

# Standard Test Method for Linear Dimensional Changes of Plastics Under Accelerated Service Conditions<sup>1</sup>

This standard is issued under the fixed designation D 1042; 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.

## 1. Scope \*

1.1 This test method is designed to provide a means for measuring in plastic specimens the dimensional changes resulting from exposure to service conditions. In particular, this test method is suitable for measuring shrinkage or elongation developed under specific oven and water conditionings.

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.*

NOTE 1—There is no similar or comparable ISO standard.

## 2. Referenced Documents

- 2.1 *ASTM Standards:*
- D 883 Terminology Relating to Plastics<sup>2</sup>

## 3. Terminology

3.1 *Definitions:* Definitions of terms applying to this test method appear in Terminology D 883.

## 4. Significance and Use

4.1 This test method is intended only as a convenient test method for measurement of linear dimensional changes in plastics subjected to defined conditions of test as outlined in Section 8. When all precautions are observed, measurements are reproducible to  $\pm 0.02\%$ .

## 5. Apparatus

5.1 *Scriber*, so constructed that two sharp needle points are rigidly separated by  $100 \pm 0.2$  mm. The scriber, as shown in Fig. 1, consists of two sharp steel needles, approximately 1.5 mm in diameter. The needles are to be inserted in drilled holes with their axes parallel to each other and perpendicular to and intersecting the long axis of a stainless steel rod,  $8.0 \pm 0.1$  mm in diameter by  $125 \text{ mm} \pm 5$  mm in length. The needles' points shall extend  $6 \pm 1$  mm beyond the supporting rod and are held

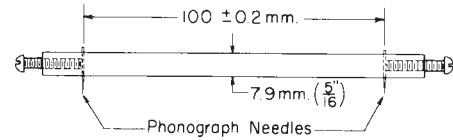


FIG. 1 Scriber

in position by set screws inserted through the ends of the rod. A stainless steel gage with reference points consisting of a center and two short concentric arcs ( $R_1 = 99.80 \pm 0.02$  mm, and  $R_2 = 100.20 \pm 0.02$  mm) shall be used for calibration of the scriber. Thickness of arc lines shall not exceed 0.02 mm.

NOTE 2—Phonograph needles may be used as a satisfactory scriber.

5.2 *Measuring Microscope*, having a magnification of at least  $20\times$  and graduated to have a resolution of 0.1 mm.

NOTE 3—For more precise measurements, a micrometer microscope should be used.

5.3 *Beaker*, having a suitable size for the number of specimens to be evaluated and is constructed of a material that is stable under the test conditions.

5.4 *Room or Conditioning Chamber*, capable of being maintained at  $23 \pm 2^\circ\text{C}$ .

5.5 *Conditioning Oven*, full draft air-circulating oven, capable of being maintained within  $\pm 2^\circ\text{C}$  of the set temperature.

5.6 *Absorbent Material*, cloth or paper suitable for drying.

## 6. Test Specimens

6.1 Specimens shall not be less than 110 mm in length in the direction of test. The preferred specimen size is  $125 \pm 5$  mm in length by  $13 \pm 0.5$  mm wide by  $3.0 (-0.0 + 0.2)$  mm thick.

6.2 Three specimens shall be tested for each conditioning.

6.3 Individual specimens shall be positioned vertically in the specified environment.

NOTE 4—A wire hook inserted in a hole drilled in one end of the specimen has been found acceptable.

## 7. Conditioning and Exposure

### 7.1 Preconditioning

7.1.1 Precondition specimens at  $23 \pm 2^\circ\text{C}$  and  $50 \pm 5\%$  relative humidity for a minimum of 40 h prior to initial scribing.

NOTE 5—If moisture equilibrium is required prior to preconditioning,

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

\*A Summary of Changes section appears at the end of this standard.

refer to the specific material specifications.

7.1.2 After removal from the conditioning environment, specimens shall be tested within 30 min.

7.2 Method A—Water Immersion

7.2.1 Specimens shall be immersed in water maintained at 23 ± 2°C for 168 ± 1 h.

7.2.2 The specimens shall be wiped dry with the absorbent cloth after removal from the water and tested within 3 min.

7.3 Method B—Oven Conditioning

7.3.1 Specimens shall be conditioned in an oven at 70 ± 2°C for 25 ± 1 h.

7.3.2 After removal from the oven, the specimens shall be tested within 3 min.

7.4 Other conditionings for specific service conditions can be used if agreed upon by all parties.

7.5 Conduct tests in a standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity.

8. Procedure

8.1 Immediately following the preconditioning, scribe an arc of 100-mm radius on the surface of the test specimen. Press one needle firmly into the specimen to form a center for this and subsequent measurements. The other needle scribes the arc which is used as a reference for all subsequent measurements (see Fig. 2). Draw the arcs smoothly, using a pressure consistent with the surface hardness and test conditions to which the specimen is subjected. It is desirable to lightly scratch the surface with the needle so that a sharp, clear arc is defined.

