Preliminary study of defocused PL measurements

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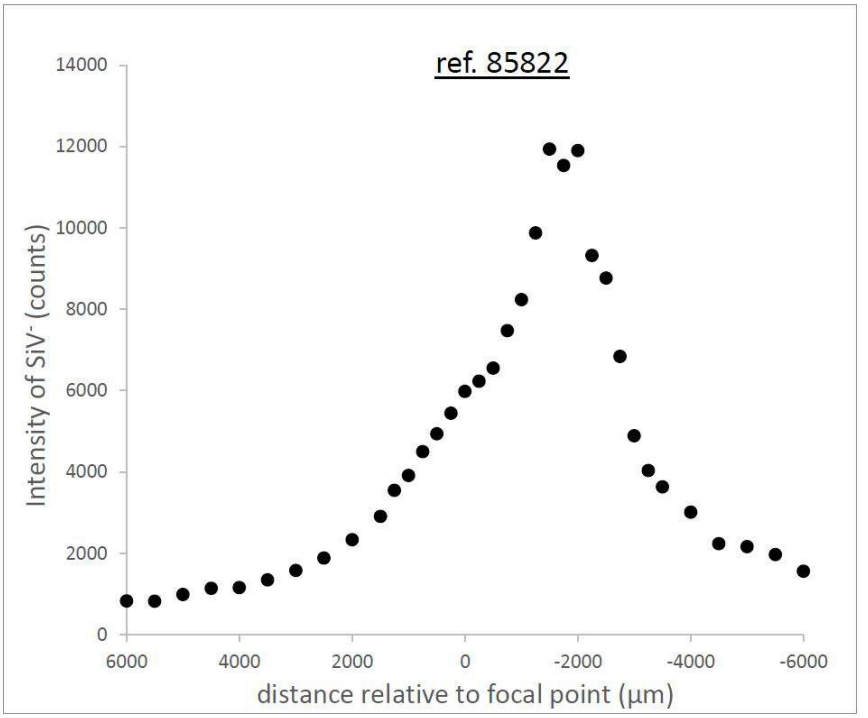
In gemmology, the use of a Raman probe for inducing photoluminescence (PL) was first described by Chalain et al. 1999. Since then, PL measurements have become a common technique, for example to study optical centres in diamond (Loudin, 2017) or synthetic spinel (Krzemnicki, 2021). PL depth profile measurements, which implies defocusing the laser beam, are more exotic in gemmology but may have interesting future applications (Ardalkar et al. 2021, unpublished). Defocusing may also be used to reduce PL and Raman signals of high intensity when it is impossible to prevent detector saturation by other means.

The Swiss Gemmological Institute (SSEF) is currently conducting measurements to understand the impact of defocusing the laser spot of the Raman probe on the diamond Raman peak (DRP) as well as on different PL-active optical centres. So far, two optical centres were studied at room temperature: the N3 centre, which causes a PL peak at 415.4 nm and the SiV- centre, which produces a PL peak at 738.7 nm.

A number of measurements were performed using both green (532 nm) and violet (405nm) laser sources (for analytical parameters, see Table 1). At first, the laser beam was focussed on the table of the diamond, so that the DRP was at its maximum intensity. The distance between the diamond and the Raman probe was then varied between 6000 µm above and 6000 µm below the focal point using a z-motion stage (precision 10 µm) and a total of 35 spectra were recorded for each stone.

Figure 1 shows the behaviour of the SiV- peak in a colourless CVD synthetic diamond (reference 85822) excited by the green laser upon defocusing. Upon approaching the surface of the diamond from above, the intensity of the SiV- peak increases, reaches a maximum and then decreases inside the stone. Interestingly, the maximum was found approximately 1750 µm below the surface of the stone, not at its surface where the DRP is at its maximum intensity (not shown in Figure 1). In addition, a shoulder in the SiV- depth profile can be seen at the surface of the diamond (0 µm in Figure 1). More work is needed to examine whether the difference in behaviour between the DRP and the PL peak is due to optical phenomena or due to a real change in concentration of the SiV- defect with depth.

Laser wavelength: 405 nm		Laser wavelength: 532 nm	
Numerical aperture	0.27	Numerical aperture	0.22
Focal length	7.5 mm	Focal length	7.5 mm
Theoretical spot size	158 µm	Theoretical spot size	NA*
Depth of field	Approx. 2.2 mm	Depth of field	NA*
Analytical conditions		Analytical conditions	
Laser power	38.1 mW	Laser power	55.4 mW
Integration time	1.05 ms	Integration time	300 ms
Number of averages	1000	Number of averages	3



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