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Standard Test Methods for Physical Dimensions of Solid Plastics Specimens[1]

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1. Scope*

1.1 These test methods cover determination of the physical dimensions of solid plastic specimens where the dimensions are used directly in determining the results of tests for various properties. Use these test methods except as otherwise required in material specifications.

1.2 The values stated in SI units are to be regarded as standard.

1.3 *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 standard and ISO 16012 address the same subject matter, but differ in technical content.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing
D638 Test Method for Tensile Properties of Plastics
D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D883 Terminology Relating to Plastics
D2240 Test Method for Rubber Property—Durometer Hardness

2.2 *ISO Standards:*[3]

ISO 472 Plastics—Vocabulary
ISO 16012 Plastics—Determination of Linear Dimensions of Test Specimens

3. Terminology

3.1 *Definitions*—See Terminology D883 and ISO 472 for definitions pertinent to these test methods.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *absolute uncertainty (of a measurement)*, *n*—the smallest division that may be read directly on the instrument used for measurement.

3.2.2 *calibration*—the set of operations that establishes, under specified conditions, the relationship between values measured or indicated by an instrument or system, and the corresponding reference standard or known values derived from the appropriate reference standards.

3.2.3 *micrometer*, *n*—an instrument for measuring any dimension within absolute uncertainty of 25 µm or smaller.

3.2.4 *verification*—proof, with the use of calibrated standards or standard reference materials, that the calibrated instrument is operating within specified requirements.

3.2.5 *1 mil*, *n*—a dimension equivalent to 25 µm (0.0010 in.).

4. Summary of Test Methods

4.1 These test methods provide five different test methods for the measurement of physical dimensions of solid plastic specimens. The test methods (identified as Test Methods A through D, and H) use different micrometers that exert various pressures for varying times upon specimens of different geometries. Tables 1 and 2 display the basic differences of each test method and identify methods applicable for use on various plastics materials.

5. Significance and Use

5.1 These test methods shall be used where precise dimensions are necessary for the calculation of properties expressed in physical units. They are not intended to replace practical thickness measurements based on commercial portable tools, nor is it implied that thickness measurements made by the procedures will agree exactly.

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[1] These test methods are under the jurisdiction of ASTM Committee D20 on Plastics and are the direct responsibility of Subcommittee D20.10 on Mechanical Properties.

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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] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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

TABLE 1 Test Methods Suitable for Specific Materials

Material	Test Method
Plastics specimens	A, B, C, or D
Other elastomers[A]	H

[A]Materials with D2240 Type A hardness of 30 to 80 (approximately equivalent to a Type D hardness of 20).

6. Apparatus

6.1 *Apparatus A—Machinist's Micrometer Caliper*[4] *with Calibrated Ratchet or Friction Thimble:*

6.1.1 Apparatus A is a micrometer caliper equipped with either a calibrated ratchet or a friction thimble. The pressure exerted on the specimen is controllable by the use of a proper manipulative procedure and a calibrated spring (see Annex A1).

6.1.2 Use an instrument constructed with a vernier or digital readout capable of measurement to the nearest 2.5 µm.

6.1.3 Use an instrument with the diameter of the anvil and spindle surfaces (which contact the specimen) of 6.4 ± 0.1 mm.

6.1.4 Use an instrument conforming to the requirements of 8.1, 8.2, 8.5, 8.6.1, and 8.6.2.

6.1.5 Use the micrometer with the locking device released or disengaged, if so equipped.

6.1.6 Test the micrometer periodically for conformance to the requirements of 6.1.4.

6.2 *Apparatus B—Machinist's Micrometer Without a Ratchet*:

6.2.1 Apparatus B is a micrometer caliper.

6.2.2 Use an instrument constructed with a vernier or digital readout capable of measurement to the nearest 2.5 µm.

6.2.3 Use an instrument with the diameter of the anvil and spindle surfaces (which contact the specimen) of 6.4 ± 0.1 mm.

