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science under pressure

Application Note

Ruby grains as a Pressure Sensor

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Ruby, (Al2O3):Cr3+, has long been used in high pressure experiments as a pressure sensor. It exhibits strong fluorescence signal centered around 692.8 and 694.25 nm at ambient pressure (R2 and R1 lines, respectively) and shifting towards the red end of spectrum upon increasing pressure. This pressure dependence was calibrated in 1986 by Mao et al. and since then has been refined several times by other researchers. In this application note, we are presenting the results of our Ruby powder characterization.

Ruby powder was prepared by crushing and grinding Ruby single crystals in a mortar. The final ruby grain size obtained is between 10 and 50 micron.. We have measured Ruby fluorescence on a 20 micron grain size ruby chip using our Optiprexx RubyLUX. A green laser (532 nm, 50 mW) was used for the acquisition of the spectra. Ruby fluorescence was measured before and after heat treatment of the powder. The Ruby powder has been heat treated to 1250 C for 40 hours. Figure 1 below shows that there is almost no difference in the intensity and the position of the R1 line measured (694.20 nm) before and after heat treatment. The value of the FWHM is roughly the same before and after heat treatment (0.8 nm).

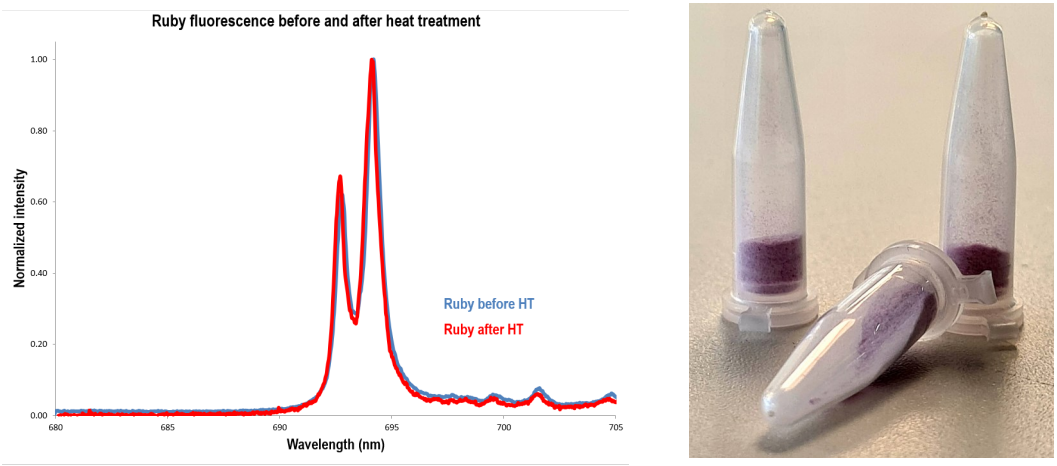

Figure 1: (Left) Ruby fluorescence spectra before (in blue) and after heat treatment (in red). (Right) Ruby ampoule supplied by Almax easyLab (200mg per vial) .

The intensity and the sharpness (FWHM) of the Ruby peak depends on the chromium content in the crystals. In collaboration with the University of Warwick-UK (Prof. Geetha Balakrishnan), we have measured X-ray Fluorescence on Ruby single crystals before grinding in order to know the chromium concentration and homogeneity across the crystal. XRF mapping on 0.6 x 0.5 mm polished surface of Ruby single crystal before grinding, shows that chromium content is homogenous across the full section measured and the concentration is 2.3 at %.

Since the pressure is obtained from the shift of the R1 line position between ambient pressure and high pressure, it is crucial to measure the position of the R1 line of the ruby grain used for the specific loading at ambient pressure. This value can vary slightly from one grain to another because of few parameters (internal stress, spectrometer calibration…)