

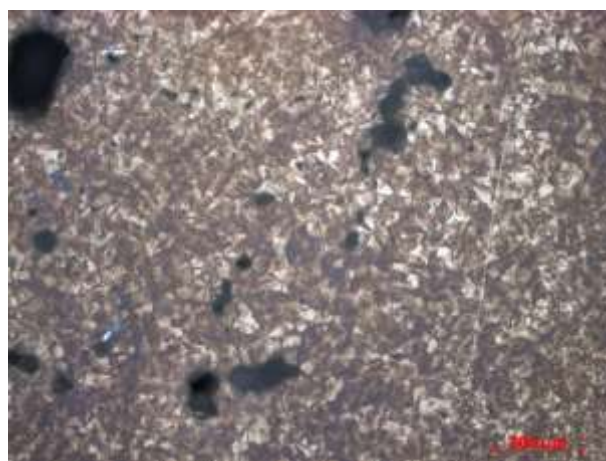
The analysis of the microstructure of S2-s9 samples after annealing shows a multiphase character, as was noted in the X-ray phase analysis. At the same time, the structure of samples S2 (Fig. 4a) and S5-S9 (Fig. 4e-h) has a similar character and consists of dark gray crystals close to the lamellar structure, and a "substrate" - a lighter background. At the same time, the S9 will still have some differences, since it is the only one heated above the melting point. It has large pores (Fig. 4g), much larger in size than the rest of the samples, and an inhomogeneous "substrate", where lighter areas are visible (Fig. 4h).

Sample S3 (Fig. 4b) stands out from the overall picture; like S2, it was annealed at a temperature of 680 °C, but for a much longer period (180 minutes). It consists of grains tending towards equiaxed shape, visually consisting of a "fan" of plates growing from a single center. This structure is characteristic of the metastable phase Bi_2SiO_5 , which is fully confirmed by the XRD results. At the same time, no amorphous component is visible in sample S3 (usually, in such types of thin sections, it is represented by light, unetched areas). This may also be due to the heterogeneity of the sample, when the samples taken for XRF and microanalysis may differ in composition.

Sample S4 will also differ, exhibiting a visually more uniform fine-grained structure in some areas, with numerous small and large pores (Fig. 4c). In other areas, this structure will be supplemented by large plate-like crystals, similar to those in samples S2, S5–S9. According to XRD data, this sample contains more than 80 % Bi_2SiO_5 . However, no characteristic plate-like or dendritic-like structure, as, for example, in reference [25], was found. All these differences, as well as those discussed above, can be explained by the heterogeneity of the sample, which was not fully melted and homogenized during synthesis. Therefore, the areas selected for X-ray phase and microstructural analysis, even within a single annealing cycle, may have had some differences. At the same time, the primary goal of the work was to investigate the possibility of obtaining stable $\text{Bi}_2\text{Si}_3\text{O}_9$ through simple annealing from an amorphous state.



