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PROPERTY OF β-PHASE QUARTZ CRYSTALS

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Abstract: The structures and radiation-optical characteristics of quartz crystals expressed on neutron-irradiated primers using the EPR spectroscopy method were studied.

Аннотация: *Исследованы структуры и радиационно-оптические характеристики кристаллов кварца, вырашенных на нейтронно-облученных затравках методом ЭПР спектроскопии.*

Keywords: quartz, luminescence center, autolocalized exciton, seed, radiation, neutron, gamma irradiation, spectrum, luminescence, band.

Introduction: Now influence of structural of not the same layer crystals as β-, metamictic phases, and also of dot defects and impurity on kinetics of phase transformations occurring in crystals of quartz at a neutron irradiation are not investigated. The task is aggravated also by that as is known [1] the β- phase of quartz in usual conditions stably does not exist separately and the defects of its structure are not investigated.

Therefore in the given work the opportunities inheritance induced radiation- induced β - phases and dot defects of the seeds by the accrued layer of the brought up crystal of quartz and law of their distribution on thickness of a crystal by a method of electronic paramagnetic resonance (EPR). As now among spectral methods at studying of a nature of the defective centers, establishment of defects' belonging to this or that phase of crystals, most informative is the method EPR.

Methods: Research of spectra of EPR crystals of the quartz which has been brought up on neutron irradiated seeds carried out on spectrometer EPR ER- 420 with length of a wave λ=3 sm. Samples previously were irradiated ɣ- ray by a doze 10^5 degree.

In [2] method EPR is shown, that in natural and artificial crystals of quartz, burned off at temperature T-970 K, after ɣ- irradiation by a doze D= 10^6 degree and heated at T=570 K, exists new paramagnetic T-centre.

Experimental results: According to classification of the paramagnetic centers for various spatial groups of crystals 3 is established, that T- centers can exist in- phase having spatial group $P6_2.22$ In opinion of the authors more preferable, that in structure of β–quartz T-centers is formed in silicon-oxygen tetrayder with vacancies of silicon.

Preceding from this it's possible to suppose, that in crystals of the quartz which has been brought up on neutron irradiated seeds should be T-centers (Fig.1).

Fig.1. EPR spectra of the T-center of stained (a) and unpainted (b) quartz crystals grown on neutron–irradiated seedings.

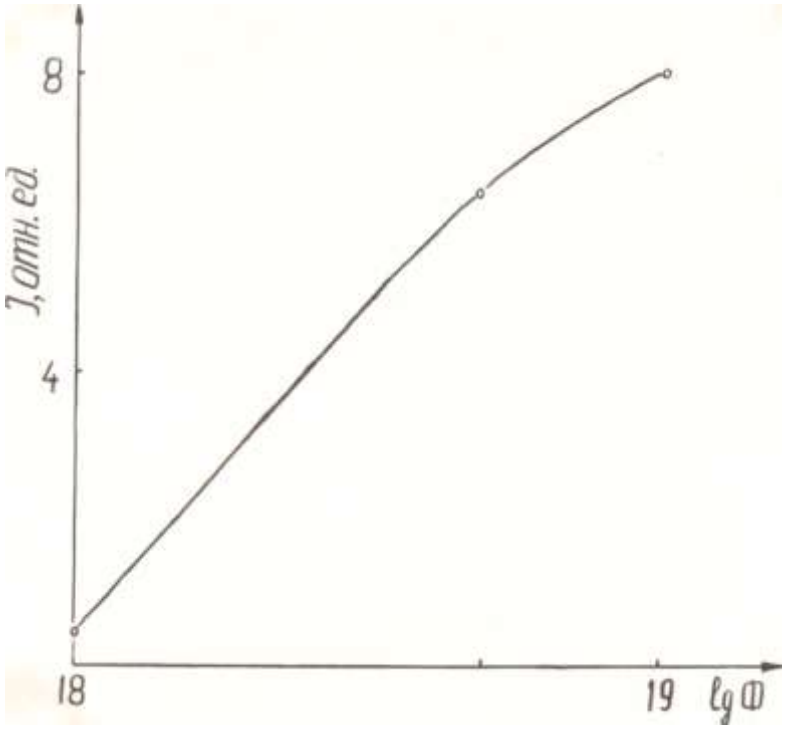

Fig.2. Dependence of the intensity of the EPR signal of the T-center on the radiation dose of the seeds.

