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Communication

*Elżbieta Pawlik, Stanisław Gębala**

Change in birefringence due to UV-irradiation in some optical glasses**

As it is well known the temperature interval 713–833 K is for the borosilicate glasses a range of transformations, the end values of the range being individual for each sort of glass. Only within this range of temperature the irreversible changes in birefringence may be introduced both thermally and mechanically. The thermally or mechanically introduced changes in birefringence below the lower limit of the transformation range are reversible (temporary) [1]. In this paper a newly discovered phenomenon of permanent change in birefringence in some optical borosilicate glasses is reported which occurs due to UV-irradiation at the temperature of 293 K.

The following optical glasses has been used in the experiments: Bak 4, Bak 104, BK 7, and Bak 2. The sample sizes were: $2a = 500$ mm, $b = 50$ mm, and $c = 10$ mm. The samples were stressed and next the birefringence distribution along the x-axis was measured (fig. 1).

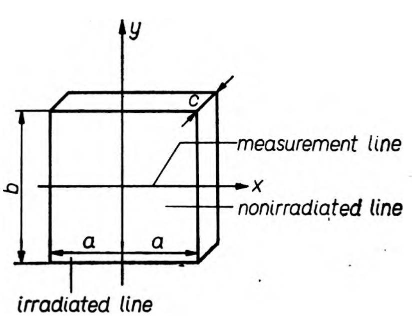

Fig. 1. Sample orientation during the experiment

As a measure of birefringence at a definite point the difference in refractive indices for the slow and speedy rays, respectively, has been assumed [2, 3]

$$W = n_w - n_s.$$

The birefringence distribution has been measured with the help of a PKS-125 polariscope by the Senarmonte's method. The measurement has been performed at 293 K always after seasoning, which is here meant as keeping the samples at the constant temperature of 253 K for a couple of days. The birefringence distribution being measured one half of plate was exposed to the UV-radiation. The plane dividing the plate into irradiated and nonirradiated parts is perpendicular to the line along which the birefringence was measured (see fig. 1). During the irradiation the nonirradiated part of plate was protected by a metal foil being subjected to the same thermal influences as the part exposed. The samples were illuminated with a HBO-200 lamp of Zeiss make for 1.5 hours without any additional heating.

After several day seasoning of the samples the birefringence value was measured at the same points as before. A change in birefringence distribution in the examined samples has been observed.

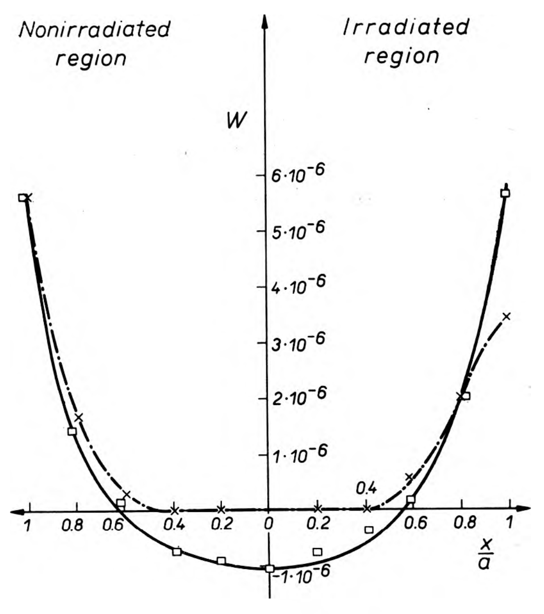

Fig. 2. Birefrigence distribution in Bak 2 before (solid line) and after (broken line) UV irradiation vs. relative distance from the sample centre □ – after irradiation, × – before irradiation

The results of measurement for the Bak 2 samples have been shown in fig. 2. It presents the birefringence distribution in a sample before (full curve) and after (broken curve) irradiation. The right hand side of the figure shows the birefringence of the nonirradiated part of the sample, while the left hand side presents that of irradiated part. The values of birefringence W are represented on the ordinate axis the distance x of the measurement points from the middle of the sample divided by the half of the side length a of the sample being shown on the abscissa. At the irradiated edge of this part of the sample birefringence diminished from 5.7×10^{-6} down to 3.4×10^{-6}.

* Institute of Physics, Technical University of Wrocław, Poland.

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A birefringence decrease was also observed in the central part of the sample. However, for the value $x/s = 0.6$ we observe an increment in the birefringence. The changes in the birefringence occur also in certain part of the nonirradiated region.

For better comparison of the birefringence distributions in the Bak 2 glass before and after the irradiation a relative birefringence distribution has been drawn in fig. 3. Similarly as in fig. 2, the relative distance from the sample center has been laid out on the abscissa, while the ordinate represents the values of birefringence normalized to the maximum values of birefringence, i.e. to the values of birefringence at the sample edges. $W(x)/W(a)$ denotes the ratio of birefringence value within the considered interval x to the value of birefringence at the edge of the sample. This refers to both the irradiated and non-irradiated parts of the sample. The curves have been normed separately before and after the irradiation.

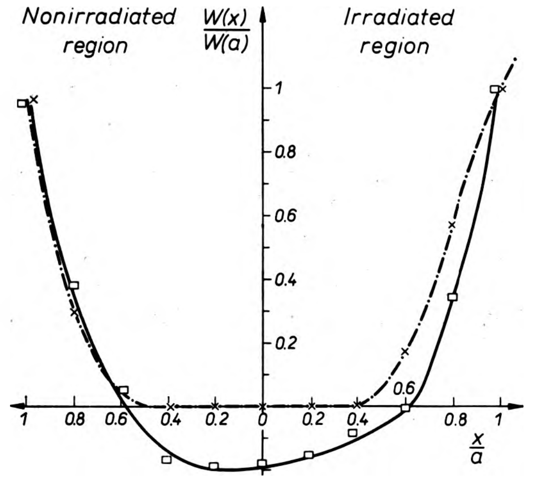

Fig. 3. Relative birefrigence distribution in Bak glass before (solid line) and after (broken line) UV irradiation vs. relative distance from the sample centre
□ — before irradiation, × — after irradiation

For the glasses Bak 4, Bak 104, and BK 7 the birefringence distributions before and after the irradiation as well as the normed curves have similar runs to those presented for Bak 2 glass. At the irradiated edges of the samples the values of birefringence decreased as follows:

for the BK 7 glass from 8.3×10^{-6} to 5.2×10^{-6},
for the Bak 4 glass from 17.5×10^{-6} to 15×10^{-6},
for the Bak 104 glass from 7.8×10^{-6} to 5.3×10^{-6}.

The same samples were heated at 373 K for 1.5 hour and after their seasoning the birefringence distribution has been measured along the border examined formerly. No change in the birefringence distribution was observed. The parts irradiated before have been reirradiated keeping the glass during irradiation at temperature of 373 K. The glass being seasoned the birefringence distribution was measured. This time any change in the birefringence distribution has not been observed, either.

The results reported in this paper allow to state the changes in the value of birefringence and its distribution occurring in the stressed optical glasses exposed to UV-irradiation. The work presented in this communication has a preliminary character. Further and broader investigations will be carried out.

References

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