STRENGTH OF GLASS CERAMIC S0115M AND ITS JOINTS BASED ON OPTICAL CONTACT


Optical glass ceramics are finding more extensive use in the optomechanical industry. Among these, glass ceramic S0115M [1], whose structural strength has not been studied sufficiently, is of considerable interest for its technological and optical properties. In order to evaluate the possibilities for using this glass ceramic in certain critical articles of new technology, it is necessary to have experimental statistically based data for strength in tension and compression. The lack of these data is connected to a considerable extent with the complexity and difficulty of accurate determination and the necessity of using new special test procedures for materials of the glass and glass ceramic type.

In instrument building, articles made of glass and glass ceramics are joined by means of optical contact (OC), in which a bond between high-precision polished surfaces of the elements being joined is due to forces of molecular interaction.

During operation these joints receive different loads. However, there is little information in the literature about the resistance of OC articles made of glass ceramic S0115M to tension, which is one of the most unfavorable forms of loading. This question may also be of considerable importance, since in fracture mechanics there is the well-known Leonov and Panasyuk model [2] for the limiting condition, which is based on the fact that in the end zone of a crack between its sides there are molecular forces of interaction depending on the distance between the sides. Experimental data on the magnitude of these forces are not given.

Fig. 1. Specimen of optical glass ceramic waisted in the gauge length in order to determine strength with axial tension.

Fig. 2. Diagram of the device for testing waisted specimens of optical glass ceramic under conditions of axial tension: 1) grips; 2) brittle material specimen; 3, 6) split sleeves; 4, 7) fixed sleeves; 5) split collars.
The aim of the present work is a study of the strength of glass ceramic S0115M in tension and compression, and also strength in tension of articles made of this glass ceramic joined by means of OC in relation to certain structural parameters of the joined elements.

Tests were carried out under axial tension conditions on cylindrical specimens of variable cross section (Fig. 1) whose loading was accomplished by means of the device shown in Fig. 2. Axial compression tests were carried out by a previously developed procedure [3] on cylindrical specimens 10 mm in diameter and 30 mm long. With the aim of obtaining comparable data the gauge lengths of specimens for testing in axial tension and compression were treated with a diamond tool to a microroughness height $R_z < 0.63 \mu m$. The cylindrical surfaces of parts 1 and 2 of assembled specimens (Fig. 3) for determining the strength of joints based on OC had a similar finish. The end faces of 1 and 2, which were joined by means of OC, were treated by the method of deep grinding and polishing in accordance with RTM 3-46-70 to a surface roughness of $R_z \leq 0.05 \mu m$ and the third class of finish according to GOST 11141-65.

The reliability of OC joints is due to a considerable extent to the degree of unevenness for the joined surfaces. In view of this, the overall inaccuracy of flatness for the zone $N = 0.5$, and the local inaccuracy $\Delta N \leq 0.2$. Surface quality was monitored in an interferometer IT-100. Before assembly the surfaces of specimens 1 and 2 being joined (Fig. 3) were degreased in an alcohol-ether mixture, and complete removal of fatty spots,