



Standard Test Method for Photoelastic Determination of Residual Stress in a Transparent Glass Matrix Using a Polarizing Microscope and Optical Retardation Compensation Procedures¹

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1. Scope

1.1 This test method covers the determination of residual stresses in a transparent glass matrix by means of a polarizing microscope using null or retardation compensation procedures.

1.2 Such residual stress determinations are of importance in evaluating the nature and degree of residual stresses present in glass matrixes due to cord, or the degree of fit, or suitability of a particular combination of glass matrix and enamel, or applied color label (ACL).

1.3 The retardation compensation method of optically determining and evaluating enamel or ACL residual stress systems offers distinct advantages over methods requiring physical property measurements or ware performance tests due to its simplicity, reproducibility, and precision.

1.4 *Limitations*—This test method is based on the stress-optical retardation compensation principle, and is therefore applicable only to transparent glass substrates, and not to opaque glass systems.

1.5 Due to the possibility of additional residual stresses produced by ion exchange between glasses of different compositions, some uncertainty may be introduced in the value of the stress optical coefficient in the point of interest due to a lack of accurate knowledge of chemical composition in the areas of interest.

1.6 This test method is quantitatively applicable to and valid only for those applications where such significant ion exchange is not a factor, and stress optical coefficients are known or determinable.

1.7 The extent of the ion exchange process, and hence the magnitudes of the residual stresses produced due to ion exchange will depend on the exchange process parameters. The residual stress determinations made on systems in which ion exchange has occurred should be interpreted with those dependencies in mind.

1.8 The values stated in SI units are to be regarded as the

standard. The values given in parentheses are for information only.

1.9 *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:*

C 162 Terminology of Glass and Glass Products²

C 770 Test Method for Measurement of Glass Stress-Optical Coefficient²

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

F 218 Test Method for Analyzing Stress in Glass²

3. Terminology

3.1 *Definitions*—For additional definitions of terms used in this test method, refer to Terminology C 162.

3.1.1 *cord*—an attenuated glassy inclusion possessing optical and other properties differing from those of the surrounding glass. **C 162**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *residual stress*—permanent stress that is resident in a glassy matrix. Such residual stress may result either from heat treatment above the strain point of the glass, or from differences in thermal expansion between the glass matrix and a cord, applied enamel, or ACL decoration.

3.2.1.1 *Discussion*—The residual stress may be modified either by heat treatment above the strain point, remelting and homogenizing the glass melt, or by removal of a fired-on ceramic or glass decoration. Residual stress caused by ion exchange may only be relieved by either reexchanging the glass to its original state, removing the exchanged glass from the matrix, or by remelting the exchanged glass and homogenizing the resulting glass melt.

3.2.2 *applied color label (ACL)*—vitrifiable glass color decoration or enamel applied to and fused on a glass surface.

3.2.3 *polarizer*—an optical assembly that transmits light

¹ This test method is under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and is the direct responsibility of Subcommittee C14.10 on Glass Decoration.

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² *Annual Book of ASTM Standards*, Vol 15.02.