



Standard Test Method for Measuring Shrinkage from Mold Dimensions of Molded Plastics¹

This standard is issued under the fixed designation D 955; 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 intended to measure batch-to-batch uniformity in initial shrinkage from mold to molded dimensions of either thermoplastic or thermosetting materials when molded by compression, injection, or transfer under specified conditions.

1.2 This test method does not provide for the measurement of shrinkages that may occur as molded materials age, after the first 48 h out of the mold.

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.*

2. Referenced Documents

2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²
- D 647 Practice for Design of Molds for Test Specimens of Plastic Molding Materials²
- D 788 Specification for Poly(Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds²
- D 796 Practice for Compression Molding Test Specimens of Phenolic Molding Compounds²
- D 883 Terminology Relating to Plastics²
- D 956 Practice for Compression Molding Specimens of Amino Molding Compounds²
- D 1896 Practice for Transfer Molding Test Specimens of Thermosetting Compounds²
- D 1897 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials²
- D 1898 Practice for Sampling of Plastics²
- D 3419 Practice for In-Line Screw-Injection Molding Test Specimens from Thermosetting Compounds³

¹ This test method is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.09 on Specimen Preparation. Current edition approved Nov. 24, 1989. Published January 1989. Originally published as D 955 – 48 T. Last previous edition D 955 – 88.

² *Annual Book of ASTM Standards*, Vol 08.01.

³ *Annual Book of ASTM Standards*, Vol 08.02.

D 4066 Specification for Nylon Injection and Extrusion Materials³

D 4181 Specification for Acetal (POM) Molding and Extrusion Materials³

D 4549 Specification for Polystyrene Molding and Extrusion Materials (PS)⁴

D 4976 Specification for Polyethylene Plastics Molding and Extrusion Materials⁴

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method⁵

3. Terminology

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

4. Significance and Use

4.1 *Compression Molding*—In compression molding, the difference between the dimensions of a mold and of the molded article produced therein from a given material may vary according to the design and operation of the mold. It is probable that shrinkage will approach a minimum where design and operation are such that a maximum of material is forced solidly into the mold cavity or some part of it, or where the molded article is hardened to a maximum while still under pressure, particularly by cooling. In contrast, shrinkages may be much higher where the charge must flow in the mold cavity but does not receive and transmit enough pressure to be forced firmly into all its recesses, or where the molded article is not fully hardened when discharged. The plasticity of the material used may affect shrinkage insofar as it affects the retention and compression of the charge.

4.2 *Injection Molding*—In injection molding, as in compression molding, the difference between the dimensions of the mold and of the molded article produced therein from a given material may vary according to the design and operation of the mold. The difference may vary with the type and size of molding machine, the thickness of molded sections, the degree and direction of flow or movement of material in the mold, the size of the nozzle, sprue, runner, and gate, the cycle on which the machine is operated, the temperature of the mold, and the length of time that follow-up pressure is maintained. As in the

⁴ *Annual Book of ASTM Standards*, Vol 08.03.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.

case of compression molding, shrinkages will approach a minimum where design and operation are such that a maximum of material is forced solidly into the mold cavity and where the molded article is hardened to a maximum while still under pressure as a result of the use of a runner, sprue, and nozzle of proper size, along with proper dwell. As in compression molding, shrinkages may be much higher where the charge must flow in the mold cavity but does not receive and transmit enough pressure to be forced firmly into all of the recesses of the mold. The plasticity of the material used may affect shrinkage indirectly, in that the more readily plasticized material will require a lower molding temperature.

4.3 Transfer Molding—In transfer molding, as in compression or injection molding, the difference between the dimensions of the mold and of the molded article produced therein from a given material may vary according to the design and operation of the mold. It is affected by the size and temperature of the pot or cylinder and the pressure on it, as well as on mold temperature and molding cycle. Direction of flow is not as important a factor as might be expected, although it can have some bearing on results.

5. Sample Preparation

5.1 Some materials require special treatment before they are molded. For example, thermoplastics which absorb moisture must be dried before molding. Materials to be tested shall be prepared for molding in accordance with the manufacturer's recommendations. The preparation given to the material prior to molding shall be recorded and reported.

6. Apparatus

6.1 Compression Mold—A single bar, single-cavity positive mold having a cavity cross-section 12.7 by 127 mm ($\frac{1}{2}$ by 5 in.) and a loading depth sufficient to obtain a molded bar 12.7 mm ($\frac{1}{2}$ in.) in thickness, or for diametral shrinkage, a single cavity positive 102-mm (4-in.) disk mold. Both shall conform to Practice D 647.

