

Be-detection by FTIR on corundum: A preliminary report

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Introduction

In mid-2001 Be-diffusion for corundum was first reported, when suddenly an unusually large number of Padparadscha coloured sapphires appeared in the market (Hänni & Pettke, 2002). Ever since, gemmological laboratories were confronted with the challenging task of detecting Be in corundum. Be however is a very light element and therefore not detectable by conventional ED-XRF trace-element analysis. New analytical methods had to be found in order to detect Be in gemstones, which potentially had been diffusion treated. Soon LA-ICP-MS (Guillong & Günther, 2002; Abduriyim & Kitawaki, 2006) and LIBS (Krzemnicki et al., 2004; Krzemnicki et al., 2007) were introduced to the field of gemmology.

Although these methods are highly sensitive and Be can be detected efficiently, they were also very sophisticated and costly. Many laboratories with smaller budgets and less specialised personnel were therefore left with no solution in the detection of Be-treatments in general and corundum in particular.

The aim of this research was to investigate the possibility to use FTIR as an alternative method and to offer an analytical option to those labs which had not been in the position to test gemstones for potential Be-diffusion treatments other than by microscopy so far.

Sample description and experimental methods

In order to investigate the potential of FTIR as a possible analytical method for Be-detection in gemmology, three samples of colourless sapphires created by three different producers of synthetic corundum were investigated. Sample 69142_A is a 4.43ct octagonal/ step cut colourless sapphire cut from rough by Thairus Gems, Russia. Sample 69142_B is a 3.15ct slab sawn and polished from rough produced by Rusgem, Russia, whereas 69142_C is a 0.71ct round/ brilliant cut colourless sapphire cut from synthetic corundum rough produced by Jeva, Switzerland (see Fig. 1).

The Be-diffusion treatment was carried out by local burners in Chantaburi, Thailand, along with a batch of commercially treated corundum, processed at the same time.

The three samples were measured by FTIR spectrometry both before and after Be-diffusion treatment. The FTIR spectra were taken in condensed-beam mode by a Thermo Scientific, Nicolet 6700 unit. For each measurement 124 scans at resolution 2 were accumulated. The spectra were taken in the range between 1500 and 5000cm⁻¹.

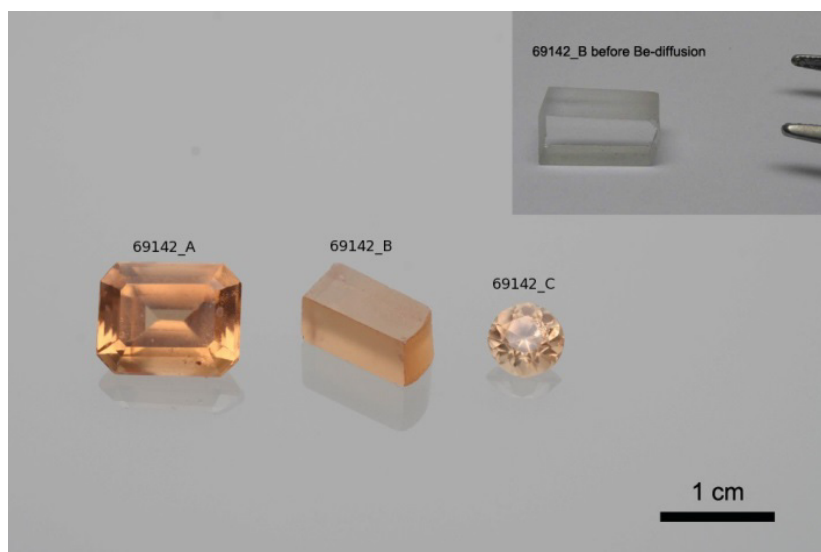


Figure 1. The photograph shows the three investigated samples after Be-diffusion treatment. As a comparison, sample 69142_B is shown before treatment in the upper right corner.

