

Extraction of Graphene from *Prosopis Juliflora*

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Abstract : Graphene is a rapidly rising star on the horizon of materials science and condensed-matter physics. It is a two-dimensional crystalline form of carbon has attracted wide and intense interest owing to its excellent physical properties. This is the decade which will experience the development of future materials. changing the waste product into useful product and making the environment eco-friendly. In this paper we discuss the method of extraction of graphene from *prosopis juliflora*.

Keywords – Graphene, Graphite, prosopis juliflora,

1.INTRODUCTION

Graphene is a two-dimensional (2D) crystalline material that consists of a single atomic layer of carbon bonded together in a hexagonal lattice resembling a honeycomb. It is considered as the parent of other low-dimensional carbon allotropes such as fullerene (0D) and carbon nanotubes (1D). Graphene has attracted a lot of attention and has been the subject of numerous theoretical and practical investigations owing to its extraordinary physical and chemical properties .In our state (Tamil Nadu) where prosopis juliflora plant grew superfluously. We need to remove this due to our ground water table condition so use this opportunity to make enormous amount of graphene from this plant.

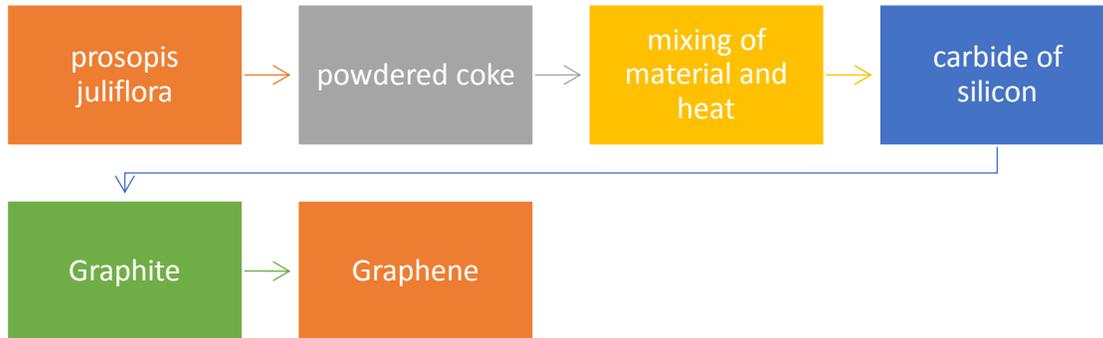
Comparison of graphene with other materials

Properties	Materials	Quantity
Thermal conductivity	Copper	401 w/(m K)
	Graphene	5000 w/(m K)
Young modulus	Steel	200 GPa
	Graphene	1 TPa
Tensile strength	Steel	550 MPa
	Graphene	130 GPa
Weight	Steel	7.85 kg/m ²
	Graphene	0.77 mg/m ²

1.1 Properties of graphene

- The material Graphene is transparent in nature.
- Comparatively graphene is stronger than steel.
- Weightless material in the world.
- It conduct electricity more than known material.
- We can store the electricity within the panel using graphene super batteries.
- We can convert sea water into drinking water easily using graphene filter.

2. Manufacturing of graphene



2.1 Graphite from prosopis juliflora

The center of the furnace A, built, preferably, of fire-brick. Carbon rods or electrodes BB, to be connected with the source of electric energy D pass through the end walls of the furnace and conduct the electric current there to, there being, preferably, a granular carbon core C, which extends the length of the furnace between the carbon rods, and this core is surrounded by the mixture M, of carbonaceous material and oxide or oxides, out of which mixture the graphite is to be produced.

The mixture M in this case is composed of powdered coke, sand, salt, and sawdust, the coke forming about fifty percent by weight of the mixture, and these materials are thoroughly mixed and introduced into the electric furnace surrounding the core of granular coke or other form of conducting carbon, which is of sufficient size to conduct the current through the mixture at the beginning of the operation and until the graphite is formed in sufficient quantity to act as a conductor of the current. The furnace being thus prepared with this material, the current is turned into it with an amperage sufficient to impart to the core the requisite heat. As the temperature rises the resistance of the core decreases, and thereby more current passes through it. The size of the core and the current strength must be sufficient and so proportioned as to raise the temperature of the core to a point where the portions of the mixture or charge immediately surrounding it will be subjected to the

chemical and other changes necessary for the production of the graphite out of the carbon or coke contained in the mixture of carbon and silica.

