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Synthesis of eulytite ($Bi_4Si_3O_{12}$) crystals in the hydrotermal solutions with different compositions

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Eulytite ($Bi_4Si_3O_{12}$) is one of the rarest minerals in a nature. It occurs in the albitized pegmatites in the tetrahedral crystals form and crust around tantalum grain in the Caucasus, find out together with quartz and native bismuth in the Shneeberg and Johanngeorgenstadt (Germany), in the Banat (Rumania), single finding – in the France and Western Australia [*Mineralogical tables,* 1981; *Mineralogical encyclopedia,* 1985; *Minerals, Reference book*, 1972].

Crystals of eulytite are uses for scintillator in the high-energy physics, computer tomography, dosimetry. One of the most promising materials for these purposes is a single crystal bismuth orthogermanate with the structure of eulytite. However, eulytite has better scintillation properties compared with bismuth orthogermanate (e.g., its decay time (0.1 ms) is 3-fold higher), but because of the difficulty of growing eulytite single crystals from the melt (due to high viscosity) the problem remains unsolved. It is well known that in modern science and technology there is a clear trend to replace the single crystal materials with the ceramic ones obtaining in fact the same or even improved functional characteristics. The technology of optical ceramics, compared with the technology of single crystals grown from the melt, has several additional advantages. A breakthrough in technology of oxide ceramics has been achieved only in the last decade. This was facilitated mainly by the use in their manufacturing powders as initial oxide components.

It is known that the ceramics of optical quality are produced by pressing small natural or synthetic crystals [*Basiev, et al.,* 2008]. We believe that the ceramics obtained from crystals of bismuth orthosilicate that we grow, will have better scintillation characteristics than the ones obtained by direct sintering of the initial oxide components.

Previously eulytite was synthesed in NaOH [*Litvin, et al.,* 1968], but subsequent researches in this field don't carried out. Eulytite crystals in ammonium fluoride and hydrogen peroxide we grown in a first time in the world. The analysis of the results of our researches has shown that hydrogen peroxide is the most perspective solvent for eulytite synthesis. So long as in the system unavailable elements, which incoming in composition of eulytine, these automatically solve a problem of impurities of dissolvent in obtained crystals. The given problem faced rather critical, so far us very difficult to separate obtained crystals from environment of growth, not allowed their contamination of dissolvent elements (Na or F).

Synthesis of the eulytite was carried out by hydrothermal method at temperature of 250–260˚C and pressure 500 bars. High-temperature autoclaves have volume of 250 ml. Use of contact Teflon fettle was feature of the technique applied by us, allowing to exclude ingress of the elements containing in a steel of autoclaves in a solution. Starting material was stoichiometric mix of Bi_2O_3 и SiO_2. The fine crystalline eulytite got in experiments with duration from 10 to 60 days. We carried out experimental researches to crystals of eulytite in the alkaline (NaOH), fluoride (NH_4F), hydrogen peroxide (H_2O_2) solutions. The best results have been received at growth of crystals in solutions NaOH with concentration from 5 to 20 wt %, NH_4F concentration 1 and 2 wt % and H_2O_2 concentration from 2 to 5 wt %. X-ray patterns show the presence of eulytine eumorphic crystals virtually without admixtures of other minerals. It is especially pronounced at growth of eulytite in a solution of hydrogen peroxide since in the system absent elements strange in composition to eulytite.

The research of obtained crystals by means of electronic-scanning microscope has showed that eulytite crystals grown in different solutions have tetrahedral habitus, but generally that's crystals aggregates with vague marked faces. Habit which is similar to natural one at the most has patterns grown in hydrogen peroxide. (fig.1, 2)

