



# GRAPHENE OXIDE – A GLANCE THROUGH RAMAN SPECTROSCOPY

**Dr. A. Oudhia<sup>1</sup>, Dr.P.C.Choubey<sup>2</sup>, D.Chowdhury<sup>3</sup>**

<sup>1</sup>Asst. Professor, Govt.VYTPG Autonomous College, Durg, Chhattisgarh (India)

<sup>2</sup>Jt. Department of Higher Education, Raipur, Chhattisgarh (India)

<sup>3</sup>Asst. Professor, C.E.C., Durg, Chhattisgarh (India)

## ABSTRACT

Graphene Oxide has attracted considerable attention because of its industrial potential for the mass production of graphene powders. Recently, chemically and thermally reduced graphene powder films have been used as flexible electrodes and transparent electrodes in organic solar cells and dye-sensitized solar cells (DSSCs). We recently worked on the Raman Spectroscopy of Graphene Oxide (GO). Graphite was the starting material of our work which was oxidized according to Hummer's method. The observed peaks in the Raman spectrum are D-band at  $1353\text{cm}^{-1}$ , G-band at  $1592\text{cm}^{-1}$  and 2D band at  $2703\text{cm}^{-1}$ . Raman Spectroscopy is capable enough in providing ample information regarding edges and grain boundaries, disorders, strains, number of layers and doping levels.

## I. INTRODUCTION

Graphene, the fundamental building block of carbon material is true two dimensional hexagonal lattices of carbon atoms [1]. It is a monolayer of  $\text{sp}^2$  hybridized carbon atoms [2]. Though graphene is an exciting material because of its extraordinary physical properties yet it shows poor processability due to insoluble behaviour in almost all common solvents [3]. Graphene Oxide, derivative of graphene is soluble in water due to the existence of hydrophilic hydroxyl group and inserted water molecules [4-5]. That means it can be viewed as a graphene whose basal plane is enriched with oxygen containing groups. Due to high affinity to water molecules graphene oxide is soluble in water and this property makes the process of film deposition smooth. Treatment of GO by heat, light or chemical reduction shows wide range of useful properties like electrical conductance, thermal resistance and many more which make GO a very interesting material [4-6].

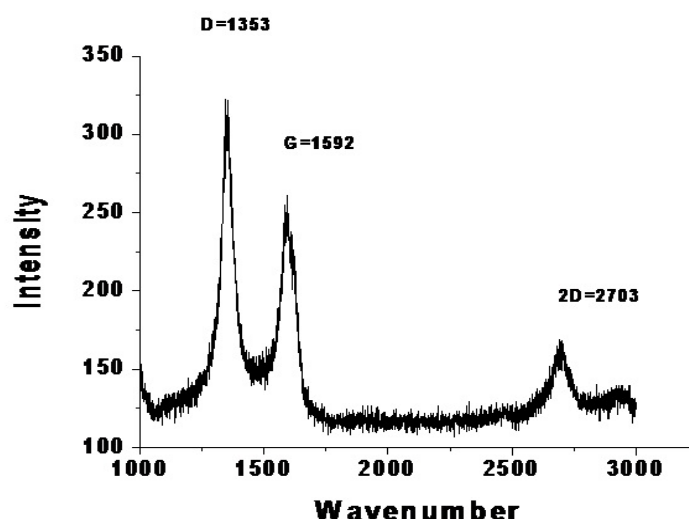
To utilize different properties and increase application of GO in a wide range it is necessary to identify C-C bonds and the orientation of these bonds in the material. In order to do so characterizing the material meaningfully, a technique is desirable which is highly sensitive to slight change in orientation of C-C bonds. Raman Spectroscopy is one such technique which is highly sensitive to C-C bonds, its orientation and can provide huge information about the structure. This ability of Raman Spectroscopy makes it a valuable tool for characterizing carbon nanomaterial [7-9].

