Designation: ~~C148 – 14~~ C148 – 17

Standard Test Methods for Polariscopic Examination of Glass Containers[1]

This standard is issued under the fixed designation C148; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods describe the determination of relative optical retardation associated with the state of anneal of glass containers. Two alternative test methods are covered as follows:

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Test Method A—Comparison with Reference Standards Using a Polariscope	6 – 9
Test Method B—Determination with Polarimeter	10 – 12

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~~Test Method A—Comparison with Reference Standards Using a Polariscope~~	~~6 to 9~~
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1.2 Test Method A is useful in determining retardations less than 150 nm, while Test Method B is useful in determining retardations less than 565 nm.

NOTE 1—The apparent temper number as determined by these test methods depends primarily on (*1*) the magnitude and distribution of the residual stress in the glass, (*2*) the thickness of the glass (optical path length at the point of grading), and (*3*) the composition of the glass. For all usual soda-lime silica bottle glass compositions, the effect of the composition is negligible. In an examination of the bottom of a container, the thickness of glass may be taken into account by use of the following formula, which defines a real temper number, T_R, in terms of the apparent temper number, T_A, and the bottom thickness, t:

$$T_R = T_A(0.160/t), \text{ where } t \text{ is in inches, or}$$

$$T_R = T_A(4.06/t), \text{ where } t \text{ is in millimetres.}$$

This thickness should be measured at the location of the maximum apparent retardation. Interpretation of either real or apparent temper number requires practical experience with the particular ware being evaluated.

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C162 Terminology of Glass and Glass Products

C224 Practice for Sampling Glass Containers

C1426 Practices for Verification and Calibration of Polarimeters

[1] These test methods are under the jurisdiction of ASTM Committee C14 on Glass and Glass Products and are the direct responsibility of Subcommittee C14.07 on Glass Containers.

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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. Terminology

3.1 *Definitions*— For definitions of terms used in these test methods see Terminology C162.

4. Significance and Use

4.1 These two test methods are provided for evaluating the quality of annealing. These test methods can be used in the quality control of glass containers or other products made of similar glass compositions, where the degree of annealing must be verified to ensure quality products. These test methods apply to glass containers manufactured from commercial soda-lime-silica glass compositions.

5. Sampling

5.1 Methods of sampling a minimum lot from a group of containers of a given type are given in Practice C224 for the various situations to which that method may apply.

TEST METHOD A—COMPARISON WITH REFERENCE STANDARDS USING A POLARISCOPE

6. Apparatus

6.1 *Polariscope,* conforming to the following requirements:

6.1.1 The degree of polarization of the field at all points shall not be less than 99 %.

6.1.2 The field shall be a minimum of 51 mm (2 in.) in diameter greater than the diameter of the container to be measured. The distance between the polarizing and analyzing elements shall be sufficient to allow the inside bottle bottom surface to be viewed through the open container finish.

6.1.3 A sensitive tint plate, having a nominal optical retardation of 565 nm, with a variation across the field of view of less than 5 nm and with its slow axis at 45° to the plane of polarization, shall be used. Such an orientation will produce a magenta background in the field of view. The brightness of the polarized field illuminating the sample shall be a minimum of 300 cd/m^2.

NOTE 2—Color discrimination remains satisfactory with retardations between 510 and 580 nm, but optimum conditions are attained at ~~565 nm.~~565 nm.

6.1.4 Samples must be allowed to equilibrate until the entire thickness of glass is at room temperature.

7. Calibration and Standardization

7.1 A set of not less than five standardized glass disks of known retardation stress shall be used to cover the range of commercial container annealing. Such disks shall be circular plates of glass not less than 76 mm (3 in.) nor more than 102 mm (4 in.) in diameter. Each disk shall have a nominal retardation at the calibration point, 6.4 mm (0.25 in.) from the outer circumference of the disk, corresponding to not less than 21.8 nm nor more than 23.8 nm of optical retardation. Each disk shall have a nominal retardation at the calibration point, 6.4 mm (0.25 in.) from the PHYSICAL EDGE of the GLASS disk, corresponding to not less than 21.8 nm nor more than 23.8 nm of optical retardation. If the disk is mounted in a frame that covers the glass edge, refer to the instructions provided by the supplier of the strain disk set with regard to the distance to the calibration point from the frame ID. If unknown, the disks may be removed from the frame, the calibration point marked accordingly, and the disks placed back into their frames.

8. Procedure

8.1 *Examination of the Bottom of Cylindrical Flint Containers*—View the inside bottom of the container through the open container finish. Rotate the container to determine the location of the highest order of retardation color at the inside knuckle position. Compare the highest order retardation color observed at the bottom of the container to the retardation color seen at the calibration point in various numbers of the standard disks stacked one on top of the other and held parallel to the surface of the polarizer. Determine whether the maximum order of retardation color in the container bottom is less than that in one disk, less than that in two and greater than one, less than that in three and greater than two, and so forth. It is seldom possible to obtain an exact match of the order of retardation color scheme in the container with the reference standards. Accordingly, record the temper number of the container using the following procedure:

8.1.1 *Temper Number Determination*—When a maximum order retardation color observed in the container bottom is greater than that of N disks but less than $N + 1$ disks, the apparent temper grade is judged to be that of $N + 1$ disks. The apparent temper number is always determined to be the next integral temper number greater in value than the actual observed value as seen in the following table:

Apparent Temper Number	Observed Temper
1	less than 1 disk
2	less than 2, greater than 1 disk
3	less than 3, greater than 2 disks
4	less than 4, greater than 3 disks
5	less than 5, greater than 4 disks
6	less than 6, greater than 5 disks
7	[A]