Raman spectroscopy on garnet and ruby as a non-destructive analytical method in gemology

N Waeselmann[1], J Schlüter[1], C Bergemann[1], Bersani D.[2] and B Mihailova[1]
[1] Department Geowissenschaften, Universität Hamburg, Grindelallee 48, 20146 Hamburg, Germany
[2] Dipartimento di Fisica, Università di Parma, Viale G.P. Usberti 7a, 43100 Parma Italy

Gemstones have fascinated the mankind throughout the human history. Their beauty and rarity make them precious and valuable. For the determination of gemstones it is of essential importance to use a non-destructive method which does not require additional treatment of the sample especially in the case of jewelry and historically valuable objects. Such a non-destructive method should be able to (i) verify the structure type of the gemstone, (ii) to determine the crystal chemistry of the gemstone, e.g. which kind of garnet, (iii) detect any additional treatments of the gemstone to artificially enhance the colour, (iv) draw conclusions about gemstone deposit on the basis of chemistry and inclusions in the host.

Raman spectroscopy is an excellent tool to identify gemstones because this method is sensitive to the structure type as well as to the chemical bonding. At the same time, Raman spectroscopy can be applied to a sample of arbitrary shape and does not require any special sample-preparation procedure. Hence, the use of Raman spectroscopy in analysis of gemstones allows us to gain information about the crystal chemistry of the main structural component as well as to detect small inclusions in a reasonably short time, without destroying the sample.

In this contribution we demonstrate the potential of Raman spectroscopy to characterize garnet and ruby. In the case of garnet ($X^{2+}_3Y^{3+}_2(SiO_4)_3$) we have used the Raman peak positions to determine the actual chemical composition on the basis of previously proposed methodology [Bersani et al. 2008]. In the case of ruby we have used the intensity ratio between the photoluminescence peak of Cr^{3+} and the Raman scattering of Al_2O_3-matrix to estimate the content of chromium and to check for possible artificial enhancement of the colour.

References:

Bersani D., Andò S.et al. (2008), Spectrochimica Acta Part A, 73, 484–491.