ACTA UNIVERSITATIS CAROLINAE - GEOLOGICA 2002, 46 (1)

Russian synthetic moissanite

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Silicon carbide - moissanite - is used since the last decades of the 19th century for technical purposes. The growth of large crystals of synthetic moissanite by a sublimation technique from the vapour phase was first described by Lely (1955), but the crystals grown by this so-called Lely technique consist of a mixture of simultaneously grown hexagonal (H), rhombohedral (R), and cubic (C) polytypes (Knippenberg 1963). This disadvantage for the technical use of the crystals is overcome by the usage of oriented seeds of a selected polytype (Tairov and Tsvetkov 1978, 1981). By seeded growth of silicon carbide by sublimation from the vapour phase it is possible to grow large single crystals consisting of only one silicon carbide polytype, e.g., 6H-SiC, 4H-SiC or 15R-SiC. This method is described in the literature as the modified Lely technique.

The modified Lely technique is also applied for the production of colourless synthetic moissanite crystals used as diamond substitutes. The colourless synthetic moissanites grown in the United States for jewellery purposes by Cree Inc., Durham, North Carolina and distributed by Charles and Colvard (formerly C3 Inc.), Morrisville, North Carolina, consist of single crystals of one of the known hexagonal silicon carbide polytypes, namely 6H-SiC (Nassau *et al.* 1997; Nassau 1999), but the growth of other polytypes and/or differently coloured moissanites for gem purposes is also possible (Schmetzer 2000).

Due to its gemmological properties, synthetic moissanite is an ideal diamond imitation, with refractive indices of 2.648 and 2.691 and a hardness of $9^1/_4$ on the Mohs scale (Nassau *et al.* 1997). Although strongly anisotropic, the thermal conductivities of synthetic moissanites are so close to those of diamonds that the commonly applied thermal probes react to synthetic moissanites as if they were diamonds. Careful testing of the reflectivity, however, allows a distinction between the two (Chalain and Krzemnicki 1999). Since the introduction of moissanite as a diamond substitute in 1997, the material is distributed widely and has appeared worldwide in gemmological laboratories as diamond imitation that was even set in antique jewellery.

Synthetic moissanites for gem purposes are also produced in small quantities in St. Petersburg, Russia (Balitsky 2000), and first samples of this material were already observed in the gem trade (Longère 2000; McClure and Moses 2000). By courtesy of Mrs. B. Schaeffer, a mineral and gemstone dealer residing in Detmold, Germany, the authors were able to study five samples of the Russian production. Their Raman spectroscopic properties are presented here.

Various techniques, e.g., X-ray crystallography, can be applied for the determination of silicon carbide polytypes. The examination of the Raman spectrum is one of the non-destructive methods which can be performed on cut gemstones without special preparation of the samples. Using a micro Raman spectroscopy facility, it is also possible to examine the samples with respect to homogeneity in different areas.

We performed Raman spectra on different facets and at different points on the larger tables of all samples including different orientations of the faceted gemstones to the incident beam. Although the spectra obtained, especially the intensities of the main peaks in the 760 to 800 and in the 960 to 970 cm^{-1} area, were found to be strongly variable and related to the orientation of the samples, we could not determine any inhomogeneity within the five samples. In other words, the samples were found to be single crystals without any admixtures of different polytypes.

In all samples, the strongest Raman peaks above 700 cm^{-1} were found at similar wavenumbers. The spectra of four samples consisted of strong lines at 767, 786 and 965 cm^{-1}, sometimes with an additional line at 795 cm^{-1}. Weak lines above 1000 cm^{-1} were also present. The spectra of the bluish brown moissanite consisted of three strong lines at 778, 794, and 969 cm^{-1}, again with two weak lines above 1000 cm^{-1}. The Raman lines with weaker intensities below 700 cm^{-1}, again, were found to be different for the sample with bluish brown colour (Fig. 1). The main Raman lines for the first four of our samples in this range were determined at about 147, 238, and 504 cm^{-1} , with one weaker line observed sometimes at 263 cm^{-1}. The remaining sample, on the other hand, revealed lines with maxima at about 201, 263, and 609 cm^{-1}, with an additional peak of weak intensity at 636 cm^{-1}.

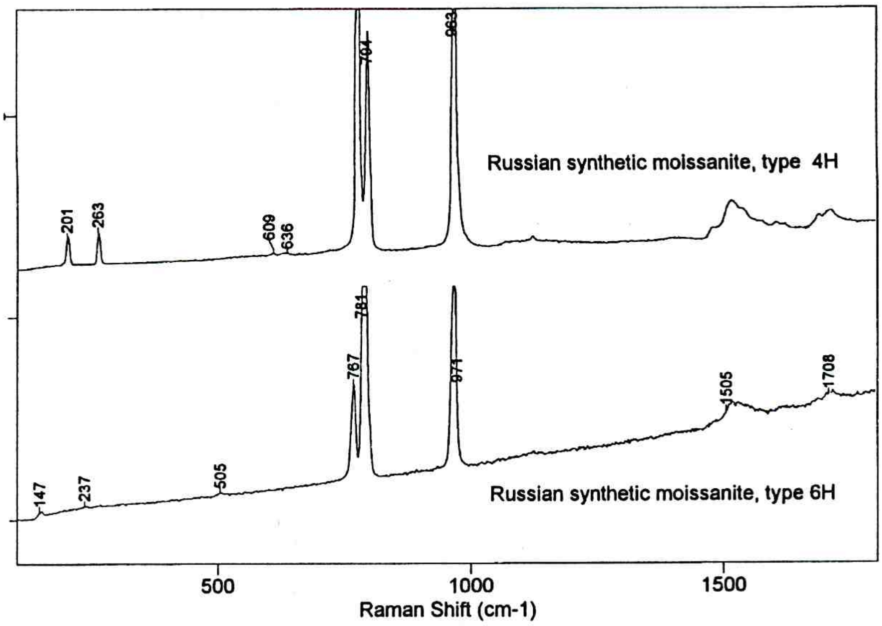

Fig.1. Raman spectra of different synthetic moissanite polytypes

Raman spectra of different synthetic moissanite polytypes; especially the lines below 700 cm^{-1} are useful for a distinction of 6H-SiC and4H-Sic silicon carbide polytypes.

These data are consistent with numerous references describing Raman data of specific silicon carbide polytypes (e.g., Nakashima and Harima 1997) and indicate that four of our five samples belong to the 6H-SiC polytype, whereas the remaining faceted moissanite was found to be 4H-SiC. The colourless material produced in USA for jewellery purposes and released to the trade was described so far as the 6H polytype of moissanite (Nassau *et al.* 1997; Nassau 1999). The different colours of these Russian synthetic moissanites are caused by various amounts of nitrogen and do not have an influence on the Raman spectra of the various polytypes. However, similar to colourless or near-colourless synthetic moissanite, these stones could be mistaken for coloured diamonds by the unexperienced jeweller who is not aware of the strongly anisotropic behaviour.

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