SYNTHETICS AND SIMULANTS

Synthetic Moissanite with the Reflectivity of Diamond

Recently, the Swiss Gemmological Institute SSEF received a transparent, colourless, round-brilliant-cut stone (1.81 ct) for diamond grading (Figure 21, inset). Testing with a Presidium Duo Tester yielded a thermal conductivity result in the range of both diamond and synthetic moissanite (Figure 22a). To distinguish the two materials, the DuoTester also allows the measurement of reflectivity. The manufacturer provides a scale that is calibrated so the typical reflectivity value of synthetic moissanite is between 100 and 116, while that of diamond ranges from 87 to 96 (identical ranges are given for the newer model, Presidium Duo Tester II). The sample described here showed a reflectivity of only 86 (Figure 22b), even after thorough cleaning and despite having a good polish. Although this relatively low reflectivity was suggestive of diamond, prior testing of the sample according to our standard procedure proved otherwise.

Unlike diamond, synthetic moissanite is optically anisotropic and strongly doubly refractive, resulting in a doubling of inclusions and of facet edges on the opposite side of the stone when observed with the 10× loupe. This doubling usually cannot be seen when looking directly through the table facet since synthetic moissanite is typically cut with the table perpendicular to the optic axis, but it can be observed easily through the crown main facets, as was the case here (Figure 23a).

Another telltale feature of synthetic moissanite is the presence of sub-parallel whitish channels or 'stringers' that follow the direction of the optic axis, although these were absent from this specimen. Instead, it showed an unusual spindle-shaped, branching inclusion (Figure 23b), as well as a multitude of tiny particles, some of which appeared needle-shaped. In addition, some of the pavilion facets had polishing marks that were parallel on adjacent facets. As a consequence of diamond's extreme hardness, the polishing orientation must be re-adjusted for each individual facet, but this is not the case for other gem materials (including synthetic moissanite). Thus, parallel polishing lines on adjacent facets indicate that a stone cannot be a diamond.

Raman (Figure 21) and IR spectroscopy unequivocally identified the specimen as synthetic moissanite. The relative intensity of the Raman lines of synthetic moissanite depends on the orientation of the sample as well as the SiC polytype present. The specimen described here appears to be of the 4H polytype (cf. Kiefert *et al.* 2001). No Raman peak for diamond at 1332 cm^{-1} was detected. In addition, the sample's hydrostatic SG value of 3.22 is typical for synthetic moissanite, and EDXRF spectroscopy revealed the presence of Si, as expected

