INTERNATIONAL STANDARD

ISO 10345-2

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Glass — Determination of stress-optical coefficient —

Part 2:
Bending test

Verre — Détermination du coefficient photo-élastique —

Partie 2: Essai de flexion

Reference number
ISO 10345-2:1992(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10345-2 was prepared by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, Sub-Committee SC 5, *Quality of glassware*.

ISO 10345 consists of the following parts, under the general title *Glass — Determination of stress-optical coefficient*:

— *Part 1: Tensile test*

— *Part 2: Bending test*

Annex A of this part of ISO 10345 is for information only.

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Glass — Determination of stress-optical coefficient —

Part 2:
Bending test

1 Scope

This part of ISO 10345 describes the bending test for determining the stress-optical coefficient of isotropic glass. The stress-optical coefficient is a characteristic value of materials and it is necessary for determining the stress from results of measurement of stress birefringence.

2 Definition

For the purposes of this part of ISO 10345, the following definition applies.

2.1 stress-optical coefficient: Ratio of birefringence effect to applied uniaxial stress on an optical material. [ISO 9802[1]]

$$K = \frac{\Delta s}{a} \cdot \frac{1}{\sigma} \qquad \ldots (1)$$

where

K is the stress-optical coefficient;

Δs is the optical path difference;

a is the light path in the test specimen (which is identical with the breadth b of the test specimen);

σ is the tensile or compressive stress.

NOTE 1 The stress-optical coefficient is a function of the wavelength. It can be either positive or negative.

3 Principle

Uniaxial loading of the test specimen in the bending test and stress-optical measurement of the optical path difference in the range of the invariable transverse moment at the point of maximum compressive stress and maximum tensile stress (edge of test specimen).

4 Apparatus

4.1 Devices for measuring the test specimen dimensions, suitable for measuring the breadth b and height h of the test specimen to the nearest 0,01 mm.

4.2 Apparatus, consisting of stressing equipment and polarization measuring equipment.

The stressing equipment (see figure 1) consists essentially of two specimen supports and two bending edges with loading pieces to be hung on gimbals. The ratio of the support span l_S to the distance of the bending edges l_a should be 5:1 (see figure 2), for example $l_S = 100$ mm and $l_a = 20$ mm. The four edges shall be of a minimum length of 24 mm. The mass of the loading piece to be applied depends on the loading bearing capacity of the test specimen.

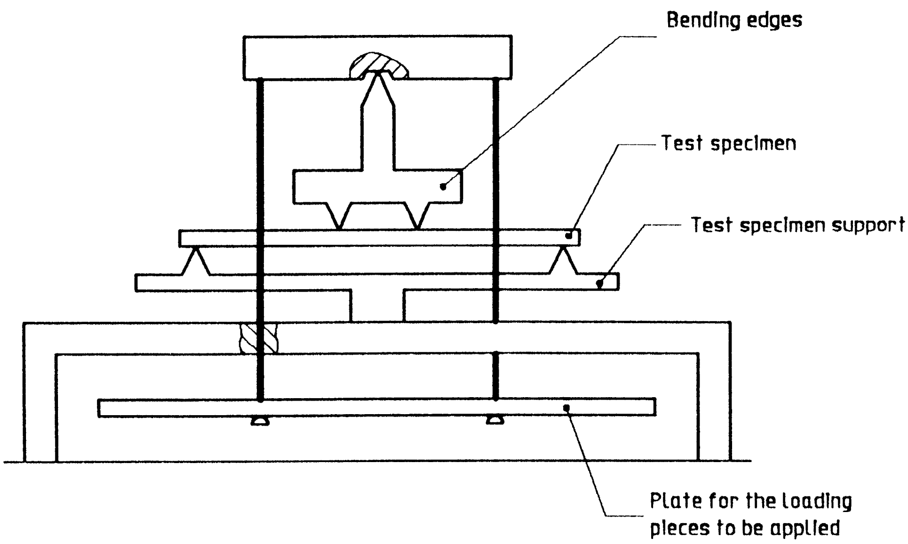

Figure 1 — Principle of stressing equipment

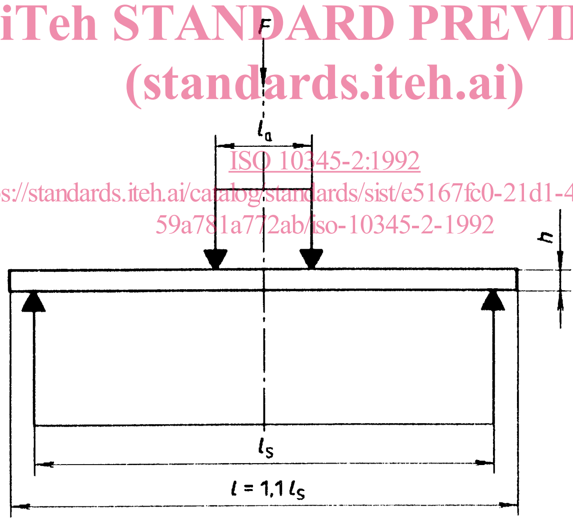

Figure 2 — Test specimen loading scheme

The polarization measuring equipment shall allow the measurement of the optical path difference with the compensator or by counting the isochromates to 5 nm. The light source shall be white light with a corresponding interference filter for the wavelength of 589,3 nm.

