# Mass Production of Powdered Graphene from Expansible Graphite

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**Abstract -** *Graphene is an allotrope of carbon, has a special set of properties that set it apart from other allotropes of carbon. Graphene is considerably stronger than steel even with its surprisingly low density. It shows excellent thermo electrical properties. But the absence of an effective industrial method keeps graphene in laboratories. This work introduces a mass production method to get graphene from expansible graphite, for commercial application. Expansible graphite is a compound of graphite that can be expanded by heat treatment. It is manufactured by treating flake graphite with reagents (such as acids that migrate between the graphite layers) and heat. Under a suitable thermal treatment temperature (550 C), force binding graphene layer can be weakened and can be tear apart mechanically by crushing, powdered few layer graphene are obtained. Expansible graphite can be exfoliated into graphene with high quality and structural integrity by dry exfoliation method. The method has a yield of 93% powdered graphene and the qualitative analysis shows nanosheets have a thickness of about 2.3 nm.*

***Key Words***: Graphene, Allotropy, Expansible graphite, Dry Exfoliation, Nanosheets

## 1.INTRODUCTION

Graphene is the Strongest known material. Which is Harder than diamond yet more flexible than rubber, Electron mobility is 100 times faster than silicon, Heat conduction is twice than diamond, Electrical conductivity is 13 times better than copper Tensile strength is 200 times than steel which is almost 130 GPA. With these fascinating properties it has vast area of application from water filtering to quantum material

Graphene is produced from graphite which is a naturally occurring allotropy of carbon. Graphite has a layered structure that consists of carbon atom arranged in hexagonal structure with strong covalent bond. These layers have weak Van der Waals force between them. This layer itself is graphene. Hence, graphene can be produced by eliminating van der Waals force from graphite. The process of separating each layer from graphene is called Exfoliation. Even though removing Van der Waals force is all it takes to produce graphene, an efficient and economic mass production is a challenge. Existing methods for producing graphene are chemical vapour deposition, mechanical exfoliation, chemical exfoliation, electro chemical exfoliation, chemical weathering exfoliation, hydrothermal reduction liquid exfoliation. These methods has many disadvantages like high production cost, low quality complex processes, advanced equipment, Time consuming obtaining structure did not bring its structural superiority into full play. So a novel method is required in graphene production.

## 2. Mass Production of Graphene

Expansible graphite is used to produce graphene, by exploiting its volume enlargement nature. The whole production process can be divided into two; Thermal Expansion process and Shattering process. In thermal expansion process graphite is heated and expanded and in shattering process it will be completely converted into graphene.

### 2.1. Thermal expansion process

To create beyond any doubt the achievability of warm development prepare of graphite, the bowl had no cover and had sufficient capacity to hold the gotten extended graphite. The expansible graphite was included in the foot of a pressed bowl. The bowl was put into a suppress heater. The warmed expansible graphite will be kept up at tall temperature for 3 hours and will be cooled back to room temperature. Amid warming beneath barometrical condition, the bowl was warmed to 550 C at a controlled warming rate of 10 C/min. The crude Expansible graphite is not fair unadulterated graphite. There will be pollutions between the layers. Whereas warming, the impurities will escape. Amid the method, it'll thrust carbon layer separated. As a result increment space between adjoining layer increments and hence debilitates Van der Waals drive indeed more or broke it. Warmed expansible graphite was kept up for 3 hours, and after that cooled normally to room temperature. The as gotten graphite has appeared. It'll be soft in nature. Sharp

### 2.2. Shattering process

The as-obtained extended graphite was exfoliated in a high-speed pulverizer. To form beyond any doubt the proficiency of the peeling prepare, the hermetically sealed depth of pulverizer was full of dry extended graphite. Beneath a rotating speed of 28000 rpm, the extended graphite was smashed for 10 min. After the pulverizer closed down, the soft extended graphite got to be conglobate graphene. Graphene will be in powdered form after shattering process. Longer the pulverizer runs, finer will be obtained graphene powder. By varying time of shattering different size of powder can be obtained for wide range of applications.

## 3. QUANTITATIVE ANALYSIS

The quality of as obtained graphene is analyzed by various qualitative analyses. Width of the sheets thickness defects are the variables considered in these analyses.

### 3.1. Scanning Electron Microscope (SEM)

A scanning electron microscope is a kind of electron microscope. Fig. 1a appears the pictures of bulk expansible graphite. Fig. 1b appears the pictures of expanded graphite after the thermal expansion process. Compared with Fig. 1a, there is expansive space between the adjoining layers, which indicates a frail van der Waals constrain within the expanded graphite test. Fig. 1c appears the arranged test after the shattering process for 5 min. The test gets to be extremely little particles.