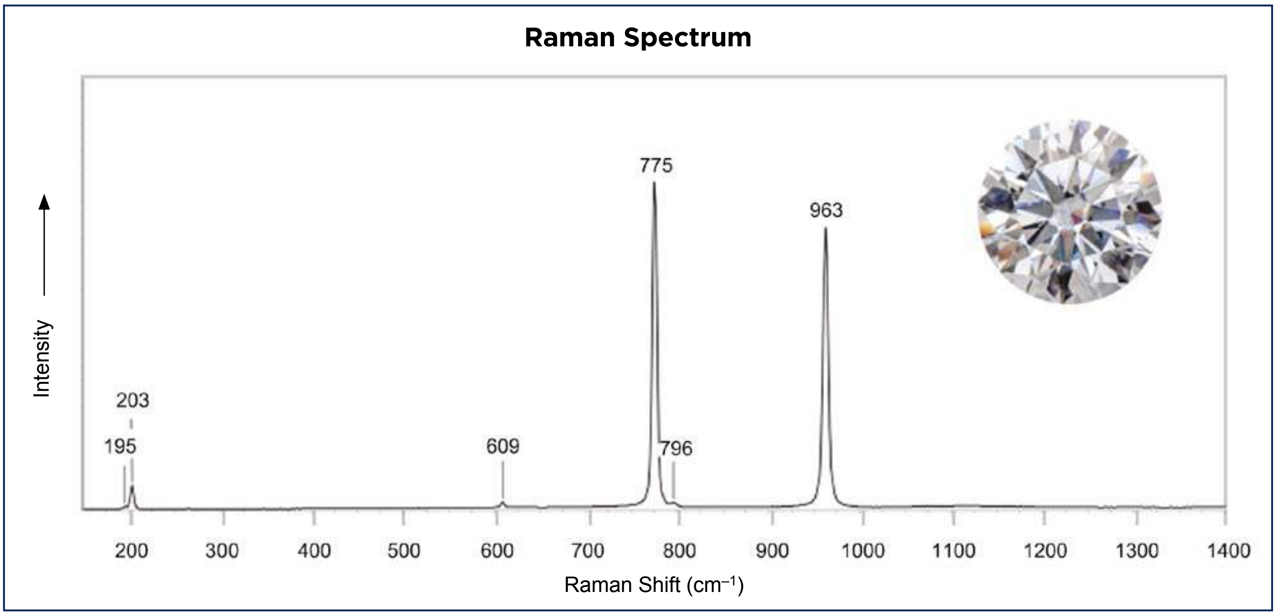

Figure 21: A 1.81 ct round brilliant submitted to SSEF for diamond grading was identified as synthetic moissanite, and its Raman spectrum was indicative of the 4H polytype that is typical of this diamond imitation. Photo by Luc Phan, SSEF.

Figure 22: (**a**) Testing of the 1.81 ct sample with a Presidium Duo Tester shows a thermal conductivity result typical for synthetic moissanite (i.e. in the diamond range). (**b**) The reflectivity value of 86 is exceedingly low for synthetic moissanite, and closer to that expected for diamond. The gem was cleaned thoroughly before testing, and the cylinder cap was removed only for the photo and did not influence the reflectivity reading. Photos by Julien Xaysongkham, SSEF.

for this diamond imitation. (Carbon cannot be detected with this method.)

Another interesting feature of the specimen was an inscription on the polished girdle (characters 'GRA' followed by a nine-digit number) which, at a glance, resembled laser inscriptions commonly found on GIA-graded diamonds. Fraudulent GIA laser inscriptions on synthetic moissanite have been reported recently (Hlatshwayo & Eaton-Magaña 2020).

To summarise, the synthetic moissanite described here has some unusual characteristics that could complicate correct identification, especially if only relying on readily available testing instruments that depend on thermal conductivity and reflectivity. Heat treatment can lower the reflectivity of synthetic moissanite so that it approximates that of diamond (or is even lower), as described more than two decades ago (Chalain 2000). However, synthetic moissanite treated in this way has never been submitted to SSEF for grading or authentication. Visually, there was no difference in the lustre, brilliance or 'fire' (dispersion) of the sample when compared to other synthetic moissanites from SSEF's reference collection. Nevertheless, careful observation with a gemmological loupe revealed strong doubling,

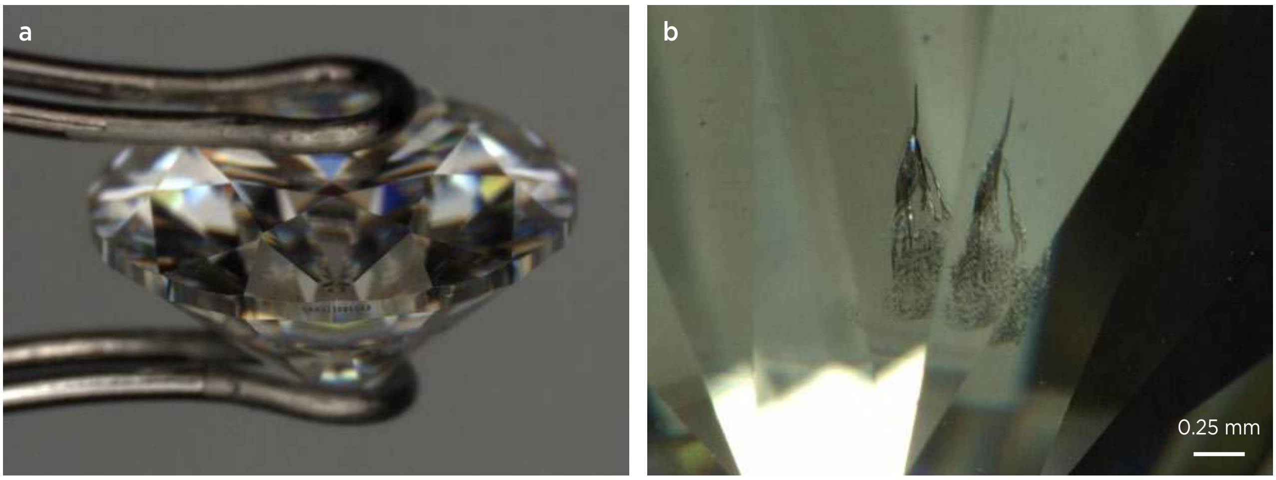

Figure 23: (**a**) Strong doubling of facet edges is visible on the opposite side of the 1.81 ct synthetic moissanite when viewed through the crown main facets. (**b**) This unusual branching inclusion appears twice here because it is seen through two separate pavilion mains. Photos by (a) Julien Xaysongkham and (b) L. Speich (taken using a polarising filter to eliminate doubling).

excluding diamond as a possible identity. This case highlights that the identification of diamond and its simulants should always be based on multiple tests and observations.