6.2.4 Use an instrument conforming to the requirements of 8.1, 8.2, 8.5.1, 8.5.2, 8.5.3, 8.6.1, and 8.6.3.

6.2.5 Use the micrometer with the locking device released or disengaged, if so equipped.

6.2.6 Examine and test the micrometer periodically for conformance to the requirements of 6.2.4.

6.3 *Apparatus C—Manually Operated, Thickness Gauge:*[5]

6.3.1 Use a dead-weight or spring-loaded, dial-type gauge or digital readout in accordance with the requirements of 8.1, 8.3, 8.4, 8.6.1, and 8.6.4 having the following:

6.3.1.1 A presser foot that moves in an axis perpendicular to the anvil face;

6.3.1.2 The surfaces of the presser foot and anvil (which contact the specimen) parallel to within 2.5 µm (see 8.3);

6.3.1.3 A spindle, vertically oriented if a dead-weight apparatus;

6.3.1.4 A dial or digital indicator essentially friction-free and capable of repeatable readings within ±1 µm at zero setting, or on a steel gauge block;

6.3.1.5 A frame, housing the indicator, of such rigidity that a load of 15 N applied to the indicator housing, out of contact with the presser foot spindle (or any weight attached thereto), will produce a deflection of the frame not greater than the smallest scale division or digital count on the indicator; and

6.3.1.6 A dial diameter at least 50 mm and graduated continuously to read directly to the nearest 2.5 µm. If necessary, equip the dial with a revolution counter that displays the number of complete revolutions of the large hand; or

6.3.1.7 An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.3.

6.3.2 The preferred design and construction of this instrument calls for a limit on the force applied to the presser foot. The limit is related to the compressive characteristics of the material being measured.

6.3.2.1 The force applied to the presser foot spindle and the force necessary to register a change in the indicator reading shall be less than the force that will cause deformation of the specimen. The force applied to the presser foot spindle and the force necessary to just prevent a change in the indicator reading shall be more than the minimum permissible force specified for a specimen.

6.4 *Apparatus D—Automatically-Operated Thickness Gauge*:

6.4.1 Except as additionally defined in this section, use an instrument that conforms to the requirements of 6.3. An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.3 and 6.4.

6.4.2 Use a pneumatic or motor-operated instrument having a presser foot spindle that is lifted and lowered either by a pneumatic cylinder or by a constant-speed motor through a mechanical linkage such that the rate of descent (for a specified range of distances between the presser foot surface and anvil) and dwell time on the specimen are within the limits specified for the material being measured.

6.4.2.1 The preferred design and construction of this instrument calls for a limit on the force applied to the presser foot. The limit is related to the compressive characteristics of the material being measured.

6.4.2.2 The force applied to the presser foot spindle and the force necessary to register a change in the indicator reading shall be less than the force that will cause deformation of the specimen. The force applied to the presser foot spindle and the force necessary to just prevent a change in the indicator reading must be more than the minimum permissible force specified for a specimen.

7. Test Specimens

7.1 The test specimens shall be prepared from plastics materials in sheet, plate, or molded shapes that have been cut to the required dimensions or molded to the desired finished dimensions for the particular test.

7.2 Prepare and condition each specimen to equilibrium in accordance with Practice D618 unless otherwise specified by the relevant ASTM material specification.

7.3 For each specimen, take precautions to prevent damage or contamination that might affect the measurements adversely.

[4] Hereinafter referred to as a machinist's micrometer.

[5] Herein referred to as a gauge.

TABLE 2 Test Method Parameter Differences

Test Method	Apparatus	Elastic Modulus Range[A] MPa	Diameter of Presser Foot or Spindle, mm	Pressure on Specimen, Approximate, kPa
A1	A	from >35 to <275	6.4	40 to 180
A2	A	from >276 to <700	6.4	40 to 300
A3	A	>701	6.4	40 to 900
B	B		6.4	unknown
C	C		6.4 to 12.7	5 to 900
D	D		6.4 to 12.7	5 to 900
H	C		6.4	30

[A]Determined by Test Method D638 or Test Method D790.

7.4 Unless otherwise specified, make all dimension measurements at the standard laboratory atmosphere in accordance with Practice D618.

