

A TRANSMISSION SPECTRUM OF A SMOKY QUARTZ HAVING A JEWELLERY-COLLECTION IMPORTANCE

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Abstract

Both transmission and reflection spectra of a sample of smoky quartz having a jewellery-collection importance, have been registered. A translucence coefficient at the end of a visible part of spectrum $\lambda = 750$ nm is 50% what is very rare for this kind of semi-precious stone. An explanation of formation of color centres in a smoky quartz has been presented.

According to some opinions, a translucence is one of the main parameters that are used in qualitative evaluation of a semiprecious stone [1]. Our country can boast of certain reserves of semi-precious stones that can be used for different purposes. Optic spectra of a smoky quartz from Budinarci location near Berovo, Macedonia have been investigated in this paper. The measurements were carried out at the Institute for Physics in Belgrade and at the Faculty of Mathematics and Physics of the Karlov University in Prague. The sample of a smoky quartz was obtained by Prof. Vakanjac from the Faculty of Mining and Geology, Department for Mineral exploration in Belgrade.

A TRANSLUCENCE COEFFICIENT VALUE

The investigated sample is a monocrystal. It belongs to the group of levo-sided examples of beta quartz, Fig. 1. It is not homogeneous, as liquid-gaseous inclusions can be noticed by a naked eye at one end of a sample. The middle part of this sample is translucent. The measurements were performed in directions normal to the Z axis.

The spectra of a transmitted light were registered at spectrophotometers VARIAN SUPERSCAN 3 and SPECORD M-40 within the interval from 200 – 900 nm. A translucence coefficient ranges from 5% for $\lambda = 200$ nm to 65% for $\lambda = 900$ nm, while it is 25% when the middle part of a visible spectrum is in question. When it is known that the majority of samples of smoky quartz is turbid, than we can say that the investigated sample has a certain collecting value.

A REFLECTED LIGHT SPECTRUM

A reflection spectrum was registered at spectrophotometer PERKIN ELMER M-599 ranging from $4000 - 200 \text{ cm}^{-1}$ and compared to a pure quartz obtained under laboratory conditions, dotted line, Fig. 2.

All the oscillators that are present in „pure” quartz also appear in the examined sample of a smoky quartz. As there is no difference in shapes of spectra, it is supposed that impurities existing in a smoky quartz did not cause any structural changes.



Fig. 1.

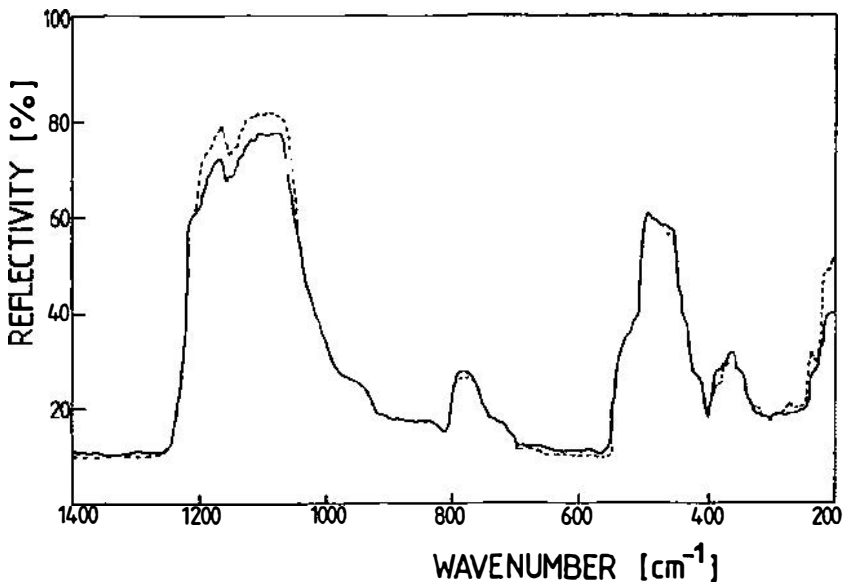


Fig. 2.

CENTERS OF COLORATION IN A SMOKY QUARTZ

Since long men have been engaged in production of crystals under laboratory conditions. Nowadays, a production process of decorative jewelry under workshop conditions is greatly developed. In 1956 Cohen A. J. produced crystals having the colour of

citrine, amethyst and smoky quartz using ionizing radiation on colourless synthetic quartz [2]. The coloration of a smoky quartz resulted from isomorphous change of Si aluminium in tetrahedron for compensating Me^+ ion or proton in space between knots (interstitial). When exposed to radiation a weakly bonded electron of a defect tetrahedron was captured by electron trap (centre of capture), the ion- compensator diffuses towards it. Thus a donor center of coloration is formed. It was also noticed that the adding of germanium impurities to quartz during a growth process stimulates formation of a smoky centers, although germanium alone does not enter the structure of a center. Some other possibilities of structure formation of centres of coloration in a smoky quartz have been suggested [3], [4], [5]. When change of Si^{4+} for $Al^{3+} + Me^+$ is not ideally isomorphous, the very distribution of smoky coloration in a crystal volume is characterized by a clearly marked sector feature.

It was experimentally proved, according to [2] that during a crystal growth under conditions of determined concentration of aluminium impurity, the centres of impurity nature ($Al^{3+} + Me^+$) are formed. In our case we can talk of extremely low concentrations of Al that could not be detected by electron microanalysis the sensitivity of 1000 ppm. The analysis was performed by D. Krajnović in laboratory for electron microanalysis at the Faculty of Mining and Geology, at electron microanalyser with energetic dispersive spectrometer.

ZAKLJUČAK

Prema nekim shvatanjima zavisno od prozračnosti uzorka poludragog kamena, gde spada i dimljeni kvarc ili čađavac, procenjuje se njegova juvelirska vrednost. Od pregledanog većeg broja uzoraka dimljenog kvarca domaćih lokaliteta, izdvojen je uzorak iz okoline Berova SR Makedonija, koji ima određenu kolekcionarsku vrednost.

Snimljeni su transmisioni i refleksioni spektri. Na kraju vidljivog dela spektra za $\lambda = 750$ nm koeficijent prozračnosti iznosi 50%, što je prava retkost, jer su uzroci dimljenog kvarca pretežno neprozračni.

Pri komparaciji refleksionih spektara dimljenog kvarca i „čistog“ kvarca nastalog u laboratorijskim uslovima, može se zaključiti, da nije došlo do strukturne promene kristalne rešetke. Prema literaturnim podacima obojenost dimljenog kvarca dolazi od izomorfne zamene atoma Si aluminijumom u tetraedru sa kompenzirajućim jonom Me^+ (metala) ili protonom u prostoru između čvorova rešetke. U našem uzorku radi se o vrlo malim koncentracijama primesa Al i ostalih metala, pa njihovo prisustvo postojećom opreom nije moglo biti dokazano.

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