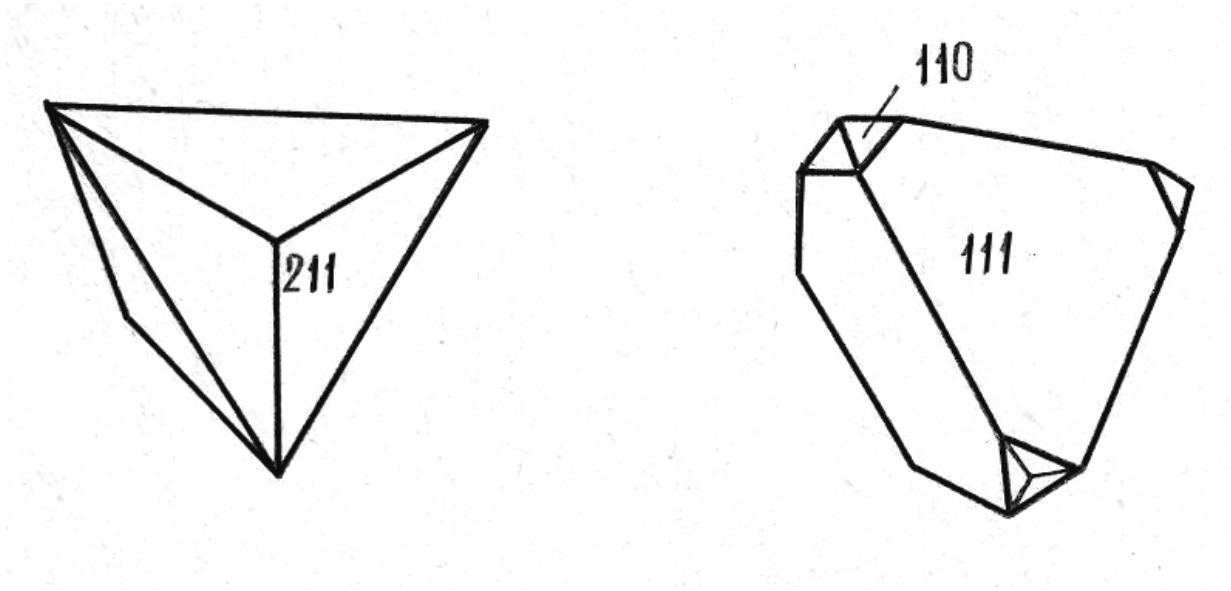

Fig.1. Crystals habit of eulytite is from field Shneeberg (Germany) [*Shulgin, et al.,* 1992]

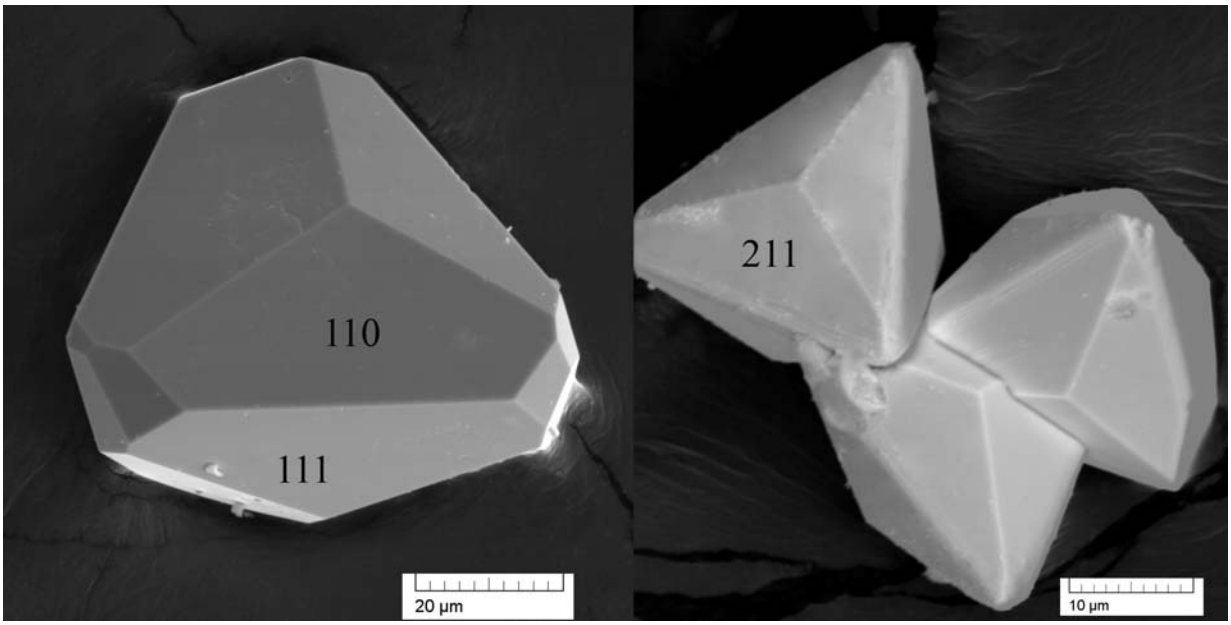

Fig.2. Eulytite crystals synthesized in hydrogen peroxide (by scanning electron microscopy)

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