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A diamond anvil cell (DAC) is a popular apparatus for producing mega bar pressures of crystalline and amorphous materials. The DAC accommodates diffraction and spectroscopic studies (e.g., single-crystal and powder X-ray diffraction, infrared and Raman spectroscopy, and Mössbauer spectroscopy). It is important to monitor the internal pressure of the DAC. Several procedures have been developed to measure the internal pressure, and the most widely used is the shift of the ruby fluorescence line. In particular, a very rapid shift (fractions of seconds) of the ruby fluorescence line is correlated to the internal pressure of the DAC (Piermarini et al. 1975; Mao et al. 1986). A DeltaNu Advantage 200A with 633-nm laser excitation and a NuScope microscope attachment were used to focus the laser on ruby crystals in the DAC.



Figure 2. Advantage 200A with Ruby in DAC



Figure 1. Advantage 200 with NuScope and Ruby Reference

Measuring Ruby Fluorescence

In the first step, the measurement of the ruby crystal is obtained at ambient conditions to establish a baseline for the system (see Figure 1 for system setup and Figure 3 red spectrum).

In the next step, the DAC enclosing the sample and ruby chip standards (5 to 10 μm) are inserted below the microscope attachment (NuScope). The red line of the laser and the NuScope are used to assist in positioning the laser on the ruby standard.

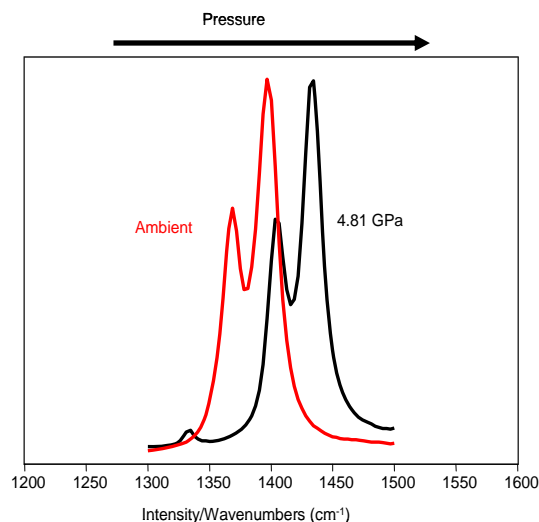


Figure 3. Ruby Fluorescence Spectra for Ambient (Red) and Pressure-Induced (Black)

Summary

The ambient peak at 1397.3 cm^{-1} Raman shift (converted to 694.421 nm) shifted to 1433.6 cm^{-1} Raman shift (converted to 696.178 nm) in the DAC cell. A 33 cm^{-1} shift correlated to an internal pressure 4.81 GPa . The standard deviation of the measurement was less than 0.05 GPa . Raman spectrometers using 633 nm laser excitation can rapidly and accurately measure the ruby fluorescence in a DAC. These systems gauge the pressure in a DAC with high reproducibility.