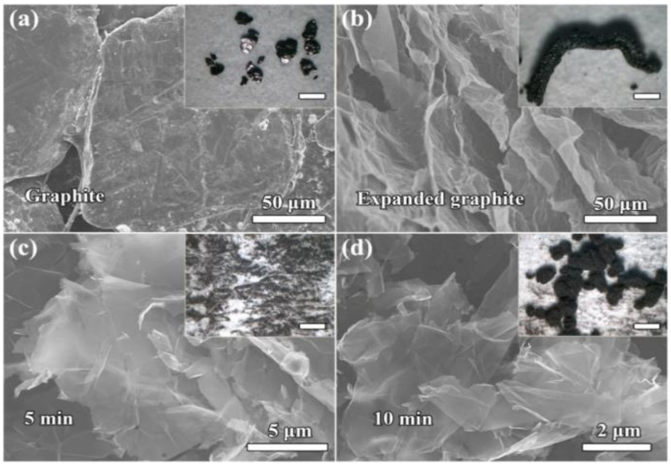


**Fig -1**: SEM Images

The little particles as of now gotten to be lean two-dimensional (2D) sheets. Fig. 1d appears the normal picture of as-obtained graphene after the dry peeling handle, after the shattering handle for 10 min, the sheets display an indeed morphology, and are nearly straightforward, showing their ultrathin nature. Graphene produce agglomeration, which moreover comparing the ultrathin nature of the items

### 3.2. Transmission Electron Microscopy (TEM)

The morphological characteristics of as-obtained graphene were assist affirmed by transmission electron microscopy. The collapsed nanosheets in Fig. 2a appear commonplace 2D characteristics and agglomerate state, comparable to overcome about within the SEM picture. The comparing cross-section and selected area electron diffraction (SAED) of the items are shown in Fig. 2b utilizing high-resolution transmission electron microscopy (HRTEM). The intaglio cross-section structure of graphene demonstrates few grid flaws after the peeling handle

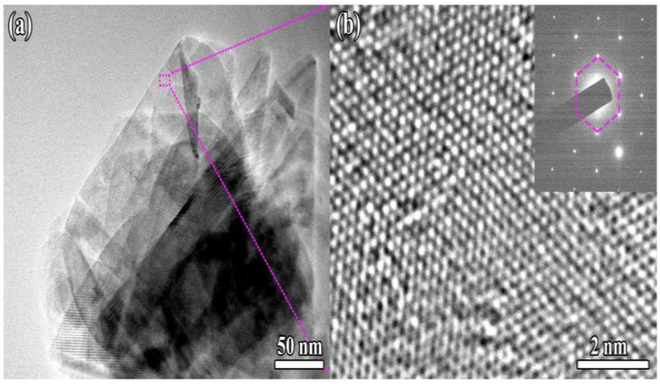


**Fig -2**: TEM Images

### 3.3. Atomic Force Microscopy (AFM)

Atomic force microscopy was conducted to advance examine the basic highlights of as-obtained graphene. The thickness and fine structure of the test have appeared in Fig. 3. This picture uncovers the thickness of the nanosheets is almost 2.31 nm, which was comparable to the perfect thickness of few layer graphene.

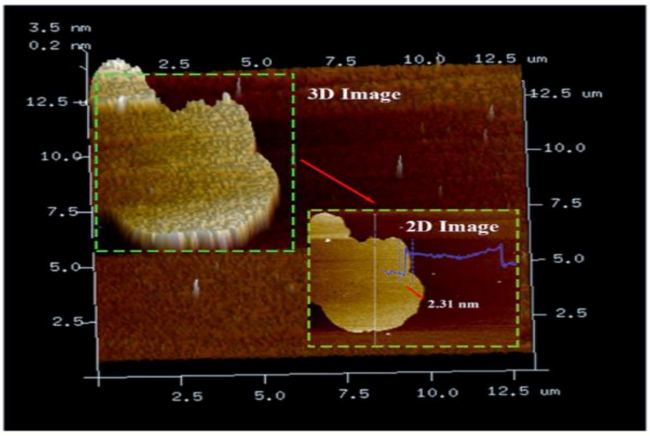


**Fig -3**: AFM Images

### 3.4. Raman Spectroscopy

The quality of as-obtained items was encourage assessed by Raman spectroscopy. The Raman spectra of expansible graphite, expanded graphite and as-obtained graphene have appeared in Fig 4 the bands found at ~1582/cm are the G band of graphite, corresponding to the in-plane vibrations of sp2 C particles The groups found at ~1356 /cm are the D band, begun from the imperfection of the structure. Agreeing to the intensity ratio (ID/IG), the as-obtained graphene presents a moo sum of defects as well as the crude graphite after the peeling preparation.

