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Zygmunt Bilewicz *

A Proposal for New Criteria of Striae Classification in Optical Glass for the Shadow Method

The contents of this report are results concerning the determination of vital conditions which may influence the visibility of striae in the shadow projection method of striae estimation.

The outcome of this work is a proposition for Polish Standards of glass classification in respect to its striae content.

The research was based on a reconstruction of setups from Soviet, Czechoslovakian and Polish Standards.

Apart from that, I carried out tests on my own setup, which after some modifications proposed by doc. Florian Ratajczyk became a proposal for Polish measurement setup.

Generally speaking, every setup for the study of glass striae content by the shadow projection method makes use of the fact that the striae disappear in certain conditions and is based on: 1) a light source, 2) the studied glass, and 3) a screen, realized differently in different standards and placed at different distances a, b, c between them.

So it may be assumed a priori that the visibility of striae is determined by the receptor, physical and geometrical properties of the light source, the distances a, b, c between the elements I, II and III, and by the glass grade and its position.

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Despite the advantages of the photoelectric methods of image recording I decided to use the photographic recording because of its simplicity and character similar to that of visual observation.

Fixing all but one of the studied parameters I obtained the following results:

1. The intensity of illumination is determined only by the recorder operation threshold and does not influence the striae character. In subjective observations the intensity should be within the limits of 50 — 150 Lx.
2. The effect of the light being monochromatic is observed only in those striae images whose character is distinctly diffractive. Since the optics made of tested glass operates, in principle, throughout the whole visible spectrum, further study was carried on using the "white" light.
3. The dimensions of the light source proved to be one of the vital factors determining the striae image.

With the distances a and b fixed at 500 and 250 mm,

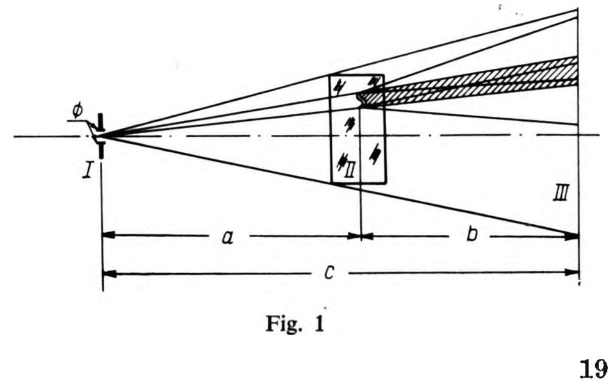

Fig. 1

respectively (see Fig. 1) I changed the dimensions of the circular light source which was an image of Phillips M8 6V 16—17A incandescent bulb overcovering calibrated apertures of $\Phi = 0.5, 0.75, 1.00$ mm and so on up to $\Phi = 3$ mm. It turned out that observable differences between the striae images appeared at about 25% change in the diameter.

Distinctly observable changes were determined by a geometric sequence of the aperture diameters with the sequence quotient equal to the $\sqrt{2}$; the diminishing of the diameters causing the appearance of more and

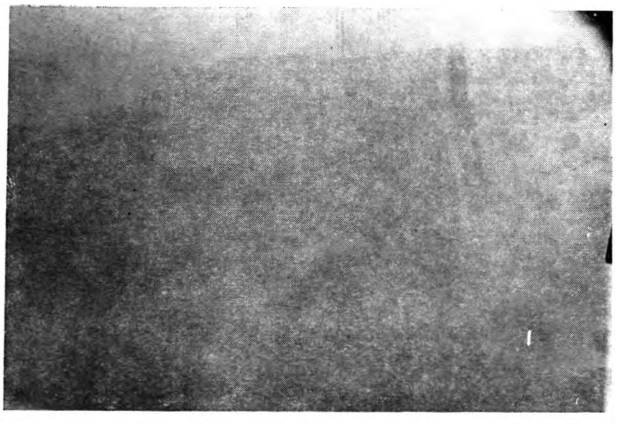

Fig. 2 a

Fig. 2 b

Fig. 2 c

more striae with improving contrast (see Fig. 2 $\Phi = 2.8, 1.4, 0.7$ mm)

4. Also the shape of the aperture had a distinct effect on the character of the formed image.

The application of a rectangular aperture of dimensions 4×0.5 mm and turning it around the axis of the system in a plane perpendicular to the axis revealed that the striae visibility improved distintly as the striae were set in parallel to the longer side of the rectangle. The changes being noticable at such alterations of the slit angle for which 20 — 25% increase in the slit width was observed (transversely to the beam).

5. With changing distances $a = 50, 100, 150$ and so on up to 500 mm at constant distance $b = 70$ mm between the screen and the specimen the visibility changed and the striae contrast improved at about 25% rise in the distance, similarly as in the third series of tests.
6. On the other hand, the visibility of the striae was found to depend on the screen-specimen distance in a very complicated way. For small distances ($b = 50 \div 100$ mm, $a = 250$ mm) a slight increase in the distance caused a rapid increase in the number of striae and in their contrast. (Fig. 3 $a = 250$ mm; $b = 50, 100, 200, 1000$ mm). For greater distances ($a = 250$ mm, $b = 500 \div 1000$ mm) an increase in the distance caused a slight decrease or, in some cases, a rise in the contrast. Presumably there exists an optimum distance, different for different kinds of striae, for which the striae contrast is maximum.
7. Similarly, by turning the studied glass block around the perpendicular axis, irregular changes were developed, without an orderly dependence on the angle of rotation.

