Designation: D 6289 – 98

Standard Test Method for Measuring Shrinkage from Mold Dimensions of Molded Thermosetting Plastics[1]

This standard is issued under the fixed designation D 6289; 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 thermosetting materials when molded by compression, injection, or transfer under specified conditions.

1.2 This test method provides for the measurement of shrinkage of thermosetting plastics from their molds both initially (within 16 to 72 h of molding) and as they age (post–shrinkage at elevated temperatures).

1.3 Knowledge of the initial shrinkage of plastics is important for the construction of molds and knowledge of post molding shrinkage is important for determining the suitability of the molding material for manufacturing thermosetting plastic components with accurate dimensions.

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

1.5 *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—This test method and ISO 2577-1984 are equivalent when bars of 120 mm length, 15 mm width, and 10 mm thickness are used for compression molding; or flat, square plaques approximately 120 by 120 by 4 mm are used for injection molding.

2. Referenced Documents

2.1 *ASTM Standards:*

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 796 Practice for Compression Molding Test Specimens of Phenolic Molding Compounds[2]

D 883 Terminology Relating to Plastics[2]

D 956 Practice for Compression Molding Specimens of Amino Molding Compounds[3]

D 1896 Practice for Transfer Molding Test Specimens of Thermosetting Compounds[2]

D 1898 Practice for Sampling of Plastics[2]

D 3419 Practice for In-line Screw-Injection Molding of Test Specimens from Thermosetting Compounds[4]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[5]

2.2 *ISO Standards:*[6]

ISO 291 Plastics—Standard Atmospheres for Conditioning and Testing

ISO 295 Plastics—Compression Molding Test Specimens of Thermosetting Materials

ISO 10724 Plastics—Thermosetting Molding Materials—Injection Molding of Multipurpose Test Specimens

ISO 2577-1984 Plastics—Thermosetting Moulding Materials—Determination of Shrinkage

3. Terminology

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

3.2 *Definitions*—For the purpose of this test method, the following definitions apply:

3.2.1 *molding shrinkage*—the difference in dimensions between a molding and the mold cavity in which it was molded, both the mold and the molding being at 23 ± 2°C when measured.

3.2.2 *post-shrinkage*—shrinkage of a plastic product after molding, during post-treatment, storage or use.

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

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

[3] Discontinued. Replaced by Practice D 5224.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

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

[6] Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

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 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.

4.4 *Materials Standards*—Always refer to material standards for special treatment prior to molding, molding conditions and special handling of the test specimens after molding. In the event the material standard is unavailable, contact the manufacturer for these recommendations.

5. Sample Preparation

5.1 Some materials require special treatment before they are molded. Materials to be tested shall be prepared for molding in accordance with the relevant material standard or the manufacturer's recommendations. The preparation given to the material prior to molding shall be recorded and reported.

6. Apparatus

6.1 *Mold, Press, etc.*, suitable for molding the test specimens specified in Section 8. For transfer or compression molding, a positive or a semi-positive mold with single or multiple cavities shall be used. For injection molding, the type of mold is defined.

6.1.1 If required, marks may be engraved in the mold near opposite ends of the specimen to facilitate the accurate measurement of the length of the cavity and the specimens.

NOTE 2—If multiple cavities are used with a positive mold, resulting variations in test specimen density may be sufficient to produce inconsistent shrinkage.

6.2 *Equipment*, suitable for measuring the lengths of the test specimen and the corresponding cavity of the mold to within 0.02 mm.

6.3 *Oven*, for post-shrinkage only.

7. Sampling

7.1 A representative sample shall be taken from the molding material and be kept at room temperature in airtight containers, without any conditioning, until molded into test specimens (see Practice D 1898).

8. Test Specimen

8.1 *Compression-Molding Materials*—For mold shrinkages of compression-molding materials, the test specimens shall be bars 120 by 15 by 10 mm, bars 12.7 by 12.7 by 127 mm (½ by ½ by 5 in.), or disks 3.2 mm (⅛ in.) in thickness and 102 mm (4 in.) in diameter made in a positive mold in such a way as to minimize laterial movement of the plastic during the molding.

8.2 *Injection-Molding Materials*—For mold shrinkage of injection-molding materials, the test specimens shall be bars 12.7 by 3.2 by 127 mm (½ by ⅛by 5 in.) gated at the end, bars 12.7 by 12.7 by 127 mm (½ by ½ by 5 in.) disks 3.2 mm (⅛in.) in thickness and 102 mm (4 in.) in diameter grated radially at a single point in the edge, plaques 120 by 120 by 4 mm or plaques 60 by 60 by 2 mm gated with a full edge gate.

8.3 *Transfer-Molding Materials*—For shrinkage of transfer-molding materials, specimens 12.7 by 12.7 by 127 mm (½ by ½ by 5 in.) gated at the end or at the top near one end, so as to provide flow throughout their entire length or disk specimen 3.2 mm (⅛ in.) in thickness and 102 mm (4 in.) in diameter gated radically at a single point in the edge.

8.4 The specimens shall be molded to shape by compression, transfer or injection molding using a mold with single or multiple cavities.

9. Procedure

9.1 If not already known, measure the lengths of the cavities (or the distances between the engraved marks in the mold) to the nearest 0.02 mm at a temperature of 23 ± 2°C (ISO 291, Atmosphere 23 or Practice D 618, T-23).

9.1.1 Record these measurements for use in the calculations of shrinkage.

NOTE 3—From time to time, molds should be checked for wear, etc. As an alternate to measuring directly the lengths of the cold molds, the gauge for the molds may be obtained very precisely by cold-molding specimens from lead and measuring their lengths.

9.2 Mold at least two specimens from the sample to be tested, under the conditions given below.

9.2.1 *For Compression Molding*—Mold the specimens under the conditions of pressure, temperature, time, etc., specified in the relevant standard for the material, in ISO 295, Practice D 796, Practice D 956, or at the recommendations of the material manufacturer if the standards are not available.

9.2.2 *For Injection Molding*—Mold the specimens under the conditions outlined in the relevant material standard, ISO 10724 or Practice D 3419. If the material standards are not