The stressing equipment and the polarization measuring equipment shall be reciprocally adjustable in both the horizontal and vertical directions, so that the measuring point is located in the viewing axis of the polarization measuring equipment.

The subtraction position of the compensator of the polarization measuring equipment shall be determined using a glass for which the sign of the stress-optical coefficient is known.

5 Test specimens

5.1 Dimensions of the test specimens

Length l: 1,1 l_s

Breadth b: 20 mm ± 2 mm

Height h: 4 mm ± 0,2 mm

The height h and the breadth b of the test specimen shall not vary by more than 0,01 mm over its length l.

5.2 Condition of the test specimens

The test specimen shall not have inhomogeneously distributed residual stresses. Homogeneously distributed residual stresses should be lower than 1 % of the measuring value.

The surfaces of the test specimen for light incidence and light exit, with areas of $(l \times h)$, shall be ground and polished in such a way that the measurement of the optical path difference is not interfered with by surface roughness.

The surfaces of the test specimen, with areas of $(l \times b)$, shall be at least fine-ground.

6 Procedure

6.1 Take all measurements at a temperature of 25 °C ± 10 °C. Any temperatures differing from this value shall be stated in the test report.

6.2 Measure the breadth b and the height h of the test specimen to the nearest 0,01 mm.

6.3 Place the test specimen symmetrically to the bending edges, in such a way that the parallel faces of the specimen are located in the parallel beam path perpendicular to the beam axis with its main stress direction forming an angle of less than 45° between crossed polarizers.

6.4 Determine the sign of the optical path difference of the glass to be tested from the orientation of the subtraction position of the compensator.

6.5 Determine the optical path difference of the stress birefringence in the central area of the constant bending moment at the point of maximum compressive stress and maximum tensile stress (close to the edge of the test specimen) by means of a compensator or by counting the isochromates between the neutral axis and the upper surface and lower surface of the test specimen, respectively.

Then turn the test specimen through 180° around its longitudinal axis and repeat the measurements.

Calculate the arithmetic mean of the optical path difference Δs from the four values measured.

6.6 The measurements according to 6.5 should be carried out with at least two different testing forces which should differ by about the factor 1,5.

7 Expression of results

7.1 For each testing force applied, calculate the stress σ according to the numerical equation (2):

$$\sigma = F \frac{3(l_S - l_a)}{2bh^2} + \sigma_E \qquad \ldots (2)$$

where

- σ is the tensile stress or compressive stress, in newtons per square millimetre;
- F is the testing force, in newtons, resulting from Cardanic suspension plus the mass of the load pieces;
- l_S is the support span, in millimetres;
- l_a is the distance between the bending edges, in millimetres;
- b is the breadth of the test specimen, in millimetres;
- h is the height of the test specimen, in millimetres;
- σ_E is the bending stress, in newtons per square millimetre, due to the dead-weight of the test specimen.

The bending stress σ_E due to the dead-weight of the test specimen is given by the numerical equation (3):

$$\sigma_E = \frac{3}{4} \cdot \frac{\rho g}{10^6 h} \cdot l_S^2 \qquad \ldots (3)$$

where

- ρ is the density of the test specimen, in grams per cubic centimetre;
- g is the gravitational acceleration ($\approx 9{,}81$ m/s^2).

In the case of tensile stress, the value of σ is positive, and in the case of compressive stress, the value is negative.

7.2 Calculate the stress-optical coefficient K according to the numerical equation (4):

$$K = \frac{\Delta s}{b} \cdot \frac{1}{\sigma} \qquad \ldots (4)$$

where

K is the stress-optical coefficient, expressed in 10^{-6} mm²/N;

Δs is the optical path difference according to 6.5, in nanometres, positive or negative according to 6.4;

b is the breadth of the test specimen, in millimetres;

σ is the stress [according to the numerical equation (2)], in newtons per square millimetre.

When the measurements have been carried out with more than one testing force, calculate the arithmetic mean of the stress-optical coefficient.

8 Test report

The test report shall include the following information:

a) reference to this part of ISO 10345;

b) type and designation of the glass tested;

c) wavelength of the light source, if 589,3 nm was not used;

d) testing temperature, if outside the range 15 °C to 35 °C;

e) stress-optical coefficient, expressed in 10^{-6} mm²/N to the nearest $0{,}05 \cdot 10^{-6}$ mm²/N.

Annex A
(informative)

Bibliography

[1] ISO 9802:—[1], *Raw optical glass — Vocabulary*.

1) To be published.

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Descriptors: glass, stresses, tests, bend tests, determination, optical properties.

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