6.2 Injection Mold—For shrinkage parallel to flow, an impact bar mold having a cavity 12.7 by 127 mm ($\frac{1}{2}$ by 5 in.). The thickness shall be 3.2 mm ($\frac{1}{8}$ in.), unless otherwise agreed upon by the seller and the purchaser. The mold shall have at one end a gate 6.4 mm ($\frac{1}{4}$ in.) in width by 3.2 mm ($\frac{1}{8}$ in.) in depth (Note 1). For diametral shrinkage, where shrinkage both parallel to flow and transverse to flow are to be measured, the mold shall have a cavity 102 mm (4 in.) in diameter by 3.2 mm ($\frac{1}{8}$ in.) in thickness with a gate, placed radially at the edge, 12.7 mm ($\frac{1}{2}$ in.) in width by 3.2 mm ($\frac{1}{8}$ in.) in depth.

NOTE 1—If, for any reason, a test specimen of thickness greater than 3.2 mm ($\frac{1}{8}$ in.) is agreed upon, the depth of the gate may be greater than 3.2 mm ($\frac{1}{8}$ in.) and must be reported.

6.3 Transfer Mold—An impact bar mold having a cavity 12.7 by 12.7 by 127 mm ($\frac{1}{2}$ by $\frac{1}{2}$ by 5 in.) and having either an end gate or top gate at one end 6.4 by 1.52 mm ($\frac{1}{8}$ by 0.060 in.) in depth.

6.4 Compression Press—A suitable hydraulic press that will deliver a pressure of 20 to 35 MPa (3000 to 5000 psi) to the material in the mold.

6.5 Injection Press—A suitable injection-molding machine that will fill the test molds when it is operated in the range from

one half to three fourths of its rated shot capacity at melt temperatures recommended by the material supplier. Different screw and barrel configurations are required for thermoplastic and thermoset materials.

NOTE 2—If injection machines of appropriate capacity are not available, the requirement of 6.5 may be met in machines of larger capacities by providing test molds with multiple cavities to be filled from a common sprue, so that the total weight of the shot, including sprue and runner will fall within the specified limits.

6.6 Transfer Press—A suitable hydraulic press that will deliver a pressure of 70 to 140 MPa (10 000 to 20 000 psi) on the material in the pot of the die or the cylinder of the press.

6.7 Balance—A balance for weighing compression-molding charges.

6.8 Measuring Tools—Measuring tools (micrometers, vernier calipers, etc.) accurate to 0.02 mm (0.001 in.) for measuring the molds and the test specimens.

7. Test Specimens

7.1 Compression-Molding Materials—For mold shrinkages of compression-molding materials, the test specimens shall be bars, 12.7 by 12.7 by 127 mm ($\frac{1}{2}$ by $\frac{1}{2}$ by 5 in.), or a disk 3.2 mm ($\frac{1}{8}$ in.) in thickness and 102 mm (4 in.) in diameter, made in a positive mold in such a way as to minimize lateral movement of the plastic during the molding.

7.2 Injection-Molding Materials—For mold shrinkage of injection-molding materials, specimens of two types shall be used: (1) bars 12.7 by 3.2 by 127 mm ($\frac{1}{2}$ by $\frac{1}{8}$ by 5 in.), gated at the end to provide flow throughout the entire length, shall be used for measurements of shrinkage in the direction of flow, and (2) disks, 3.2 mm ($\frac{1}{8}$ in.) in thickness and 102 mm (4 in.) in diameter, gated radially at a single point in the edge, shall be used for measurements of shrinkages of diameters parallel and perpendicular to the flow.

7.3 Transfer-Molding Materials—For shrinkage of transfer-molding materials, specimens 12.7 by 12.7 by 127 mm ($\frac{1}{2}$ by $\frac{1}{2}$ by 5 in.), gated at the end or at the top near one end, so as to provide flow throughout their entire length, shall be used for measurement of shrinkage in the direction of flow. A disk specimen 3.2 mm ($\frac{1}{8}$ in.) in thickness and 102 mm (4 in.) in diameter gated radially at a single point in the edge, shall be used for measurements of shrinkages of diameters parallel and perpendicular to the flow.

8. Conditioning

8.1 Conditioning—Conditioning of molded specimens shall be done in the Standard Laboratory Atmosphere, 4.2, of Practice D 618 for various lengths of time as discussed in 9.3.

8.2 Test Conditions—Conduct tests in the standard laboratory atmosphere of $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and 50 ± 5 percent relative humidity, unless otherwise specified in the test methods or in this specification. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) and ± 2 percent relative humidity.

9. Procedure

9.1 Measure the length of the cavity of the bar mold, or the diameter of the cavity of the disk mold parallel and perpendicular to the flow, to the nearest 0.02 mm (0.001 in.). Make