As the temperature of the core rises the heat radiating therefrom passes into the mixture, and the carbon or portions thereof unite with the silicon of the sand to form a carbide of silicon. When this chemical combination takes place, there is formed around the core a layer of amorphous and crystalline carbide of silicon or silicide of carbon, which in its crystalline form is called "carborundum," and as this process continues this layer or zone of carborundum is gradually increased.

Upon continuing the application of the electric current, producing a very high temperature, much higher than is necessary for the formation of the silicide of carbon or carborundum, the carbon is disassociated or separated from the carbide of silicon into the graphitic form, while the silicon is volatilized and passes off in the form of vapor. As the destruction of the carbide goes on and the graphite is formed around the core the graphite becomes a conductor and the core is increased as the graphite is formed, so that the intense heat necessary to the production of the graphite is transmitted to the surrounding carbide, and more carbide is destroyed and graphite deposited on the core until the graphite formation has extended outward to a point so close to the walls of the furnace as to endanger them from the intense heat produced.

2.2 Graphene from Graphite

2.2.1. Mechanical exfoliation

Mechanical exfoliation is the simplest of the preparation methods and surprisingly is the method that made standalone. In this technique, a piece of graphite undergoes repeated tape exfoliation and is then transferred to a substrate. The number of layers can then be evaluated with different methods; by using a simple optical microscope, Raman spectroscopy, atomic force microscopy and/or scanning tunneling microscopy. This preparation method still makes the highest quality crystals, but is only useful for lab scale experiments and prototyping as it is not possible to scale-up the process.

2.2.2. Chemical vapor deposition (CVD)

CVD is one of the most useful methods to prepare monolayer graphene of high structural quality for use in different devices. Large area samples can be prepared by exposing a metal to different hydrocarbon precursors at high temperatures. There are different types of CVD methods available such as plasma-enhanced CVD, thermal CVD, hot/cold wall CVD and many others. The exact mechanism of the formation of graphene depends on the growth substrate but typically initiates with the growth of carbon atoms that nucleate on the metal after decomposition of the hydrocarbons and the nuclei grow then into large domains. Apart from gaseous hydrocarbons such as methane, ethylene or acetylene, liquid precursors have also been used such as hexane or pentane while the quite diverse set of materials that can be used for the CVD production of graphene can even include food, insects and waste. The transfer of graphene from the growth substrate to a substrate of interest can be difficult due to the chemical inertness of graphene and it can attribute defects and wrinkles to the material, while the thermal fluctuations can also affect the stability of the grown material. Moreover, the complexity of the CVD process and the high energy demands for the specific method add to the difficulties of the task, but CVD still remains one of the most successful methods for large-area graphene production.

In terms of upscaling, CVD is a viable candidate for the production of high quality graphene in large area quantities and for this reason several research groups have focused their attempts towards this direction. One of the first attempts was the one from Bae et al. who used a roll-to-roll (RTR) process for the production of 30-in. graphene films and subsequently the RTR technique was successfully applied for the continuous production of graphene. In a similar recent number of graphitic flakes in the dispersion. The yield can be adjusted by altering the starting amount of graphite, the sonication time and the rotational speed of

report by Pol-sen et al., graphene was once again produced by a RTR process using a concentric tube CVD. Lin et al. developed a surface engineering method and succeeded in producing cm-size single-crystalline graphene by passivation of the active sites and control of graphene nucleation by using melamine pretreatment of the Cu surface. Moreover, a really promising and different attempt by Bointon et al. recently produced high-quality monolayer graphene by using resistive heating cold-wall CVD, that was also 100 times faster than conventional CVD. Despite the promising results reported from these and similar studies, the mass production of graphene by CVD has predominantly focused on the electronic device industry.