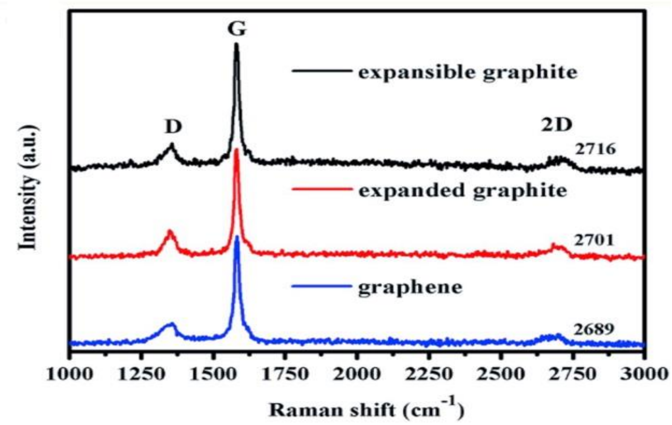


**Fig -4**: Raman Spectra

The bands found at ~2700 /cm are the 2D band, which can be utilized to confirm the number of graphene layers Compared with the 2D crests of expansible graphite and expanded graphite, the 2D crest of the as-obtained graphene shifts somewhat to 2689 /cm, demonstrating the few-layer graphene sheet. In the interim, the 2D crest isn't very strong; this can be due to the number of layers and disorder.

## 3.5. X-ray diffraction (XRD)

The examination was performed to ponder the structure of the as-obtained graphene. Fig 5 reveals that the graphene shows a comparative characteristic structure compared with expansible graphite.

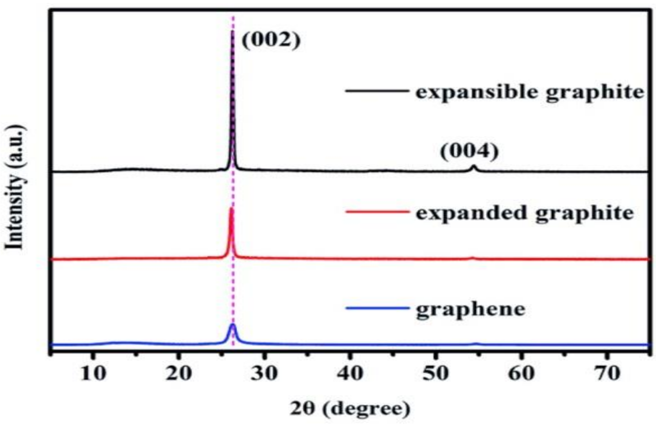


**Fig -5**: XRD Pattern

The escalated of the (002) crest of as-obtained graphene altogether diminishes compared with that of bulk expansible graphite, illustrating the ultrathin nature of the sheets

## 4. QUANTITATIVE ANALYSIS

Out of 200g expansible graphite, 188g was left after heat treatment. That is 12g of loss. Another 2 grams was lost in the pulverization process. At last, ~186 g of graphene with a 93% yield was obtained. Both quantitative and qualitative analysis shows positive results on the production process. Quantitative analysis shows the thin, wide and defect less nature of graphene, while qualitative analysis shows an excellent yield of 93%

**Table -1:** Quantitative analysis

| | |
|---|---|
| Loss in Heat treatment process | 6% |
| Loss in Shattering Process | 1% |
| Total Yield | 93% |

## 5. APPLICATION

Sensors are required to identify and record even little changes within the environment. The planar shape of graphene permits it to uncover each iota to the encompassing, in this way giving it a greatly tall degree of affectability. Owing to its fabulous electrical properties, graphene-powder can before long supplant the anode and cathode in ordinary Lithium-Ion batteries that are utilized nowadays. This fabric is extraordinary when it comes to making strides in the life and charge capacity of the battery. The higher level of angle proportion and the free bond associations at either conclusion of graphene permit fabulous electron tunneling. It makes for a compelling elective to materials that are expectedly utilized in fabricating touch-screen and other electronic displays. Graphene powder is additionally progressively utilized in printing technology. The extraordinary electrical properties of this fabric offer assistance to proficiently dispense graphene nanopowder into the routine ink and offer assistance with way better and made strides printing innovation. There are studies proving phase changing material and graphene composites shows excellent thermophysical property, that is can be used for energy storage applications

## 6. CONCLUSION

This novel dry exfoliation method for preparing graphene features fast process, high quality, low cost and replicated on a mass production scale. The proposed method overcame limitations of existing methods. The as-obtained graphene presents a small value for thickness and a good size for width.93% yield shows the high efficiency of this method. Graphene powder is all-inclusive considered as being a ‘wonder material,’ owing to its noteworthy properties. It is additionally known as graphene Nano powder, due to its Nano-structural behaviour. It is one of the most grounded and perfect conductors of heat and power. This gigantically flexible fabric is finding progressively farreaching application in inquiring about and assorted businesses all over the world.

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## BIOGRAPHIES

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