



Standard Test Method for Measurement of Glass Stress—Optical Coefficient¹

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1. Scope

1.1 This test method covers procedures for determining the stress-optical coefficient of glass, which is used in photoelastic analyses. In Procedure A the optical retardation is determined for a glass fiber subjected to uniaxial tension. In Procedure B the optical retardation is determined for a beam of glass of rectangular cross section when subjected to four-point bending. In Procedure C, the optical retardation is measured for a beam of glass of rectangular cross-section when subjected to uniaxial compression.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

C336 Test Method for Annealing Point and Strain Point of Glass by Fiber Elongation

C598 Test Method for Annealing Point and Strain Point of Glass by Beam Bending

C1426 Practices for Verification and Calibration of Polarimeters

F218 Test Method for Measuring Optical Retardation and Analyzing Stress in Glass

2.2

NIST, Recommended Practice Guide “Fractography of Ceramics and Glasses” (Section 4.6.2—Flexural Strength)

3. Significance and Use

3.1 Stress-optical coefficients are used in the determination of stress in glass. They are particularly useful in determining the magnitude of thermal residual stresses for annealing or

pre-stressing (tempering) glass. As such, they can be important in specification acceptance.

4. Apparatus

4.1 Stressing Equipment and Polarimeter:

4.1.1 Procedure A—Figs. 1 and 2 illustrate a polarimeter employing a quarter-wave plate and rotatable analyzer,³ described in Test Method F218. The quarter-wave plate shall be designed for the wavelength of the light being used. The polarizing axes of the polarizer and analyzer shall be set at right angles to each other with each being located at an angle of 45° with the horizontal and vertical. The analyzer, however, shall be mounted in a rotatable mount having a scale graduated on either side from 0 to 180°. The quarter-wave plate shall be fixed to give maximum extinction when the polarizer and analyzer are crossed at right angles; that is, when its polarizing axes are set at 45° and 135° to the horizontal and vertical. In place of the immersion cell *E*, a means of supporting and loading a glass specimen shall be provided, either in air (Fig. 3(a)) or in an immersion liquid (Fig. 3(b)). In this arrangement the optical elements of the polarimeter between light source and telescope have been reversed and a large scale graduated in 2-nm divisions is employed with the rotatable analyzer *I*.

4.1.1.1 Fig. 3 illustrates the fiber-stressing and optical arrangement used in Procedure A. Figure 3(a) shows the fiber mounted vertically, positioned, and supported by two brass collars with swivel handles so that the kilogram weight may be applied to load the fiber. A light shield having entrance and exit slits surrounds the fiber providing a degree of collimation to the light passing through the fiber and also helping to eliminate stray light.

4.1.1.2 In Fig. 3(b) the fiber is stressed while immersed in a liquid which matches the refractive index of the fiber. This arrangement provides more satisfactory viewing of the fiber.

4.1.2 Procedure B:

4.1.2.1 The polarimetry apparatus for the beam-bending procedure is shown in Figs. 4 and 5. Radiation from a white-light source passes through the following components and in this sequence: a diffuser, a polarizer whose axis is at 45°

¹ This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.04 on Physical and Mechanical Properties.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

³ Goranson and Adams, “Measurement of Optical Path Differences,” *Journal of Franklin Institute*, Vol 216, 1933, p. 475. Goranson and Adams, “Measurement of Optical Path Differences,” *Journal of Franklin Institute*, Vol 216, 1933, p. 475.