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Letters to the Editor

Birefringence changes in barium-silicon glasses under the influence of photothermal processing*

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As it is well-known the birefringence distribution stabilizes within the transformation region, which is the region of transition from the fluid into steady state. For the barium-silicon glasses the region of transformations occurs between 823 K and 933 K, i.e. from the viscosity equal from 10^{12} to $10^{16.5}$ kg/m·s [1].

The mechanically and thermally induced changes in birefringence introduced within the above temperature range are practically irreversible in the lower temperature as the relaxation time is very long (of order of years). On the other hand, the birefringence changes induced mechanically or thermally below the lower limit of transformation are reversible.

During examination of the interaction of the radiation with the barium silicon glass previously subjected to stress we have observed that by illuminating these glasses with UV- or γ-radiations within the 293–373 K temperature range some steady changes of birefringence may be obtained.

In our experiments the Bak-102 optical glass has been used. The samples of the dimensions: $2a = 50$ mm, $b = 50$ mm, $c = 100$ mm were stressed and next the birefringence distribution along the x-axis was measured (fig. 1).

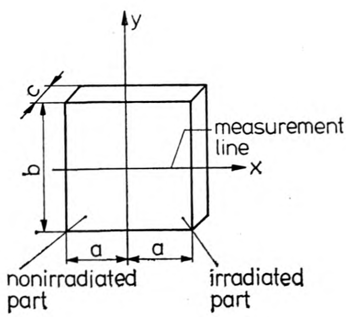

Fig. 1. Orientation of the sample during the experimental

As a measure of birefringence at a definite point we have assumed the difference of refractive indices of the slow and quick rays, respectively, i.e.

$$W = n_0 - n_e.$$

The birefringence distribution has been measured with the help of PKS-125 polariscope by the Senarmonte method. The measurement has been carried out at the room temperature always after seasoning, which consisted in keeping samples in the steady 393 K during several days.

The samples were subjected to the photothermal processing:

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Sample No. 1

a. A half of the sample has been irradiated with the UV-radiation. The plane dividing the sample into the nonirradiated and irradiated parts was perpendicular to the line along which the birefringence has been measured (fig. 1). During the irradiation the nonirradiated part of the plate was covered with a metal foil and was subjected to the same thermal treatment as the irradiated one. The sample was irradiated with the HBO-200 lamp of the Zeiss make, during two hours at room temperature. The changes in birefringence distribution have been observed within the sample before (continuous curve), and after irradiation (broken curve) (fig. 2). The ordinate axis represents the values of birefringence *W*, while the abscissa axis shows the distance of the measurement points from the middle of the sample. The result obtained is similar to those obtained for the other barium-silicon glasses and published in [2].

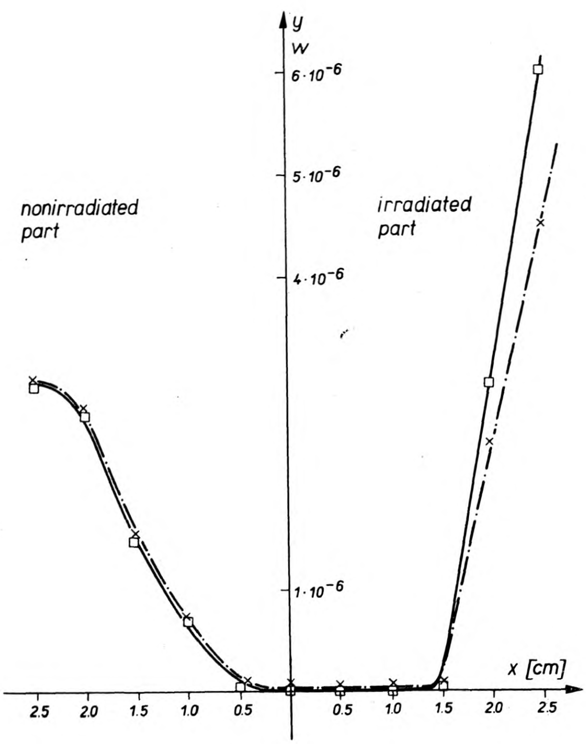

Fig. 2. The distribution of birefringence in the sample No. 1 before and after the irradiation with the UV-radiation
□ before irradiation, × — · — after irradiation

b. Same part of the sample was again irradiated with UV-radiation at the temperature 473 K in the course of 0.5 hour. No changes in the birefringence distribution have been observed.

c. The transmission of the sample before and after the irradiation was measured. The results shown in fig. 3 allowed to state a reduction in the sample transmission after irradiation.

The stabilization of glass increases with the increase of its density, modulus of elasticity and refractive index, whereas its transmissivity lowers [1]. It seems that the glass excited from the equilibrium state by the quantum interaction of the UV-irradiation returns to the state of greater equilibrium; the stress diminishes the birefringence and the transmissivity become smaller, too.

