, the charcoal materials along with the waste material of low value were used in hummer’s method for chemical exfoliation. The AFM and Raman spectroscopy (figure 10) were used for characterization of GO sheets obtained from waste materials. The Raman spectra were utilized to examine the crystal structure of GO samples of GO, sourced from different starting materials. A 2D peak positioned at \( \sim 2680-2700 \text{ cm}^{-1} \), illustrates the presence of both single layered and multilayered GO sheets in the sample and authors also demonstrated ratio \( I_d / I_{2d} \).

![Figure 10](image)

**Figure 10.** (A) Raman spectra of GO sheets synthesized from (a) highly pure graphite, (b) wood, (c) leaf, (d) bagasse, (e) fruit, (f) newspaper, (g) bone, (h) cow dung, and (i) soot as the starting materials, and (B) \( I_d/I_{2g} \) and \( I_{2D}/I_{G} \) ratios of the samples.

They claim that AFM images (figure 11) of the GO sheets which were made from different starting materials, indicated that even though the graphene sheets’s quality (which were produced from different carbonaceous materials) can be negligibly different, but synthesis of GO sheets formed with thickness \( < = 4 \text{ mls} \) is fixid, feasible and does not dependent on the starting material.
They analyzed the graph to see the electrical properties of graphene, and these were roughly equivalent to those of graphene sheets which were obtained by HPG. This method indeed illustrates successful waste recycling to generate high-quality graphene of high value.

**Conclusion**

Here, we have studied the properties and synthesis of GO by using carbon waste material for electronic and optoelectronics devices. It was found that the synthesis of graphene oxide has prepared by using carbon-based materials such as food, a Girl Scout cookie and chocolate etc. Graphene oxide is the oxidized form of graphene sheet, which is mass-producible from pristine graphite by various chemical oxidation methods of chemical oxidation. This form can be readily exfoliated in water, which occurs usually via ultrasonication, to produce stable light suspensions of yellowish-brown color predominated by a layer of monolayer GO flakes. Here we presented a detailed overview of the subject field with sufficient stress on its origin and development, gliding through various genres of applications of budding.

**References**


