AOGS 2006
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Pressure-Mapping Around Inclusions in Corundum Crystals Determined by the Shift of CR^{3+} Luminescence Bands

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Since 1972, Cr^{3+} luminescence in ruby has been used to calibrate the pressure in Diamond Anvil Cell(DAC). It is an important internal pressure sensor for this high pressure instrument. The values of the maximum intensity and the wavelength are calculated by the combination of the Gaussian and Lorentzian functions. The R1 band shows a red shift with higher pressure. The actual pressure in the lattice can be calculated with approximately 1 Å by a change of 2.75 kbar.

In our experiments, this method is applied to natural corundum crystals that contain Cr^{3+} as trace element. The confocal luminescence mapping is used to determine the relative remnant pressure around inclusions in the host corundum. By the confocal method, the shift of R1 can be determined in direct contact to an inclusion with a spatial resolution of $\sim$50 μm^3. It is of advantage to show the characteristics of internal pressure of the host around a certain guest inclusion. The full width at half-maximum(FWHM) of the R1 luminescence band, normally in hydrostatic pressure, decreases very slightly with increasing pressure but the mapping data show vice versa effects. This contradiction might be explained by the increasing of pressure gradient towards the inclusion, which leads to a nonhydrostatic pressure around the inclusion. This non-destructive technique can be used to calculate the actual pressure between host and inclusion and the pressure during crystal growth of the Cr^{3+} containing corundum. The determination of the pressure relation between host and guest lattices is also a useful tool in the case of origin determination of those materials.