A very interesting method for the production of inch-sized single-crystalline graphene has been proposed by Wu et al. The authors applied a controlled nucleation method on a Cu-Ni alloy, by locally feeding carbon precursors to a desired position. According to the authors, the use of the specific alloy activated an isothermal segregation mechanism, which resulted in higher growth rates. The final material that they obtained was high-quality, 1.5-in. single crystalline graphene, which was synthesized in 2.5 h and exhibited a Hall mobility of $10,000\text{--}20,000\text{ cm}^2\text{ V}^{-1}\text{ s}^{-1}$ at room temperature.

2.2.3. Liquid phase exfoliation

Liquid phase exfoliation is another method used widely for the production of graphene and it involves three different steps; (1) dispersion in a solvent or surfactant, (2) exfoliation and (3) purification in order to separate the exfoliated material from the non-exfoliated and, if supplied as powder, completely remove any solvent traces. Initially studies used ultrasound to exfoliate graphite flakes in a suitable solvent, such as NMP. Sonication time is very important since higher concentrations of graphene can be achieved by longer sonication times, at the expense of energy consumption. Following the sonication step, the material is composed of thicker flakes, which can be removed by ultracentrifugation. Higher centrifugation speeds result in thinner flakes but with a small lateral size, that are not so useful for applications such as composites. A variety of liquids can be used for the dispersion of graphene, including aqueous surfactants. The output of this process can be estimated from the yield by single-layer graphene percentage, which has been defined as the ratio of the number of single layer flakes to the total

the centrifuge amongst other parameters. The problems that are related with the specific process include the electrical properties of produced graphene which can be

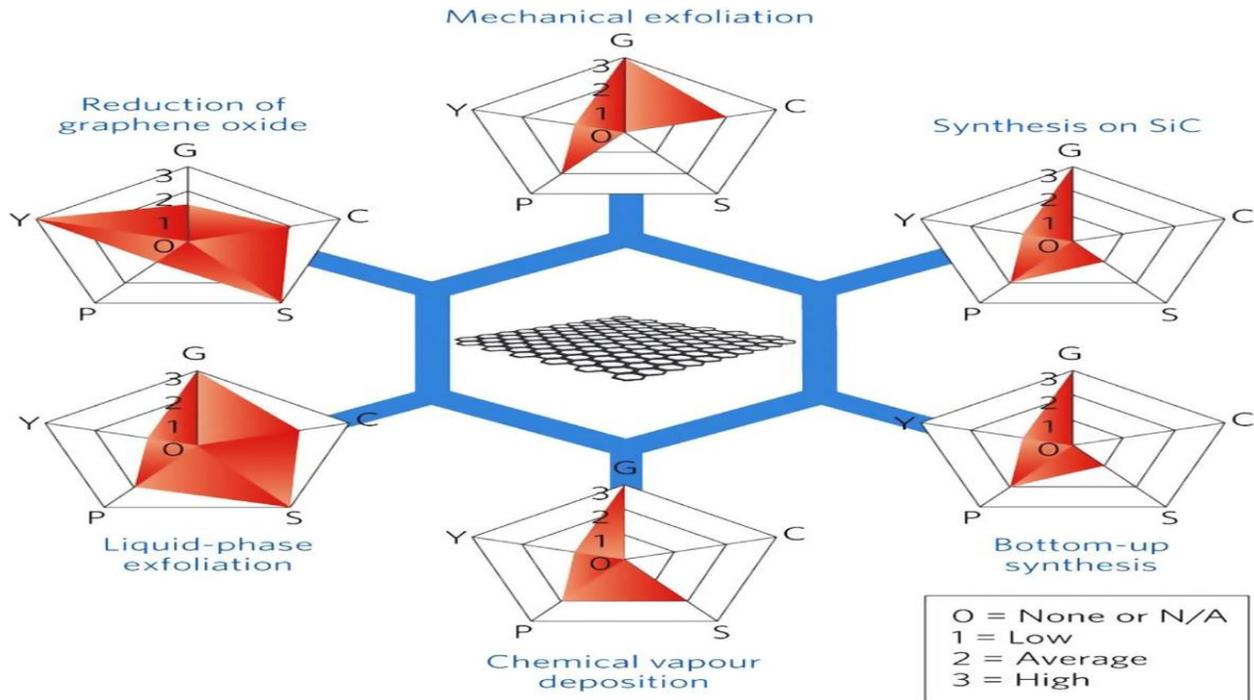
similar to the ones of graphene oxide as a result of poor transport at contacts between the graphene sheets. Additionally, the use of highly-reactive solvents can increase the cost, while the process itself is potentially not ecologically-friendly as a large amount of solvent has to be used due to the very low solubility of the graphene.