The similarity of the results obtained from tests with changing a and Φ allows to conclude that the visibility of the striae, their contrast and observability depend, first of all, on the ratio of the circular light source diameter to the distance "a" between the studied glass block and the source (see Fig. 4 $\Phi/r = 0.5/125, 1/250, 2/500$ mm/mm).

I propose to regard this quantity as an essential criterion of dividing glasses into categories in respect to the striae content.

If we based ourselves on the sequence of doubled diaphragm surface areas, often used in photographic practice, then for an assumed distance, e. g. $a = 1000$ mm, we would have to deal with a striae classification which enabled us to compare different standards (see Fig. 5).

It turns out that there is no simple correlation between these categories.

Since the criterion of striae classification is based on the subjective (visual) estimation of striae disappearance, the limits of this classification are not sharp and do not allow too fine a classification. Also the ununivocality of estimation that follows from small difference, in some standards, between the distance a and thickness of the studied block speaks for broadening the "spacing" between categories.

Therefore, I propose the division into categories marked by squares on the scale in Fig. 5. The proposition is the more justifiable as the quality of glass markedly depends on the number of week striae, which are not detectable in the regions of currently accepted standards in Poland.

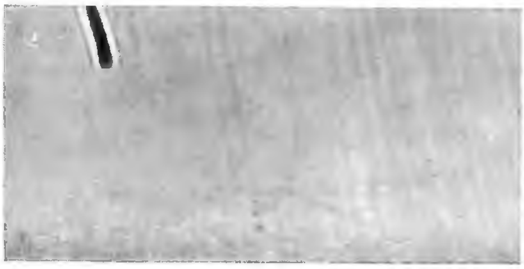

Fig. 3 a

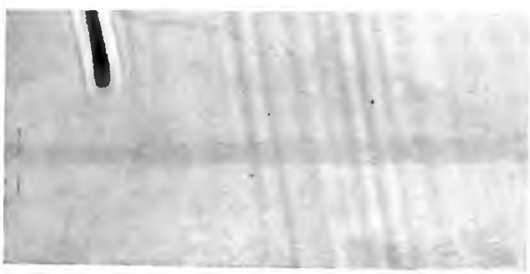

Fig. 3 b

Fig. 3 c

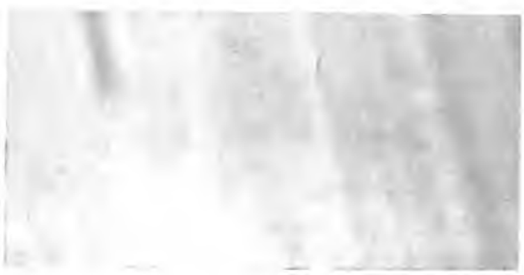

Fig. 3 d

Finally I wish to thank doc. dr hab. inż. F. Ratajczyk for help in the work and to dr B. Lisowska and mgr H. Plokarz for preliminary selection of the studied material.

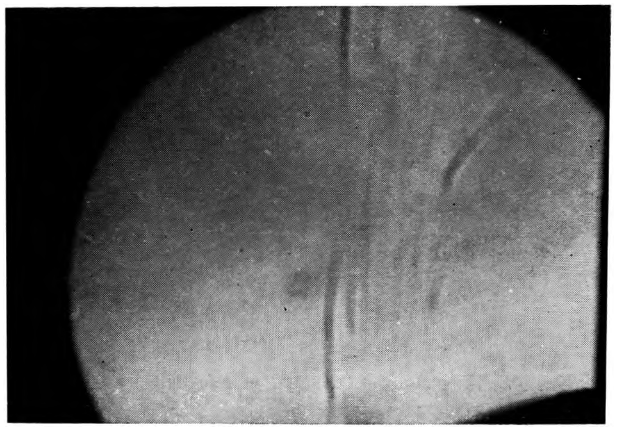

Fig. 4 a

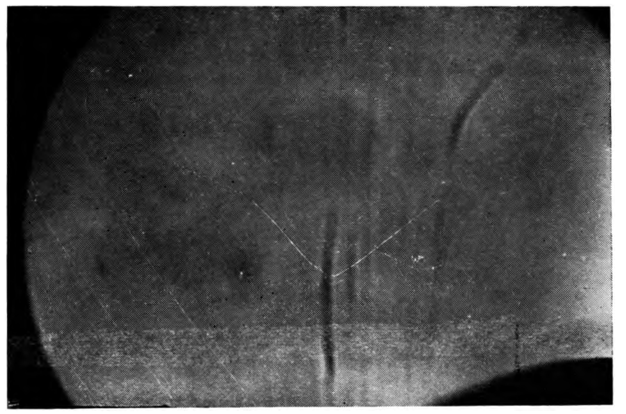

Fig. 4 b

Fig. 4 c

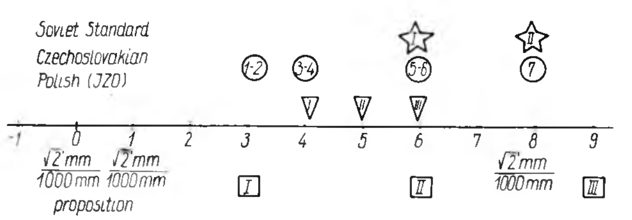

Fig. 5