

# Technical Reference Chart for Common Calculations Involving Raman Measurements with Carbon Nanomaterials

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## Key Words

- G-Band
- Graphene Thickness
- Nanotube Diameter
- RBM-Band

## eV to nm Conversion Chart

| eV   | nm   |
|------|------|
| 3.82 | 325  |
| 2.71 | 458  |
| 2.62 | 473  |
| 2.54 | 488  |
| 2.41 | 514  |
| 2.33 | 532  |
| 1.96 | 633  |
| 1.58 | 785  |
| 1.59 | 780  |
| 1.27 | 976  |
| 1.17 | 1064 |

### Formula for Reference

$$eV = 1240/nm$$

where: eV is the eV value  
nm is the wavelength in nm

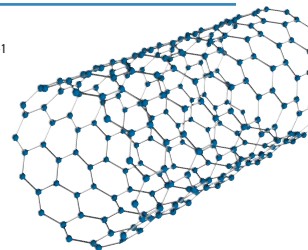
## Approximate Carbon Nanotube Diameter Based on RBM-Band Position

| cm <sup>-1</sup> Position of Band | Diameter of Isolated Tube (nm) | Diameter of Tube in Aggregated Bundle (nm) |
|-----------------------------------|--------------------------------|--|
| 50                                | 4.96                           | 3.90                                       |
| 75                                | 3.31                           | 2.75                                       |
| 100                               | 2.48                           | 2.13                                       |
| 120                               | 2.07                           | 1.80                                       |
| 150                               | 1.65                           | 1.46                                       |
| 200                               | 1.24                           | 1.11                                       |
| 250                               | 0.99                           | 0.90                                       |
| 300                               | 0.83                           | 0.75                                       |
| 350                               | 0.71                           | 0.65                                       |
| 400                               | 0.62                           | 0.57                                       |

### Formula for Reference

$$\omega_{RBM} = A/(D_t+B)$$

where:  $\omega_{RBM}$  is the frequency of the RBM-band in cm<sup>-1</sup>  
 $D_t$  is the diameter of the tube in nm  
 $A = 248$  for isolated tubes and 234 for aggregated bundles  
 $B = 0$  for isolated tubes and 10 for aggregated bundles  
 Note that the relationship gets weaker with tubes < 1 nm



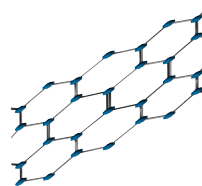
## Estimated Graphene Layer Thickness Based on G-Band Frequency

| G-Band Position | Number of Layers of Graphene |
|-----------------|------------------------------|
| 1587.1          | 1                            |
| 1584.3          | 2                            |
| 1583.2          | 3                            |
| 1582.7          | 4                            |
| 1582.4          | 5                            |
| 1582.2          | 6                            |
| 1582.1          | 7                            |
| 1582.0          | 8                            |
| 1581.6          | graphite                     |

### Formula for Reference

$$\omega_G = 1581.6 + (11/(1+n^{1.6}))$$

where:  $\omega_G$  is the frequency of the G-band in cm<sup>-1</sup>  
 $n$  is the number of graphene layers  
 Note that this relationship should be independent of excitation wavelength



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