Liquid-phase exfoliation is one of the most promising techniques for the upscaling of graphene production. The simplicity, speed and high throughput that are associated with this process make the specific route attractive for the mass production of graphene. A key advance was from Paton et al who showed that high shear forces can be used rather than ultrasonic cavitation and thus exfoliated graphene on a 100 litre scale. The critical shear rate for the exfoliation of graphene was found to be 10^4 s^{-1} , which can be achievable even from conventional kitchen blenders. Following centrifugation, the mean number of layers was found to be less than 10, while the typical lateral sizes of the Nano sheets were in the 300–800 nm range. However, it should be noted that the yield achieved was relatively low and the choice of starting material along with the optimization of the rotor can strongly affect the exfoliation efficiency. Recently, Dimiev et al. prepared graphene Nano platelets over a 3–4 h time period, at room temperature and the conversion yield from graphite to GNPs was almost 100%. Due to the existing industrial knowledge and equipment, liquid exfoliation is possibly the most viable option for upscaling graphene production, however as Ciesielski and Samori have pointed out in their review, it is critical to standardize the procedure and define a reproducible protocol, relying on the key parameters of the process. This will be a major step towards the simplification of the process which is definitely needed in order to make it applicable for industry.

2.2.4. Electrochemical exfoliation

The specific approach includes the use of a liquid solution (electrolyte) and an electrical current which is used to consume an electrode consisting of graphite. This process takes place via anodic oxidation or cathodic reaction of the graphite-based electrode. Cathodic reaction methods are more suitable for the production of high-quality few layer conductive graphene for use in energy and optical applications. On the other hand, anodic oxidation is more widely reported in the literature. The resulting anodic material consists of several graphene layers, has a low yield and resembles graphene oxide in terms of its oxidation state, in contrast to pristine monolayer graphene. The advantage of electrochemical exfoliation over the other methods is that the process takes place via a single step, which makes it easier to operate, while it proceeds over a period of minutes/hours, in contrast to most methods which demand longer times for the preparation and stabilization of the final material. A very important parameter for nanocomposites is the lateral size of the flakes produced, which depends on the graphite source and the conditions of the intercalation-exfoliation process. The products of intercalation with non-oxidative salts can reach a lateral size of 50 nm with a thickness of 2–3 layers. Moreover, the use of liquid electrolytes or aqueous surfactants makes the process eco-friendly, while interestingly, this method can be used to produce a product very similar to graphene oxide (GO), with the use of LiClO_4 as an electrolyte, avoiding the dangerous and toxic chemicals used in most GO preparation methods.

The electrochemical route can offer potential for scaling up the production of graphene due to all the advantages mentioned above, however there are several drawbacks that should be additionally considered. The ionic liquids used in some routes are expensive, while the crumpled morphology of graphene that can be produced may limit its applications



2.2.5. Chemical reduction of graphene oxide

Chemical reduction involves the exfoliation of graphene oxide into single-layer GO sheets, followed by the in-situ reduction of the GO for the production of graphene-like monolayers. This process is strongly affected by the choice of the solvent, the reducing agent and the surfactant, which are combined in order to maintain a stable suspension. The quality of the material produced cannot be considered high since it contains both intrinsic defects (such as edges or deformations) and extrinsic defects (such as O- and H-containing groups), therefore it is debatable if the material produced can be properly classified as graphene. Various reducing agents can be used such as hydrazine monohydrate (which is the most common in the early literature), hydroquinone Sulphur-containing compounds and others. The elimination of the oxygen containing groups from GO demands strong reduction ability but the process should not leave traces that may affect the final product. The use of environmentally-friendly approaches, such as L-ascorbic acid has been followed over the past few years due to the need to avoid the use of strong chemicals. Such methods have the advantage of the process ability of the material in different solvents or the relatively easy scale up of the process. On the other hand, the use of environmentally-friendly solvents does not quite yield graphene with a quality as high as that prepared by hydrazine, while the