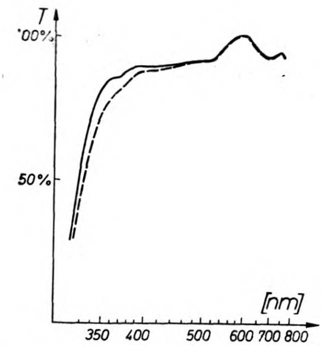

Fig. 3. The transmissitivity of sample No. 1 before (continuous curve) and after (broken curve) irradiation with the UV-radiation

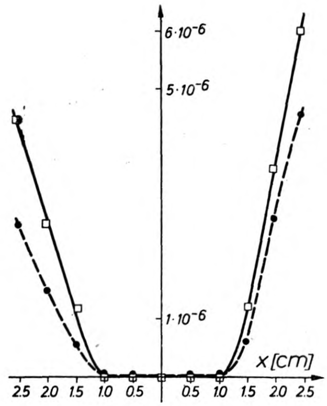

Fig. 4. The distribution of birefringence in the sample No. 2 before and after the irradiation with γ-radiation □ — before irradiation, · — · — after irradiation

Sample No. 2

a. The sample stressed pretty symmetrically has been UV-irradiated at room temperature, during 2.5 hours The birefringence distribution remained without unchanged (fig. 4).

b. The whole sample has been irradiated once more at the 473 K during 0.5 hour. No changes in the birefringence distribution were induced.

c. Then the right part of the sample was subjected to UV-radiation at room temperature for 1 hour. No changes have been observed.

d. The sample was subjected to γ-radiation ($\gamma = 0.9$ Mrad) at the room temperature for 1 hour. The decrease of birefringence was non-symmetrical, being smaller at the part subjected to UV-irradiation for a longer time. The result is presented in fig. 4.

Sample No. 3

a. The whole stressed very non-symmetrically (fig. 5) was irradiated by UV-radiation during 1.5 hour at the room temperature. No changes in the birefringence distribution have been observed.

b. A UV-irradiation of the sample in its part with greater stress at the room temperature during 1 hour has not introduced any changes.

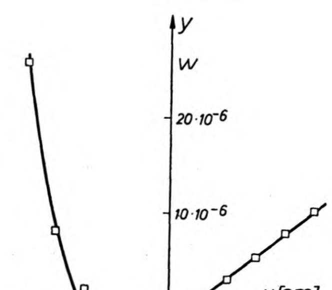

Fig. 5. The birefringence distribution in sample No. 3

Sample No. 4

a. The whole sample has been subjected to γ-irradiation (0.9 Mrad) for 1 hour, at room temperature. A considerable reduction of birefringence at the plate edge was stated (fig. 6).

b. The whole sample was irradiated with the UV-radiation during 2 hours at the room temperature. An increase in birefringence at the plate edges was observed.

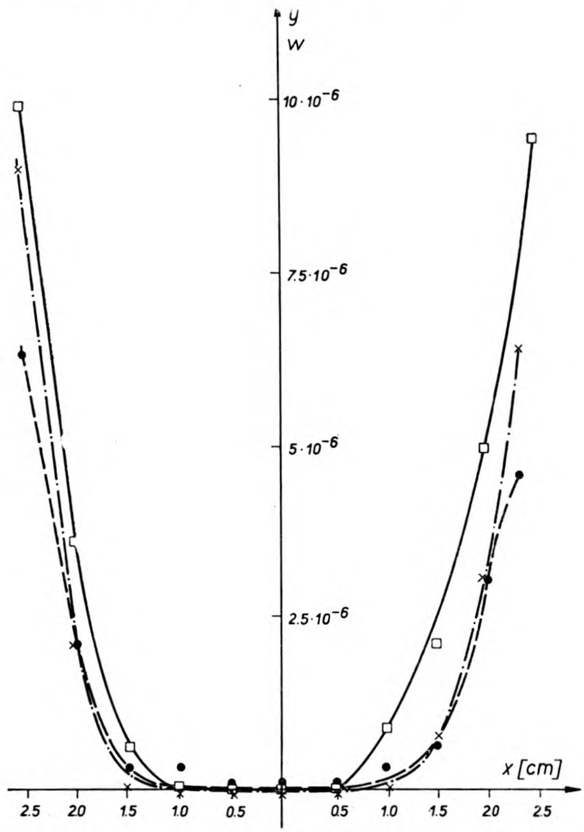

Fig. 6. The birefringence distribution in sample No. 4 before and after the irradiation with the γ-and UV-radiation
□ — before irradiation, · — · — after γ-irradiation , × — · — after UV-irradiation

c. The sample was once more subjected to the UV-radiation at the temperature 473 K during 3 hours, but no changes in the birefringence distribution have been induced.

No results have been obtained by illuminating non-stressed samples.

The optical induction of the birefringence samples observed in some electro-optic crystals and has been called photobirefringence [3]. The photobirefringence — as it was stated in [4] — is connected with electro-optic internal effects. By choosing the proper quantities and directions of the external field the effect of photobirefringence may be compensated.

The photobirefringence depends upon the internal field of still unclear nature (comp. [5]).

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