

Graphene, due to its ultrathin, two-dimensional structure and exceptional properties, is the most studied nanomaterial. In the coming decade, it is expected to be used in various applications, including high-frequency electronics and smart coatings. Industries will need large-scale production of defect-free graphene for uses in printed electronics, conductive coatings, and composite fillers.

Graphene is likely to serve as a low-cost electrode material in solar cells, batteries, sensors, anti-corrosive paints, and lubricants. **Ferro Refratech** produces various grades of graphene, including Graphene, Graphene Oxide, Reduced Graphene Oxide (RGO), and graphene composites, with Graphene F and Graphene R being the two types synthesized th**ere**. Test reports for these materials are provided below.



Fig. 1: XRD data of Graphene F and Graphene R

Form Fig. 1 the 100% phase pure graphitic phase is confirmed for Graphene F and Graphene R.

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Fig. 2: Raman spectra of Graphene R

Raman spectroscopy is the primary tool for characterizing 2D materials. The Raman spectrum of Graphene R, shown in Fig. 2, reveals a D band intensity of 114, and G and 2D band intensities of 335 and 158, respectively. This gives an ID/IG ratio of 0.34, indicating multi-layer graphene, as well as an I2D/IG ratio of 0.47. These results align with those from the Instanano software in Fig. 3. Generally, graphene with 5 to 10 layers is considered multi-layer graphene.[https://doi.org/10.3390/ma14164590].

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	Graphene Number of Layers Calculat Raman Spectroscopy	or From ID/IG and I2D/IG Ratio via	
	Cite This in Your Publication Graphene Number of Layers Calculator From ID-IG and I2D-IG Ratio via Raman Spectroscopy - InstaNANO, https://instanano.com/characterization/calculator/raman/graphene-layers/(accessed August 31st, 2022.). Number of layers in graphene can easily be determined by using this calculator. You need intensity values of G, D and 2D band.		
	Number of Layers Calculator from ID/IG Ratio G Band Intensity D Band Intensity Results 0.34 multi layer	335 114 ID/IG Ratio Number of Layers	
	Number of Layers Calculator from 12D/IG Ratio G Band Intensity 2D Band Intensity Results 0.47 multi layer	335 158 I2D/IG Ratio Number of Layers	

Fig.3 : The screenshoot of layer calculation for Graphene R from Instanano software.

Fig 4 (a,b) and (c,d) are shown the FESEM and TEM photomicrographs, respectively of Graphene R. From FESEM photomicrograph 5 layers of graphene are clearly seen and that was confirmed from TEM images [Fig. 4(c,d)].



Fig. 4: electron microscopy of Graphene R (a,b): FESEM photomicrograph and (c,d): TEM Photomicrograph.

So, 6-10 layers Graphene is confirmed for **GRAPHENE R** from the aforesaid characterizations and the density of Graphene R powder is 0.08 gcc^{-1} . Figure 5 depicts the Raman spectra of Graphene F.





Fig. 5: Raman spectra of Fraphene F

From Fig. 5, Intensity of 'D band' is 112 and that of G ,2D are 285 and 146, respectively. So, ID/IG ratio is 0.39 which depicts the multi layer Graphene. I2D/IG ratio is 0.51 resulting multi layer Graphene. Same result was observed from Instanano software, Fig. 6.

Gradiene Number of Layers (Raman Spectroscopy	Calculator From ID/IG and I2D/IG Ratio via	
Cite This in Your Publication		
Graphene Number of Layers Calculator From ID, nano.com/all/characterization/raman/graphene	/IG and I2D/IG Ratio via Raman Spectroscopy - InstaNANO. https://insta -layers/ (accessed October 26th, 2023).	
Number of layers in graphene can easily be determ band.	nined by using this calculator. You need intensity values of G, D and 2D	
Number of Layers Calculator from ID/IG Ratic	,	
G Band Intensity	12765	
D Band Intensity	2766	
Results		
0.22	ID/IG Ratio	
multi layer	Number of Layers	
Number of Layers Calculator from I2D/IG Rati	0	
G Band Intensity	12765	
2D Band Intensity 6454		
Results		
0.51	I2D/IG Ratio	
6	Number of Louise	

Fig.6 : The screenshoot of number of layer calculation for Graphene F from Instanano software.

Fig 7 (a,b) and (c,d) are shown the FESEM and TEM photomicrographs, respectively of Graphene F.



Fig. 7 (a,b): FESEM photomicrograph and (c,d): TEM photomicrograph of Graphene F.

From FESEM photomicrograph [Fig.7 (a,b)] 10-15 micron diameter Graphene sheets are confirmed but 3 to 5 layers of graphene sheets are clearly seen from TEM images [Fig. 7(c,d)]. Density of Graphene F powder is 0.09 g cc^{-1} .

So it can be concluded that Graphene R and Graphene F are 100% phase pure 5-10 and 3-5 layers Graphene, respectively.