a



b

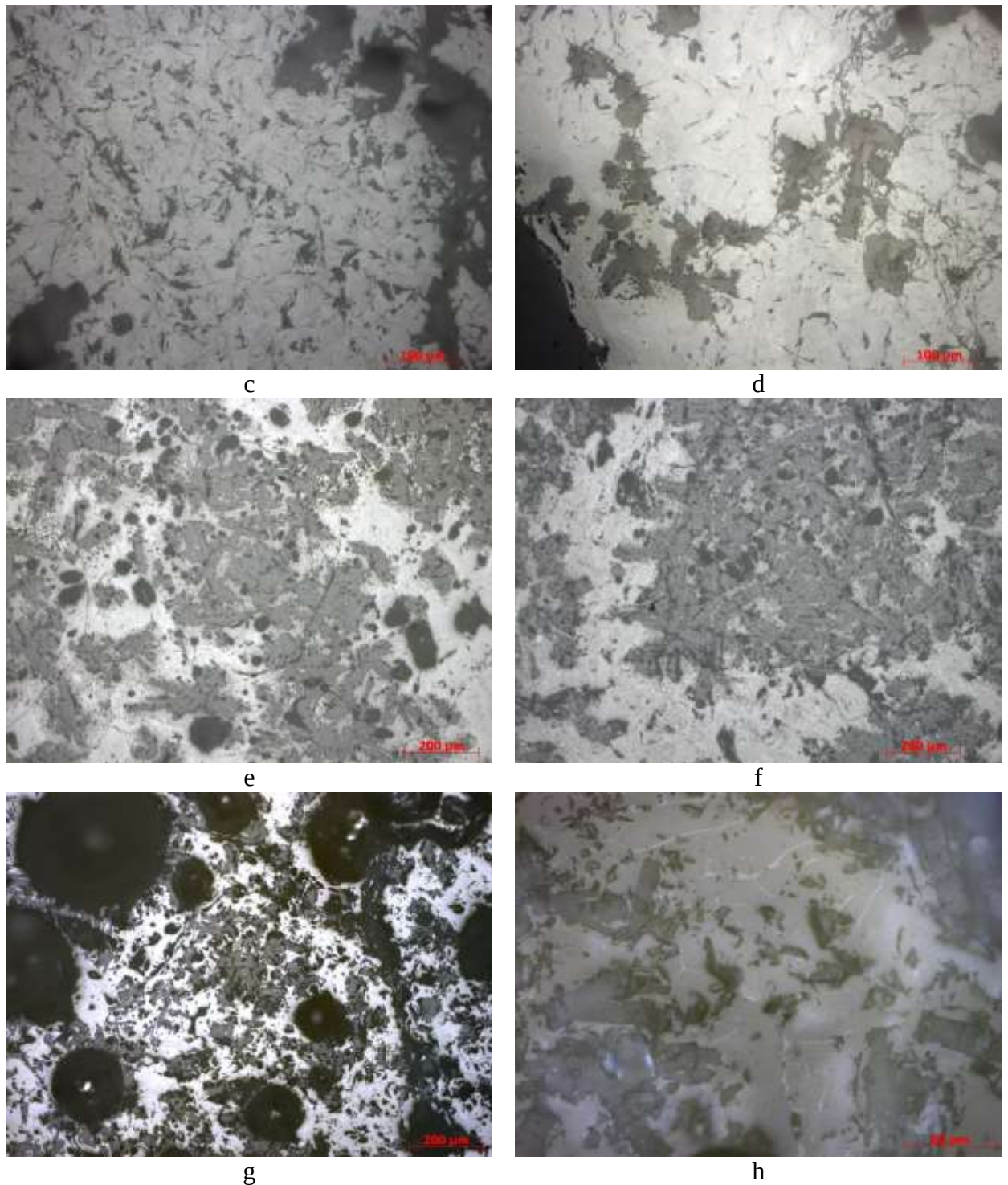


Fig. 4 – Microstructure of the samples: a - S2 (annealing 680 and 15 min, x100), b - S3 (annealing 680 and 180 min, x100), c - S4 (annealing 700 and 30 min, x200), d - S4 (annealing 700 and 30 min, x200), e - S5 (annealing 830 and 15 min, x100), f - S6 (Annealing 830 and 180 min, x100), g - s9 (annealing 1050 and 30 min, x100), h - s9 (annealing 1050 and 30 min, x500)

When studying the microstructure, it was noticed that the bulk of the sample consists of grains in the form of polyhedra (Fig. 7a, b), which is characteristic of the $\text{Bi}_2\text{Ge}_3\text{O}_9$ compound and is confirmed by the results of X-ray diffraction, in which this phase is the main one (Fig. 5).

The edge samples on the microstructure, which are light in macro photography (Fig. 6d), also stand out vividly (Fig. 7c, d) and have a very small structure that is difficult to distinguish

even at x500 magnification. At high magnifications of the optical microscope, there are strong distortions and the image quality drops significantly. We obtained similar sites in the structure on the samples in [12]. However, there, thin glasses obtained by quenching a melt between two copper plates were used for annealing. Here we also use more massive glasses obtained by casting a heated platinum substrate.