Dr Laura Speich FGA *(diamonds@ssef.ch),*
Jean-Pierre Chalain and
Dr Michael S. Krzemnicki FGA
Swiss Gemmological Institute SSEF
Basel, Switzerland

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Black Sapphire Melee as a Black Diamond Imitation

As black diamond has become increasingly fashionable in recent years, various simulants have appeared. Among them, black synthetic moissanite is commonly used in jewellery (e.g. in cluster settings), as well as cubic zirconia, boron carbide and others (e.g. Kammerling *et al*. 1991; Li *et al*. 2011; Choudhary 2013).

Recently, a pendant set with 22 black stones was submitted to the National Gemstone Testing Center's (NGTC) Beijing laboratory for identification (Figure 24, centre). Due to the opacity of most black diamonds, Fourier-transform infrared (FTIR) spectra usually cannot be collected, but Raman spectroscopy can quickly distinguish diamonds from imitations. Raman spectra of the black stones in the pendant revealed that all of them were diamonds except for one, which lacked the 1332 cm^{-1} feature characteristic of diamond; it was identified as sapphire.

All of the stones in the pendant showed a high lustre, with excellent cut and polish, making it difficult to pick out imitations, even under a microscope. However, with closer examination the black sapphire showed a rougher surface, slightly less sharp facet edges and a slightly weaker lustre (Figure 24, left) as compared to the diamonds' smooth surface, sharp edges and adamantine lustre (Figure 24, right). In addition, when illuminated from the side using a fibre-optic light source, the sapphire appeared almost opaque while the diamonds were semi-transparent.

This is the first time we have encountered black sapphire as a diamond imitation. This serves as a reminder that various melee-sized black materials are being mixed with black diamonds and set into jewellery. In addition to Raman spectroscopy, methods such as DiamondView imaging and thermal conductivity testing are helpful for identifying imitations in black diamond jewellery.

Yang Wang (wangyang@ngtc.com.cn),
Zhonghua Song and Ting Zheng
NGTC, Guangzhou and Beijing, China

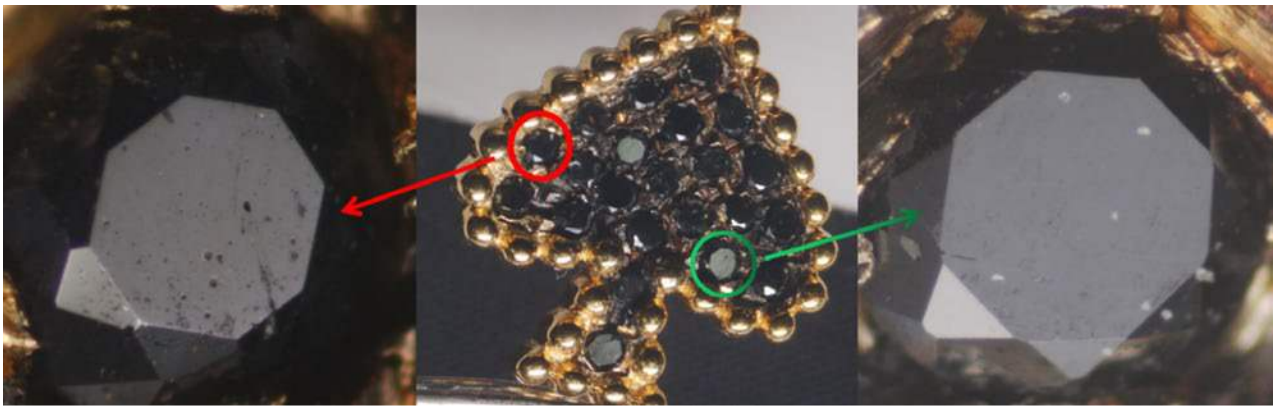

Figure 24. In this pendant (centre, approximately 2 × 2 cm), the stone marked by the red circle is a black sapphire and the others are diamonds. With 50× magnification, the sapphire (left) shows a rougher surface, slightly less sharp facet edges and a slightly weaker lustre than the diamonds (e.g. right). Photos by Z. Song.