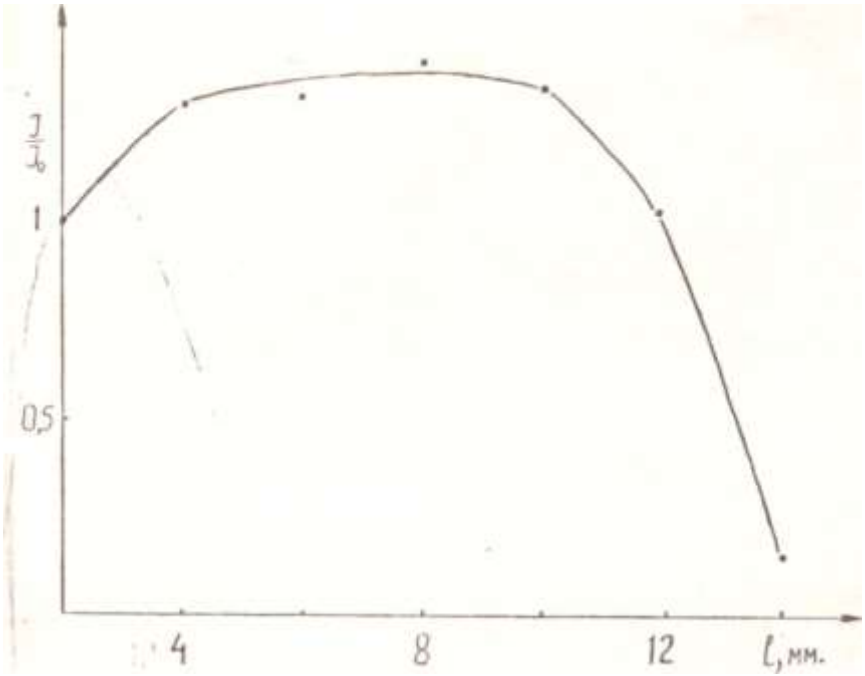

Fig.3. Distribution of the EPR centers of the T-center signal over the thickness of the overgrown layer.

Discussion of the results: Our experimental results show, that in all crystals which have been brought up on neutron irradiated seeds, the T-centers are observed. With growth of neutrons fluency the signal strength of T- centers is increased. The comparative researches have shown, that in all cases the signal strength of T- centre is much more in dark–smoky crystals, than in transparent. The comparison shows, that the increase of concentration of T-centers with fluency growth of seeds irradiation of crystals is qualitatively well coordinating to the data of the x-ray structure analysis [4] and results of luminescent researches [5].

Thus it's necessary to note, that to direct quantitative correlation between quantity of β - phase and concentration of T- the centers should not exist, as T-centre are formed in structure of β-phase of the quartz.

lt is known, that in crystals of quartz the smoky coloring is caused $[A1O_4]$-centre appearing for the account of isomorphic replacement of ions Si^{4+} by an impurity Al^{3+} [6]. In [7,8] is shown, that the entry Al^{3+} promotes creation E- centers in crystals $Si0_2$ under action of ionized radiations. Then according to model of T- centre (Fig.1) and data [6, 8] it's possible to assume, that different concentrations of $[A1O_4]$ and E-centers results to observable quantitative distinction of T-centers in dark and transparent samples. The research of spectra EPR has shown, that is valid in dark samples the intensity of signals from $[A1O_4]$ -and E'- centers more than in transparent crystals.

For study of laws of T-centers formation the spectra EPR of the usual neutrons irradiated crystals of quartz and crystals which have been brought up on neutron irradiated seeds, after an additional neutron irradiation are investigated. In spectra EPR of the usual crystals, irradiated with neutrons, in spite of the fact that in them the β phases exist, the T-centers are not found out. The additional irradiation of crystals of the quartz which has been brought up on neutron irradiated seeds, results to reduction of quantity of the T-centers. At fluencies of an additional irradiation 10^{18} n. sm^{-2} spectrum EPR from T-centre is not found out (Fig.2).

In [2] is shown, that in natural crystals of quartz T -centre are formed in those sites of a crystal, which grew at temperatures close to temperature of transition. Most of low temperatured

crystals do not contain T-centers. We for studying laws of distribution of T-centers on crystal thickness were investigated spectra EPR plates which have been cut out from an accrued layer in parallel seeds by thickness 2 mm. It is revealed, that up to the certain thickness, the concentration of T-centers is increased, and then falls Research of structure of crystals of the quartz which has been brought up on neutron irradiated seeds by a method, irradiated with neutrons, described in [9,11], has shown, that quantity of β-phase decreases with growth of thickness of the accrued layer.

For example, in crystals brought up on fluency irradiated neutrons 5.10^{19}, n. sm^{-2} seeds, quantity of - the β - phases in the first plate, thickness of 2-4 mm, which has been cut out from an accrued layer in parallel seed, are made by 48% from total amount of a crystal. In the third plate, i.e. in the accrued layer removed from seed on 6-8 mm of quantity of β-phase- 13% and in the fifth plate (10-13 mm) – the β- phase is not found out (Fig.3) [12].

Let's note that crystals of quartz on neutron irradiated seeds were grown up in usual P-T-conditions of growth for quartz. As in this case in the seed α and β –phases available, distinguished from each other in physic-chemical and structural parameters [6], it is necessary to expect, that the variation of phase structure of the seed will result to change of P-T-conditions of growth as a whole for a crystal. Therefore it is possible to assume, that the reduction of concentration of T- centers is caused by change of P-T of growth conditions with increase of quantity of β-phase.

On the basis of the above-stated data we consider, that in crystals of the quartz which have been brought up on neutron irradiated seeds, inherited with the accrued layer by the induced radiation phase is defective and display of paramagnetic T-centre is provided at the expense of change of P- T conditions of growth.

Conclusions: Thus, the received data show the opportunity of synthesis of stable in normal conditions of β-phase of quartz on irradiated seeds, i.e. opportunity of reception by hydrothermal method of crystals with the given structural characteristics.

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