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TREATMENT OF SILICA FOR THE NEEDS OF THE ELECTRONIC INDUSTRY

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The silica is one of the main raw material for the electronic industry. The requirement for silica are: high purity and fragment size. Usual native quartz is not of sufficient qualitative. This article proposes method for quartz processing. After processing the quartz can be used in electronic industry.

Key words: silica, electronic industry, defects, treatment

INTRODUCTION

The requirements for silica as a raw material for the electronic industry are related both to its purity and fragment size. The latter is necessitated in a view of certain hindrances in the operation of a silica smelting furnace. The silica concentrates contain monocrystal quartz or quartzites of purity higher than 99%. The Al_2O_3 content is determined within the range of 0.15–0.20%. The Fe_2O_3 content has to be lower than 0.05%. The presence of As, P and S is undesirable because they create an adverse gas phase in the furnace. The silica has to be resistant to high temperature so that it can be reduced in size when heated in the furnace. It is not admissible to use finely crushed silica since it changes the furnace gas circulation thus leading to a local gas compensation which can cause explosion in the furnace. The energy consumption varies between 12,000 and 14,000 KWh/t of the feed. The process runs at a temperature of 1500–2000°C. The silica feed should have a grain size of 20–150 mm. Therefore,

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quartz sand cannot be used for Si production. Sand pelletization is also considered to be unprofitable. From all that has been said above it follows that the requirements for the silica feed for the electronic industry are as follows:

1. Purity within the necessary requirements
2. Absence of defects which can break down the fragments during the silica processing into Si thus disturbing the operating mode
3. 20–150 mm fragment size.

The optical properties of quartz depend mainly on its purity and the presence of different kinds of defects. The Frankel and Schottky defects are of particular importance. These defects occur as a result of the thermal motion of the atoms building up the lattice. At any temperature there are certain atoms whose energy is much higher than the average energy of the atoms. At a given moment, the higher energy atoms may not only move considerably away from their equilibrium position in the lattice but may also overcome the potential barrier created by the neighbouring atoms and move to the interstitial space. As a result, two point defects occur: "interstitial atom" and "vacancy". The combination of these two lattice defects is called Frenkel's defect. If the atom, which leaves the lattice site, comes from the crystal surface, then the slight mobility of the Frenkel defects can result in a redistribution in the crystal depth that cause vacancy inside the volume without the presence of an atom in the interstitial site. Such vacancies are called the Schottky defects. The quartz colour depends essentially on the Frenkel defects, on their distribution in the volume and on the charge (positive or negative) of the atoms located in the interstitial site. The Frenkel defects can also be created by preliminary treatment of the material with high energy particles. When radiated with electrons, the defects exhibit a local character because of their low penetrating capacity. The gamma rays interact slightly with the nuclei of the substance. The interaction occurs mainly with the electrons released by these nuclei. The gamma ray energy should comply with the particular substance with the view to increasing the effective gamma cross-section. The interaction takes place within the whole volume of the treated material and the defects are evenly distributed thus avoiding their local character in other types of interaction. The gamma quantum energy, required for dislocating the atom and forming the Frankel defects, is determined by the energy of the photoelectrons and Compton recoil electrons. Therefore, under the action of gamma rays it is possible to recharge the lattice site atoms which have formed Frenkel defects. This will lead to a change in the material colour and hence, to a change in its optical properties.

MATERIALS AND METHODS

The quartz raw materials are represented by both monocrystal quartz and quartzites. In both cases coarse and fine size fractions are obtained thus requiring further treatment. With the coarse size fractions there is also a problem of assessing their stability during heating.

EXPERIMENTAL WORK AND DISCUSSION

The laboratory experiments were performed on a monomineral quartzite sample. A monomineral fragment was crushed to a size under 150 mm. The size fraction under 20 mm was separated. It was passed through a 0.16 sieve mesh. The two quartzite size fractions thus prepared were subjected to radiation treatment with gamma rays from Co 60, which has an energy of 1.33 MeV. An average sample was preliminarily taken from the two size fractions, ground to powder and chemically analysed. The values obtained for the admixtures are presented in Table 1.