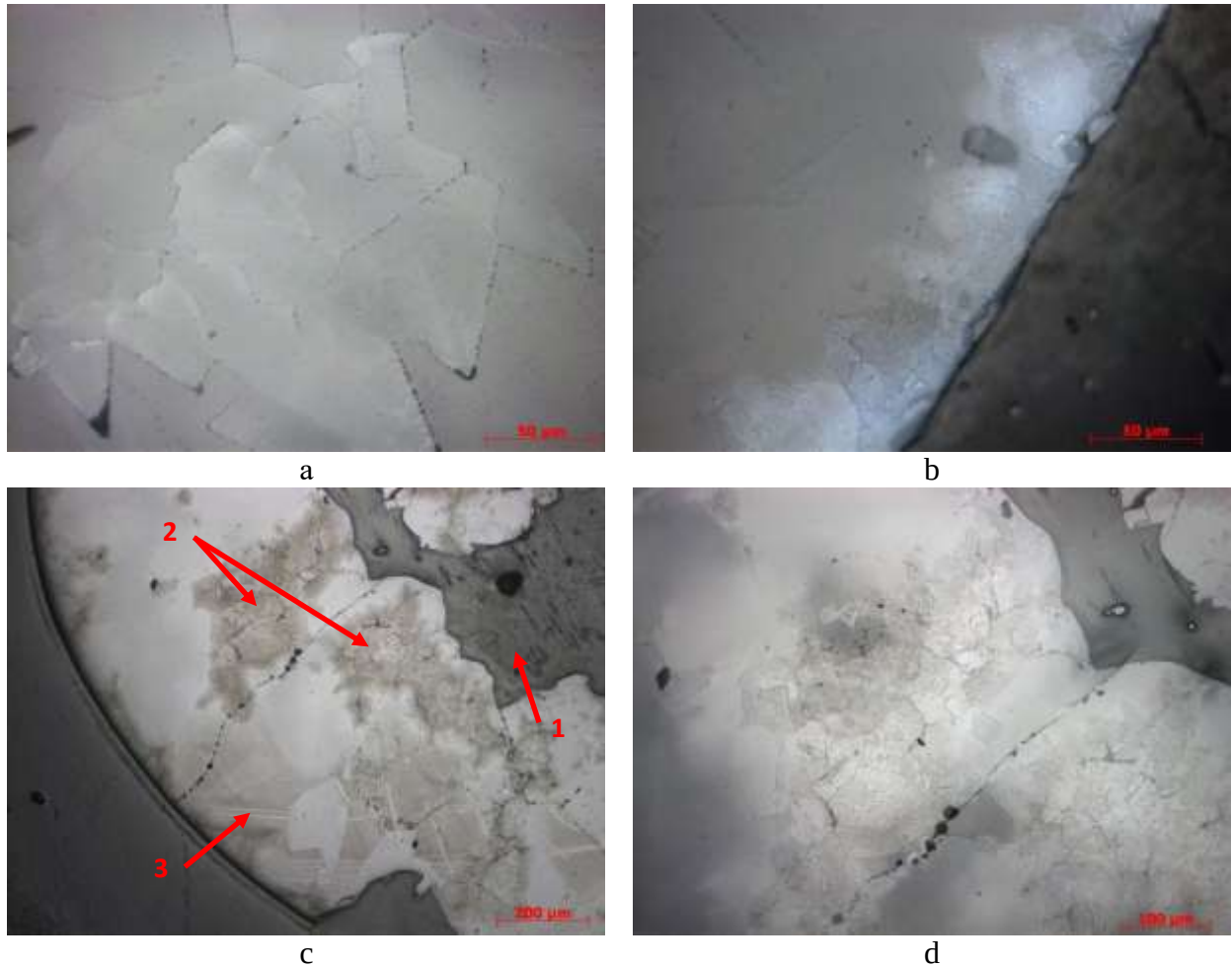


Fig. 7-Microstructure of the G3 sample (annealing 820 ° C, 1 h): the main volume of the sample is x500 (a), the light edge of the sample in one of the x500 (b) sections, the light areas in the main volume with an increase of x100 (c) and x200 (d). 1 is a large pore, 2 is " light areas " of the structure, 3-etching defects

Areas with a structure different from the main volume ($\text{Bi}_2\text{Ge}_3\text{O}_9$), indicated in the photo by the number 2, were found not only from the edge of the slot, but also in the central part of the sample (Fig. 7c, d). The number 1 indicates large pores, 3 – etching defects. According to the RFA data, the samples contain 1.84-9.15 wt. % of the impurity phases are $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ and GeO_2 . It can be assumed that it is in these sections of the structure formed at the edges and partially in the center (Fig. 7c, d) that these phases will be contained.