



APPLICATION NOTE # 105

Quality Assurance of Diamond films

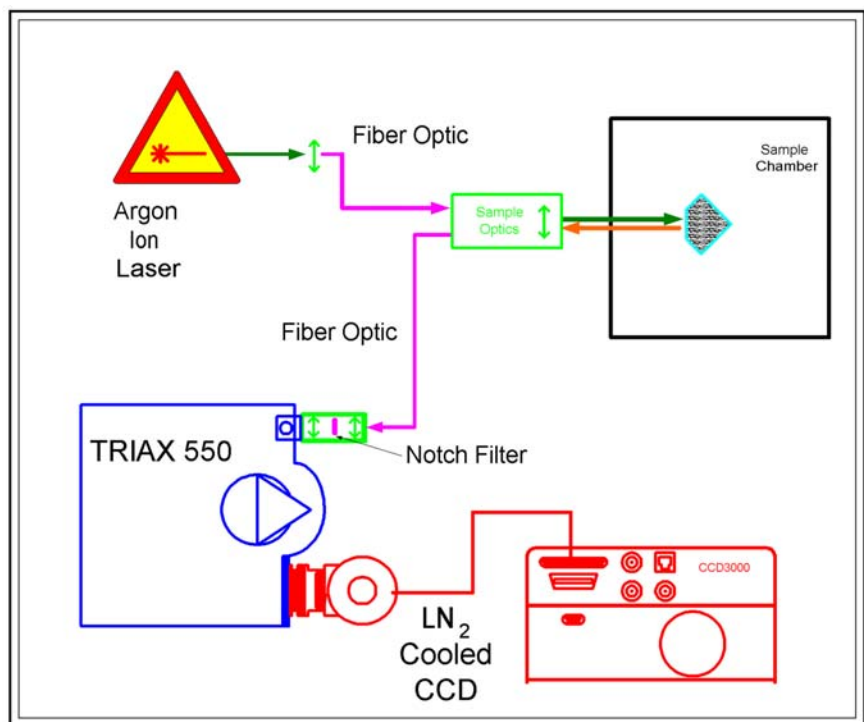
Introduction:

Due to their unique physical properties, diamond films find applications in protective coatings, cutting tools and thermal and electronic devices. Most diamond films are grown by chemical vapor deposition, aiming for a high content of diamond and very little graphite. Raman spectroscopy can be used for diagnostic testing to determine the quality of the diamond films. Raman offers a quick, sensitive, non-destructive, and non-contact method to qualitatively test the resulting films.

Experiment:

Since Raman spectra have low signal levels compared to the inherent Rayleigh scatter, it is important to optimize the experimental setup. Several factors are responsible for the ultimate success of a Raman experiment: Excellent stray light rejection, signal collection, and complete removal of the Rayleigh scatter. The Jobin Yvon low-cost system was based on a TRIAX550 spectrograph with a Spectrum-One liquid nitrogen cooled CCD camera. The excitation source was a 150 mW Argon Ion laser emitting at 514 nm. The laser beam was launched into a fiber and coupled via sampling optics to the diamond sample. The Raman signal was collected via the same sampling optics and transmitted through fiber optics to the spectrometer. The signal was fiber optically coupled into the spectrometer with an $f/\#$ - matching fiber adapter and Raman notch filter. The signal was acquired by the LN₂-cooled Spectrum ONE CCD 1024 x 256 back-thinned VIS-AR detector. The system was completely controlled and all data managed using Jobin Yvon's SpectraMax for Windows software.

Experimental Setup:



Features

- Fully-Optimized High Throughput Optical System
- Fiber Optics Interconnects
- LN₂-cooled CCD Detector with Ultra-Low Dark Noise

Benefits

- Maximizes Collected Raman Signal while Minimizing Stray Light
- Flexible Configuration
- Virtually Unlimited Acquisition Length free of Dark Noise Issues



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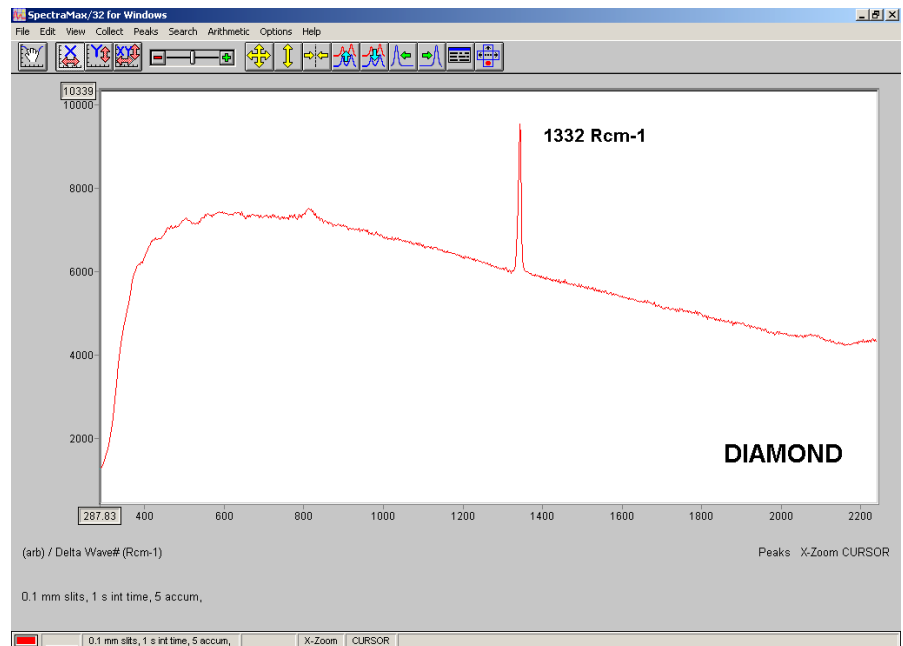
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Results:

Pure carbon can occur in several polymorphic forms, as the four valence orbitals of carbon can hybridize to sp^2 and sp^3 orbitals. Two well-known forms of elemental carbon are graphite and diamond. Graphite Raman lines occur at 1360 and 1580 Rcm^{-1} , and the ratio of their intensities determine the long-range order of the crystalline lattice. However, the main feature in a Diamond Raman spectrum is a sharp peak at 1332 Rcm^{-1} , sometimes accompanied by fluorescence bands.

Lately, engineered carbons such as fullerenes and carbon nanotubes also have come of industrial interest. An example of a typical Raman spectrum of diamond is shown in Figure 1. The data was collected using averaged accumulations and the result obtained in 5 seconds.

A characteristic diamond line is found at 1332 Rcm^{-1} . Intensity of the line is proportional to the amount of diamond in the sample as compared to the other components in the spectrum. The sharpness of the band at 1332 Rcm^{-1} , along with the absence of side bands, demonstrates high diamond content without the presence of graphite and other impurities. The shape of the baseline at low frequencies is defined by the absorption of the notch filter. The notch filter and TRIAX550 spectrograph combination allows Raman analysis to 200 Rcm^{-1} of the excitation line.



Conclusion:

The presence of the diamond band was observed with the low-cost Raman system. This and similar systems are suitable for characterization and quality assurance of diamond films.

For more demanding research measurements closer to the excitation

line, the Jobin Yvon Raman Division focuses on dedicated, fully-characterized Raman systems based on single, double and triple monochromator configurations. These systems allow analyses within 10 Rcm^{-1} from the Rayleigh excitation line with ultra-low stray light rejection.

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