Tab. 1. Chemical composition of quartzite's subjected to radiation treatment

Size fractions, mm	Content, %				
	Al_2O_3	Fe_2O_3	Cu	Au	S
+16; -20;	1.05	0.27	0.01	slight	0.02
+20; -150	0.16	0.10	0.01	no	0.02

The chemical analysis showed that the fines require a subsequent treatment. The size fraction over 20 mm was subjected to radiation treatment and the fines under 20 mm were washed and analysed again. After washing, the fines were subjected to radiation treatment. The colour of the samples was checked successively after radiation treatment with the following doses 0.1; 0.2; 0.3; 0.4; 0.5; 1.0; M rad. A change was observed in the colour of some grains after 1.0 M rad. In coarse fragments this tarnishing occurred in spots whereas in fine grains it was complete. The tarnishing started as slight greying, which gradually changed its nuance. It was interesting to observe that the increased radiation on the coarse fragments did not cause equalisation of colour, but only affected sections which changed (darkened their colour). The results obtained enabled us to continue our investigations on the treatment of processing plant quartz concentrates and separation of ore samples from quartzite's.

Quartz sand was used in conducting the experiments which is obtained as a waste product during ore treatment from the Brutes ore deposit in the Burgas ore region. As a waste product from flotation it has a size grading of +0.16; -0.25. The samples were subjected to radiation treatment with gamma rays from Co 60 which have an energy of 1.33 MeV. After homogenisation, the material was divided into 36 samples, which were grouped in 9 groups. Each group was subjected to radiation treatment with the following doses: 0.5; 1.0; 2.0; 3.0; 5.0; 8.0; 10.0; 25.0 M rad (1 rad = 10^{-2} Gy), respectively. 1000 grains of each sample were studied by means of a binocular magnifier. Fig. 1 shows the dependence of the ratio of tarnished to untarnished grains N_{untar}/N_{tar} on the radiation dose [D_r(M rad)].

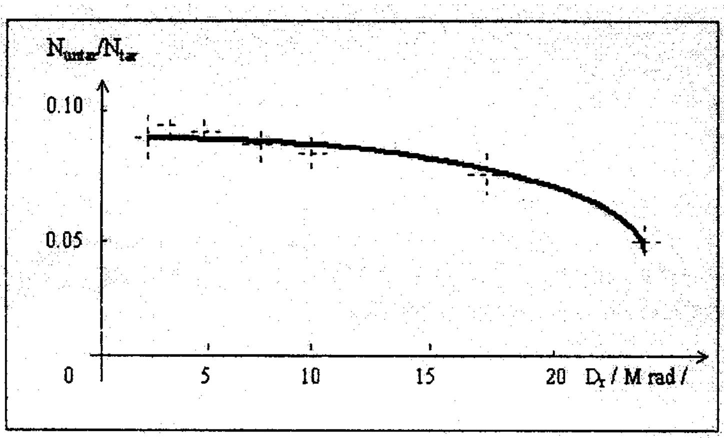

Fig. 1. Dependence of the ratio of tarnished to untarnished quartz grains (N_{untar}/N_{tar}) on the radiation dose [D_r(M rad)]

The analysis of the sample shows that, as a whole, the tarnishing increases with increasing the dose. At doses 0.5 and 1.0 (M rad) a change is observed in the sample colour, though visually it is difficult to differentiate the individual grains by colour. From the differential analysis shown in Fig.1 it can be seen that the ratio of tarnished to untarnished grains remains relatively constant for the different radiation doses. It can be concluded that the tarnishing of the samples as an integral characteristic of the properties of the different doses, is due only to certain grains which change their colour at different doses. A smaller part of the grains preserve their qualities regardless of the radiation doses. Part of each sample was subjected to dry roll electric separation. Separation in size fractions depending on the radiation dose was not observed. Since the electric separation proved to be unusable for separating the tarnished from the untarnished grains, a laboratory optical separator, constructed on the laser beam principle, was used. The separation of the untarnished quartz grains was effected by using this separator. These proved to be the grains without defects. On this basis, a standard optical separator was proposed to be used for separating quartz with grain sizes +15 mm; -20 mm. This separator managed to separate single spotted grains from the unchanged ones, which proved to be high quality quartz. The latter was established by analysis. A well-coloured (purple) amethyst was subjected to radiation treatment with gamma rays. The amethyst lost its colour bur remained dull.

CONCLUSIONS

The results of the studies showed the possibility for increasing the quality of quartz concentrates used for special applications by their preliminary radiation treatment with definite gamma ray doses.

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Krzemionka jest jednym z głównych surowców stosowanym w przemyśle elektronicznym. Wymagania stawiane krzemionce są następujące: wysoka czystość i odpowiedni kształt. Najczęściej mineralna krzemionka nie spełnia tych jakościowych wymogów. W pracy przedstawiono proces przeróbki krzemionki przez jej naświetlanie promieniami gamma. Po przeprowadzenie procesu napromieniowania krzemionka była wzbogacana w laboratoryjnym separatorze optycznym, a uzyskany materiał może być użyty przez przemysł elektroniczny.