production of the initial GO product involves the use of equally strong and hazardous chemicals, which ought to be minimized during this process. Moreover, thermal reduction of GO can be performed using a fast heating rate, under an inert gas and high temperatures (up to 1000 °C). The efficiency of the process depends on the pressure generated from the heating procedure that counteracts the van der Waals forces that are present between the graphene sheets and facilitates exfoliation of the flakes. The produce of graphene-like material from the reduction of GO has the potential to be scaled up, similar to liquid phase exfoliation, however the chemical inhomogeneity of GO along with the inevitable generation of defects during the oxidation process can lead to difficulties.

3. Conclusion

Prosopis plant affects the soil nutrients and structure. It mainly influences the amounts of organic carbon, nitrogen, and calcium and its affect ground water level. So we need to abate this plant. And the marvelous material Graphene is possible to produce from this superfluous plant prosopis juliflora. This waste plant makes a tremendous change in the environment and new technologies are emerging. It makes a material revolution. The material Graphene changes the entire world and upgrade all the materials in all the field.

4. References

- [1] Dimitrios G. Papageorgiou^a, Ian A. Kinloch, Robert J. Young^b Mechanical properties of graphene and graphene-based nanocomposites
- [2] Andrea Lazzarini^{a,*}, Andrea Piovano^b, Riccardo Pellegrini^c, Giovanni Agostini^d, Svemir Rudii^e, Carlo Lamberti^{a,f} and Elena Groppo^g Graphitization of activated carbons: a molecular-level investigation by INS, DRIFT, XRD and Raman techniques
- [3] Somnath Bharech¹ and Richa Kumar², A Review on the Properties and Applications of Graphene
- [4] D. Shitanda¹, K. Mukonyi², M. Kagiri¹, M. Gichua and L. Simiyu¹, PROPERTIES OF PROSOPIS JULIFLORA AND ITS POTENTIAL USES IN ASAL AREAS OF KENYA
- [5] Wencheng Du,^a Xiaoqing Jiang^{*a} and Lihua Zhub, From graphite to graphene: direct liquid-phase exfoliation of graphite to produce single- and few-layered pristine graphene
- [6] K. Harigaya, Journal of Computational and Theoretical Nanoscience, vol. 9, pp.645-648 (2012)
- [7] Suriapparao, D.V.Pradeep, N.Vinu, R, Bio-oil production from Prosopis juliflora via microwave pyrolysis
- [8] Lenacuru, C. I. (2003). Impacts of Prosopis spp in Baringo district. Proceedings of workshop on Integrated Management of Prosopis species in Kenya, pp. 41-47
- [9] Zolfaghari, R. and M. Harden (1982). Nutritional value of mesquite beans (Prosopis glandulosa). pp. K1-K16 In: Mesquite Utilization. (Ed.) H. W. Parker. Texas Tech University, Lubbock, Texas, USA.
- [10] K. S. Novoselov, D. Jiang, F. Schedin, T. J. Booth, V. V. Khotkevich, S. V. Morozov, and A. K. Geim, Proceedings of the National Academy of Sciences of the United States of America 102, 10451 (2005).
- [11] Tung, V. C.; Allen, M. J.; Yang, Y.; Kaner, R. B. Nature Nanotechnology, 2009, 4, 25.
- [12] F. Schwierz, Nat. Nanotechnol., 2010, 5, 487–496.
- [13] Kashyap S, Pratihari SK, Behera SK. Strong and ductile graphene oxide reinforced PVA nanocomposites. J Alloys Compd 2016;684:254–60.
- [14] A.JAFAR AHAMED* and K. RIAZ AHAMED Preparation and Characterization of Activated Carbon from the Prosopis juliflora Plant.
- [15] J.W. Hassler, Purification with Activated Carbon, Chemical Publishing Co. Inc., New York, edn. 2 (1974).