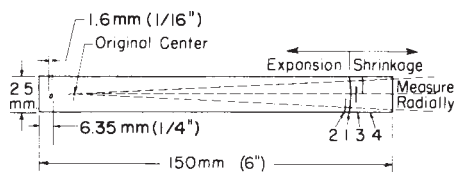
NOTE 6—A contrasting colored, permanent type marker may be used on the surface of the specimen, in the area of the scribe to aid in defining a sharp, clear arc.

8.2 After conditioning, reinsert one needle in the original center and draw a short arc with the other. Measure the distance between the original arc and the new arc with the microscope. Measure the separation of the arcs between corresponding positions, for example, center to center.

8.3 If the test specimen is not flat, flatten it by pressing or clamping it against a plane surface before scribing the arcs and making the measurements. In no case shall the specimen be clamped or otherwise confined during the period of exposure to accelerated service conditions.

9. Calculation and Measurement

9.1 Measure the distance between arcs to the nearest 0.1 mm.



- 1—Original arc
- 2—After 37.7°C (100°F) and 100 % humidity
- 3—After 60°C (140°F)
- 4—Final conditioning

FIG. 2 Scribing Test Specimens for Measurement

9.2 Determine the amount of linear expansion or shrinkage by the following:

$$L_C = D_B / D_I \times 100$$

where:

$L_C$  = percent of linear change,

$D_B$  = distance between the scribed arcs, and

$D_I$  = initial scribed distance.

10. Precision and Bias <sup>3</sup>

10.1 This test method is in use by a limited number of D20.50 members. Subcommittee D20.50 was not able to locate a sufficient number of laboratories willing to conduct a round robin, for the purpose of developing an acceptable Precision and Bias statement. However, Repeatability conducted on six materials was developed by one laboratory. Results are as follows:

TABLE Method A—Water Conditioning

Material	Thick. (mm)	Exp. or Shr.	Spec. 1 (mm)	Spec. 2 (mm)	Spec. 3 (mm)	AVG (mm)	STD DEV	% CH (Lc)
PA 66	3.10	Expansion	0.108	0.114	0.091	0.104	0.012	0.104
PP	3.00	Shrinkage	0.059	0.064	0.072	0.065	0.007	0.065
ABS	2.98	Expansion	0.119	0.308	0.131	0.186	0.106	0.186
PC	3.15	Shrinkage	0.051	0.067	0.138	0.085	0.046	0.085
PS	3.10	Shrinkage	0.054	0.072	0.065	0.064	0.009	0.064
PMMA	2.98	Expansion	0.056	0.032	0.076	0.055	0.022	0.055

TABLE Method B—Oven Conditioning

Material	Thick. (mm)	Exp. or Shr.	Spec. 1 (mm)	Spec. 2 (mm)	Spec. 3 (mm)	AVG (mm)	STD DEV	% CH (Lc)
PA 66	3.10	Shrinkage	0.059	0.064	0.078	0.067	0.010	0.067
PP	3.00	Shrinkage	0.169	0.171	0.158	0.166	0.007	0.166
ABS	2.98	Shrinkage	0.150	0.185	0.128	0.154	0.029	0.154
PC	3.15	Shrinkage	0.250	0.222	0.232	0.235	0.014	0.235
PS	3.10	Shrinkage	0.223	0.268	0.321	0.271	0.049	0.271
PMMA	2.98	Shrinkage	0.170	0.189	0.147	0.169	0.021	0.169

11. Report

11.1 The test report shall include the following information:

11.1.1 A reference to this standard;

11.1.2 Date of testing;

11.1.3 A statement that test results relate only to the behavior of the test specimens under the conditions of this test;

11.1.4 Identification of the material tested, including the manufacturer, designation, type of material, the specimen orientation with respect to any anisotropy, and anything unique to the material;

11.1.5 Dimensions of the specimen;

11.1.6 Method of conditioning: A, B, or other;

11.1.7 Distance between the arcs after each conditioning; and

11.1.8 Percent linear expansion or shrinkage ( $L_C$ ).

12. Keywords

12.1 accelerated service conditions; linear dimensional changes; plastics

<sup>3</sup> To participate in the development of precision and bias data, contact the staff manager of ASTM Committee D20 at ASTM Headquarters.

## SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since its last issue, on March 10, 2001, that may impact the use of this standard.

- (1) Removed references to D 576 and D 1898, which have been withdrawn.
- (2) Added Section 7 on Conditioning.
- (3) Added appropriate equipment to condition samples (5.3-5.6).
- (4) Removed reference to inch units and added tolerances to critical dimensions (5.1, Figs. 1 and 2).
- (5) Changed recommended specimen size (6.1).
- (6) Added requirement for number of specimens to test (6.2).
- (7) Added specific times to test after conditioning (7.1.2, 7.2.2, and 7.3.2).
- (8) Added a Repeatability statement (10.1).
- (9) Added a Report section (11).

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