## II. EXPERIMENTAL SECTION

GO was prepared according to the modified Hummer method [10]. A conical beaker with magnetic stirrer was filled with 69ml of  $\text{H}_2\text{SO}_4$  and cooled to  $0^\circ\text{C}$ - $5^\circ\text{C}$  by immersion in an ice bath. Graphite (1.5gm) was then added slowly with vigorous stirring while maintaining the reaction at  $0^\circ\text{C}$ - $5^\circ\text{C}$ . After the added Graphite flakes formed a well dispersed black slurry.  $\text{NaNO}_3$  of 1.5gm was added slowly over 15mint.at  $0^\circ\text{C}$ - $5^\circ\text{C}$ . The mixture was allowed to warm to room temperature and stirred for 1hr. 120ml of DI water was then added, and the solution was stirred for 30min.while the temperature was raised to  $100^\circ\text{C}$ . The mixture was poured to 300ml of DI water, after which 10ml of  $\text{H}_2\text{O}_2$  was added slowly. The colour of the solution changed from dark-brown to yellow. The solution was then filtered and again the material was re-dispersed in water and washed with water until the Ph of the filtrate was neutral. The resultant GO material was dried in a vacuum desiccators over night at room temperature and stored in the ambient condition.

## III. RESULT AND DISCUSSION

The Raman Spectroscopy of the as-prepared sample is shown in the graph given below.



### 3.1 G-Band

In our sample the G-band appears at  $1592\text{cm}^{-1}$ . The G-band is an in-plane vibration mode which involves the  $\text{sp}^3$  hybridized carbon atoms present in the graphene oxide sheet. The positioning of G-band is highly sensitive to the number of layers present in the sample. This property of G-band provides us a method for determining the layer thickness of the particular sample. The intensity of G band increases linearly with increase in the number of layers in the GO sample. As the thickness of the layer increases the position of the band shifts to lower energy showing a slight softening of the bond with each additional layer of graphene. One has to be very much conscious while using the position of G band for determining the thickness of the layer as its position is effected by temperature, doping and even small amount of strain present in the sample .



### **3.2 D-Band**

The D-band originates due to hybridized vibration mode associated with graphene oxide edges indicates the presence of disorder in the structure of the sample. Due to the defects this band is also known as the disorder band or defect band. In our Raman spectrum the D- band appears at  $1353\text{cm}^{-1}$ . This band represents a ring breathing mode from  $\text{sp}^2$  hybridized carbon rings. These carbon rings must be active if they are adjacent to the graphene oxide edge or defect. D-band is a resonant band which shows the dispersive behaviour.

### **3.3 2D-Band**

This band is the second order of D band. It is also known as an overtone of D-band. This band appears due to the lattice vibrations of two phonons but not needed to be activated by the proximity of a defect. In our sample the 2D band appears around  $2703\text{cm}^{-1}$ . This 2D band is a strong band in graphene which does not represents any defects. These bands help in determining the layer thickness & for this along with the band position it also depends on shape of the band.

## **IV. CONCLUSION**

Raman Spectroscopy is a great technique for characterization of carbon nanomaterial. Due to high sensitivity in detecting slight change in the structural morphology of carbon nanomaterial, Raman spectroscopy has become an indispensable tool for many material scientists working with carbon nanomaterial.

## **REFERENCES**

- [1]. Andrea C.Ferrari, solid state communications 143(2007) 47- 57.
- [2]. Te-Fu Yeh, Jaroslav Cihlar, Chih-Yung Chang, Ching Cheng and Hsisheng Teng, Materials Today, vol.16,3 march 2013.
- [3]. Siegfried Eigler, Christoph Dotzer, Andreas Hirsch, carbon 50 (2012) ;3666-3673.
- [4]. Daniel R. Dreyer, Sungjin Park, Christopher W. Bielawski and Rodney S . Ruoff. Chem. Soc. Rev.2010,39,228-240
- [5]. Yanwu Zhu, Shanthi Murali,Weiwei Cai,Xuesong Li, Ji Won Suk, Jeffrey R. Potts, Rodney S. Ruoff.Advanced Materials,vol.22,issue 35,3906-3924.
- [6]. Jaemyung Kim, Laura J.Cote, Franklin Kim, Wa Yuan, Kenneth R. Shull, Journal of the American Chemical Society 2010;132(23);8180-8186.
- [7]. JoeHodkiewicz, Thermo Scientific Application note AN51948,2011.
- [8]. Bolotin KI, Sikes KJ, Jiang Z, Klima M, Fudenberg G, Hone J, Et al. Solid State Communications 2008;146(9-10);351-5.
- [9]. Bai H, Li C, Shi G, Adv Mater;2011;23(9);1089-115.
- [10]. Shuai Wang, Lena Ai Ling Tang, Qiaoliang Bao, Ming Lin, Suzi Deng, Bee Min Goh,JACS,vol.xxx,no.xx,XXXX.