

Analysis of Carbon Nanotubes

Carbon Nanotubes are gaining increasing attention on account of their potential application in many diverse industries. These properties are attributed to their fullerene-type cylindrical structure which affords the nanotubes phenomenal mechanical strength and unique electrical and thermal properties. Characterization of nanotubes by Raman spectroscopy involves four major band groups in the spectrum.

- Radial Breathing Modes (RBMs): This collection of bands appears in the 140-300 cm^{-1} region and is directly related to the diameter of the tubes
- G band: The intense G-band of the nanotubes (around 1590 cm^{-1}) is related to the strain in the tubes and their semi-conducting properties
- D band: The D-band (around 1335 cm^{-1}) is related to the disorder in the nanotubes
- G' band: This band is an overtone of the D-band and can be used to derive information about the electronic structure of the nanotubes



Fig. 1 R-300QE – fully integrated Raman spectrometer system.

We have used the R-3000QE Raman spectrometer system, with 785nm excitation (9 mW) and fiber optic sampling, to study carbon nanotubes. Optical filters designed specially to observe low frequency regions enable us to detect RBMs, the most crucial of the above bands.

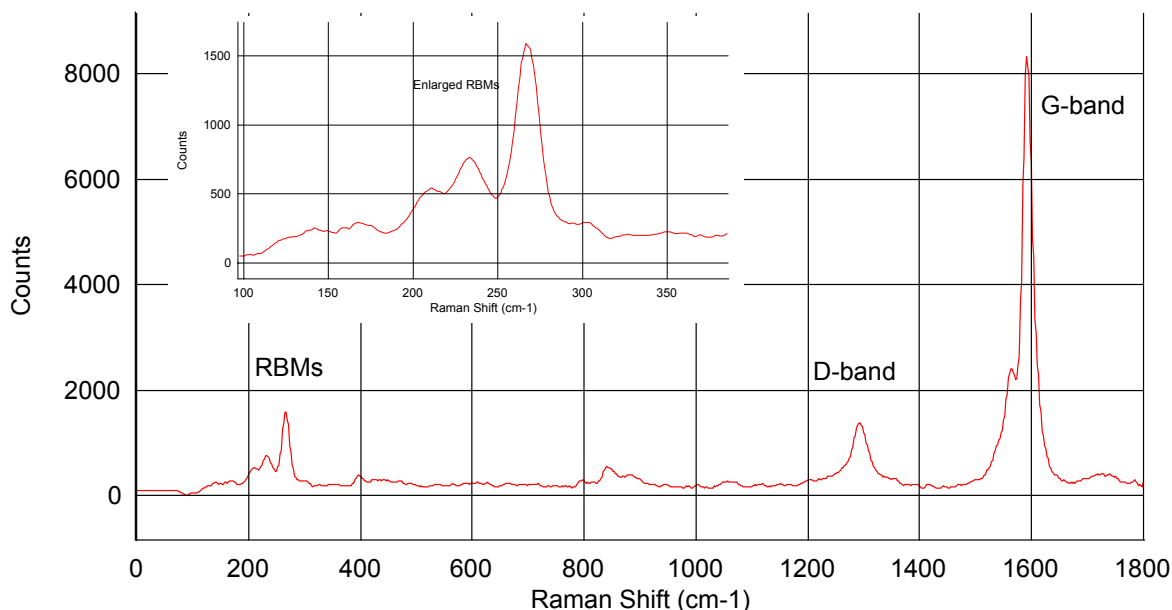


Fig. 2 Spectrum of a single walled carbon nanotube sample obtained on an R-3000QE system, with the insert showing the Radial Breathing Modes.

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The spectrum for a second sample is shown below. The D-band and the G-band with its all important shoulder are indicated.

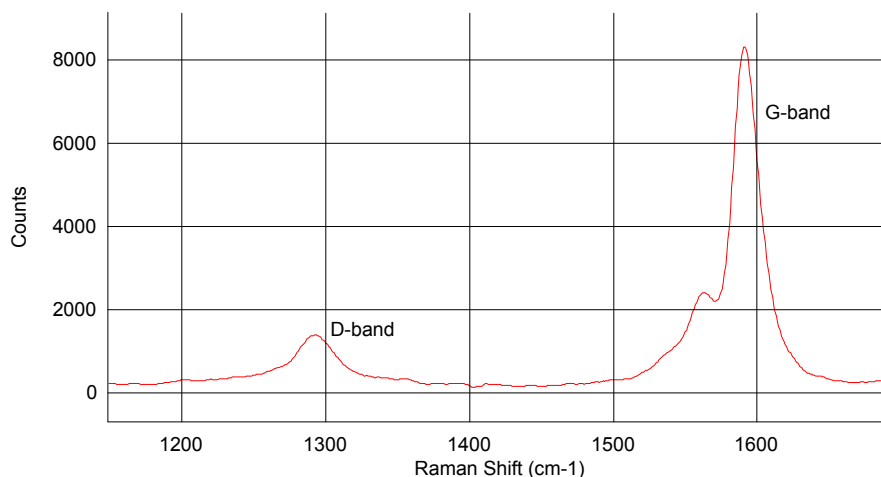


Fig. 3 Spectrum of a carbon nanotube sample obtained on an R-3000QE system showing the D and G-bands.

R3000QE Specifications

- Excitation Wavelength (Fiber Bragg Grating Stabilized):
 - ⊕ Laser Power: User Selectable from 9 to 300 mW
- Spectral Resolution
 - ⊕ Better than 6 cm^{-1}
- Dynamic Range
 - ⊕ $140 - 1800\text{ cm}^{-1}$
- Hamamatsu S7031-1006 detector
- Range: 200-1100 nm
- Pixels: 1024 X 58 2-D Array
- Pixel Size: $24.6\ \mu\text{ square}$
- Quantum Efficiency: 90% peak
- Cooling: Thermo Electric
- Temperature range: -15° to 50° C
- Condensation: No
- RSIScan[®] software for spectral acquisition, display and storage & library building. Compatible with commercial libraries
- Data Storage: SPC and ASCII
- One touch instrument verification
- Frames based integration
- Spectral smoothing & peak picking
- X-axis stability: Better than 1 cm^{-1}
- Y-axis stability: Better than 4%
- f/4 Symmetrical Crossed Czerny-Turner Optics
- Entrance Slit: Standard 50μ (Available sizes: 5, 10, 25, 50, 100, 200)
- Gratings: Several available
- Optical Resolution: 0.14-7.7 nm
- Signal to Noise: 1000:1 (At full signal)
- A/D resolution: 16 bit

Call/email us for more information

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