Results and discussion

Besides known artefacts related to CO₂, H₂O and grease no other signals were recorded for the examined synthetic corundum samples before treatment. Subsequent to Be-diffusion treatment two new features were observed in all three samples instead. A clear band at 3053 cm⁻¹ and a less pronounced band at 2490 cm⁻¹ were observed (see Fig. 2).

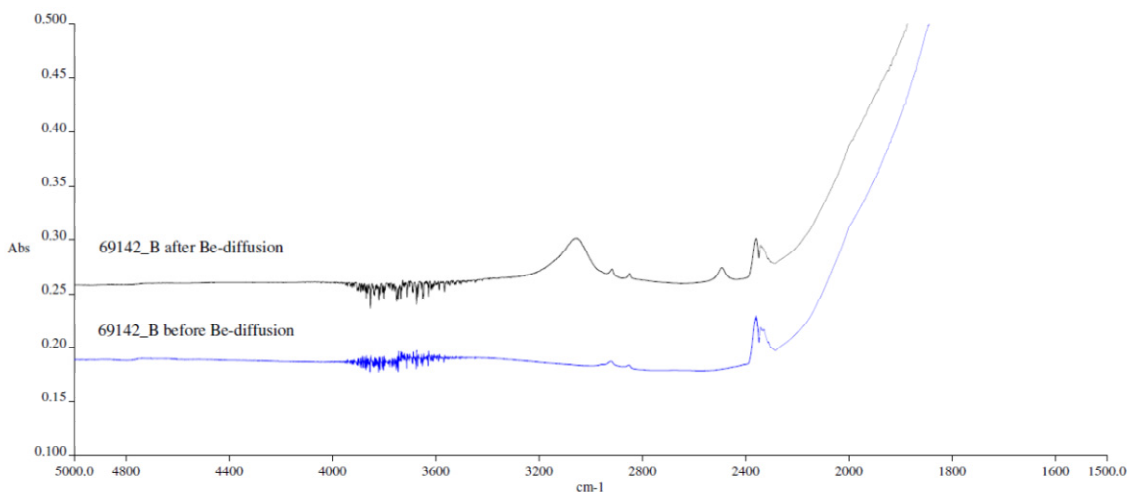


Figure 2. The samples tested in this study showed distinct differences in their FTIR signature before and after Be-diffusion treatment. Especially a clear band at 3053cm⁻¹ and a less pronounced band at 2490cm⁻¹ were identified as typical characteristics for Be-diffusion treated corundum.

The band at 3053 cm⁻¹ seems to be the same band as observed by Kitawaki & Abduriyim (2008) at 3068cm⁻¹ and is located in an IR-range where bands related to diaspore (Farmer, 1974; Downs, 2006), dolomite (Downs, 2006), and an “unknown” band (Smith & van der Bogert, 2006) had been described before. The band at 2490cm⁻¹ however lays in an IR-range where no common artefacts or signals of inclusions in corundum are known so far (Balmer, 2011).

Conclusion

All three samples showed the same distinct changes in their FTIR signature compared to the FTIR spectra taken before the Be-diffusion treatment was carried out. Due to the fact that the same effect was observed in three individual samples and that the band at 2490cm⁻¹ in particular was never described in gemmology before, it is assumed that it is possible to positively link the latter to Be-diffusion treatments in corundum when detected.

However, the cause of the distinctive spectra characteristics is not yet understood. It further has to be investigated how frequent the introduced criterion occurs in Be-diffusion treated natural corundum. In order to verify whether quantification of Be-contents in corundum by FTIR is possible, trace-element analyses by LA-ICP-MS have to be carried out first. And finally, whether the analytical criteria presented in this study can be applied to all types of corundum still has to be examined however. This implies that further information still has to be collected.

Nevertheless, it had been possible to demonstrate that FTIR has the potential to be used as an alternative analytical method for Be-detection in corundum in the future.

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