INTERNATIONAL STANDARD

# ISO 10345-1

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# Glass — Determination of stress-optical coefficient —

## Part 1:
## Tensile test

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*Verre — Détermination du coefficient photo-élastique —*

*Partie 1: Essai de traction*

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## Foreword

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International Standard ISO 10345-1 was prepared by Technical Committee ISO/TC 48, *Laboratory glassware and related apparatus*, Sub-Committee SC 5, *Quality of glassware*.

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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 1:
Tensile test

## 1 Scope

This part of ISO 10345 describes the tensile 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 the results of measurement of stress birefringence.

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## 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]]

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

where

$K$ is the stress-optical coefficient;

$\Delta s$ 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);

$\sigma$ 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 tensile test and stress-optical measurement of the optical path difference at the centre of the test specimen.

NOTE 2 The stress-optical coefficient can also be determined by a compressive test if bend stress and shear stress are sufficiently insignificant (see 4.2 and 6.3). The direction of the testing force is then opposite to that of the tensile test and the compensator shall be applied after being turned through 90°.

## 4 Apparatus

**4.1 Device for measuring the height of the test specimen**, to the nearest 0,01 mm.

**4.2 Apparatus, consisting of stressing equipment including force measuring device and polarization measuring equipment with compensator.**

The stressing equipment shall allow the application of an uniaxial tensile load to the vertically arranged test specimen across the measuring area (see figure 1). The test specimen shall not be loaded simultaneously by shearing and bending. The force measuring device shall be capable of determining the testing forces to an accuracy of 1 %. The design of the stressing equipment and test specimen holding device shall allow the tensile axis to be aligned with the axis of the test specimen during the test.

The polarization measuring equipment shall allow the measurement of the optical path difference with the compensator 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 centre of the test specimen is located in the viewing axis of the polarization measuring equipment.

Dimensions in millimetres

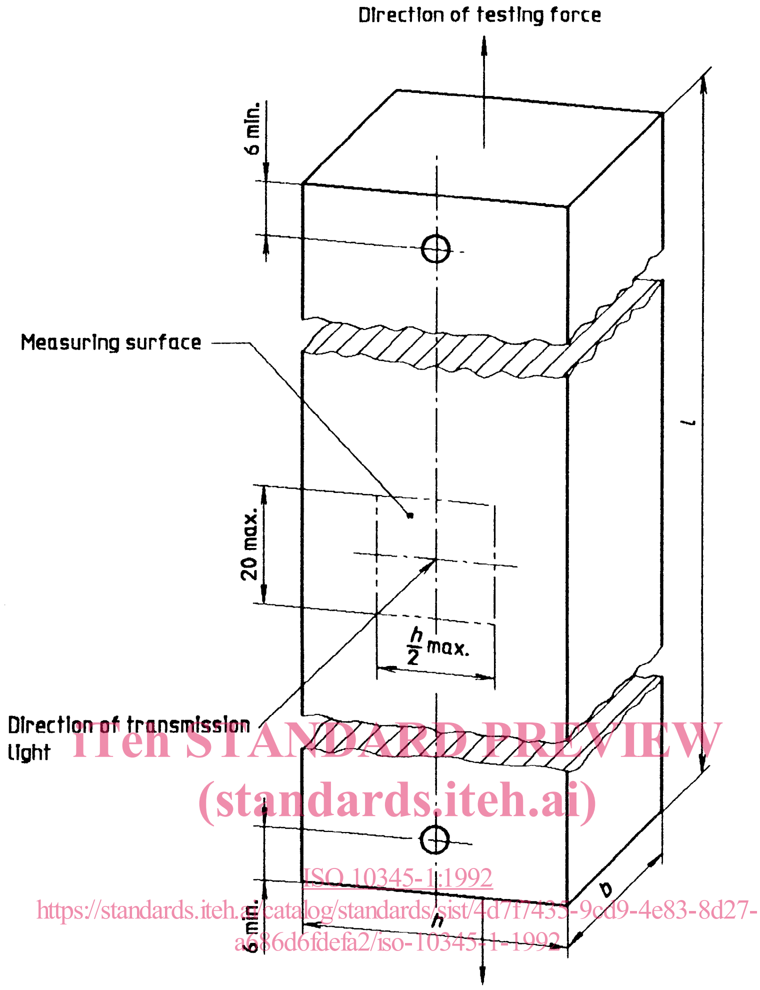


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**Figure 1 — Test specimen with holes**

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

Over the total length of the test specimen (see figure 1), the rectangular cross-section ($b \times h$) shall be at least 25 mm$^2$ and the length $l$, at least 50 mm. The breadth $b$ and the height $h$ shall be not less than 4 mm. In addition, the test specimen shall be straight.

If the test specimen is to be held by steel pivots set in holes, the height $h$ and the breadth $b$ of the test specimen shall be not less than 6 mm. The distances between the holes and the upper and lower surfaces of the test specimen shall be at least 6 mm.

If the test specimen is held in the stressing equipment by bonding its upper and lower surfaces, these surfaces shall be normal to the axis of the test specimen and nearly plane-parallel. Small deviations from plane-parallelism are compensated by hardened adhesive remaining between the test specimen holding device and the upper and lower surfaces of the test specimen. For good bonding, the upper and lower surfaces of the test specimen should be rough-ground.

### 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 transmission, 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 room temperature between 15 °C and 35 °C. Any temperatures differing from this value shall be stated in the test report.

**6.2** Measure the height $h$ of the test specimen at the measuring surface, to the nearest 0,01 mm.

NOTE 3 It is not also necessary to measure the breadth $b$ of the test specimen, because it is not needed for the calculation of the stress-optical coefficient according to equation (2).

**6.3** Mount the test specimen in the stressing equipment in such a way that the axis of the test specimen is in line with the tensile axis and that any bending and shearing load is excluded at the measuring surface (see 6.4 and figure 1). This requirement is considered to be fulfilled when a gradient of birefringence does not exist in this region in the horizontal direction.

**6.4** In the vertical direction, the distance between the point of polarizing optical measurement and the centre of the test specimen shall be not more than 10 mm.

In the horizontal direction, this distance shall be not more than a quarter of the height of the test specimen (also see the measuring surface in figure 1).

**6.5** When the light passes through the test specimen in a perpendicular direction, measure the optical path difference of the birefringence at the measuring surface (see figure 1), twice for each of at least two testing forces to be applied. Use testing forces of more than 100 N which shall differ by more than 200 N. The direction of light transmission shall be perpendicular to the stressing direction of the testing force and parellel to the end faces of the test specimen. For test specimens with striae or other inhomogeneities, three different testing forces should be applied for the determination of the optical path difference.

## 7 Expression of results

Calculate the stress optical coefficient $K$ according to the numerical equation (2):

$$K = \frac{h(\Delta s_1 - \Delta s_2)}{F_1 - F_2} \qquad \ldots (2)$$

where

$K$ is the stress-optical coefficient, expressed in $10^{-6}$ mm$^2$/N;

$h$ is the height of the test specimen, in millimetres;

$F_1$ and $F_2$ are the testing forces, in newtons;

$\Delta s_1$ is the optical path difference with testing force $F_1$, in nanometres;

$\Delta s_2$ is the optical path difference with testing force $F_2$, in nanometres.

When the optical path differences have been measured with more than two testing forces, the stress-optical coefficient should be determined from the measuring values using a graph or by calculation.

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## 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 $10^{-6}$ mm$^2$/N to the nearest $0{,}05 \cdot 10^{-6}$ mm$^2$/N.

## Annex A
(informative)

## Bibliography

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

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