8. Calibration (General Considerations for Care and Use of Each of the Various Pieces of Apparatus for Dimensional Measurements)

8.1 Good testing practices require clean anvil and presser foot surfaces for any micrometer instrument. Prior to calibration or dimensional measurements, clean such surfaces by inserting a piece of smooth, clean bond paper between the anvil and presser foot and slowly moving the bond paper between the surfaces. Check the zero setting frequently during measurements. Failure to repeat the zero setting may be evidence of dirt on the surfaces.

NOTE 2—Avoid pulling any edge of the bond paper between the surfaces to reduce the probability of depositing any lint particles on the surfaces.

8.2 The parallelism requirements for machinists' micrometers demand that observed differences of readings on a pair of screw-thread-pitch wires or a pair of standard 6.4-mm nominal diameter plug gauges be not greater than 2.5 µm. Spring-wire stock or music-wire of known diameter are suitable substitutes. The wire (or the plug gauge) has a diameter dimension that is known to be within ±1 µm. Diameter dimensions may vary by an amount approximately equal to the axial movement of the spindle when the wire (or the plug gauge) is rotated through 180°.

8.2.1 Lacking a detailed procedure supplied by the instrument manufacturer, confirm the parallelism requirements of machinist's micrometers using the following procedure:

8.2.1.1 Close the micrometer on the screw-thread-pitch wire or plug gauge according to the calibration procedure of 8.6.2 or 8.6.3, as appropriate;

8.2.1.2 Observe and record the thickness indicated;

8.2.1.3 Move the screw-thread-pitch wire or plug gauge to a different position between the presser foot and anvil, and repeat 8.2.1.1 and 8.2.1.2; and

8.2.1.4 If the difference between any pair of readings is greater than 2.5 µm, the surfaces are not parallel.

8.3 Lacking a detailed procedure supplied by the instrument manufacturer, confirm the requirements for parallelism of dial-type micrometers given in 6.3.1.2 by placing a hardened steel ball (such as that used in a ball bearing) of suitable diameter between the presser foot and anvil. Mount the ball in a fork-shaped holder to allow it to be moved conveniently from one location to another between the presser foot and anvil. The balls used commercially in ball bearings are almost perfect spheres having diameters constant within 0.2 µm.

NOTE 3—Exercise care with this procedure. Calculations using the equations given in X1.3.2 show that the use of a 680 g mass weight on a ball between the hardened surfaces of the presser foot and anvil can result in dimples in the anvil or presser foot surfaces caused by exceeding the yield stress of the surfaces.

8.3.1 Observe and record the diameter as measured by the micrometer at one location.

8.3.2 Move the ball to another location and repeat the measurement.

8.3.3 If the difference between any pair of readings is greater than 2.5 µm, the surfaces are not parallel.

8.4 Lacking a detailed procedure supplied by the instrument manufacturer, confirm the flatness of the anvil and the spindle surface of a micrometer or dial gauge by the use of an optical flat that has clean surfaces. Surfaces shall be flat within 1 µm.

8.4.1 After cleaning the micrometer surfaces (see 8.1), place the optical flat on the anvil and close the presser foot as described in 8.6.2, 8.6.3, 8.6.4, or 8.6.5, as appropriate.

8.4.2 When illuminated by diffused daylight, interference bands are formed between the surfaces of the flat and those of the micrometer. The shape, location, and number of these bands indicate the deviation from flatness in increments of half the average wavelengths of white light, which is taken as 0.25 µm.

8.4.2.1 A flat surface forms straight parallel fringes at equal intervals.

8.4.2.2 A grooved surface forms straight parallel fringes at unequal intervals.

8.4.2.3 A symmetrical concave or convex surface forms concentric circular fringes. Their number is a measure of the deviation from flatness.

8.4.2.4 An unsymmetrical concave or convex surface forms a series of curved fringes that cut the periphery of the micrometer surface. The number of fringes cut by a straight line connecting the terminals of any fringes is a measure of the deviation from flatness.

8.5 *Machinist's Micrometer Requirements*:

8.5.1 The requirements for a zero reading of machinist's micrometers are met when ten closings of the spindle onto the anvil, in accordance with 8.6.2.3 or 8.6.3.3, as appropriate, result in ten zero readings. The condition of zero reading is satisfied when examinations with a low-power magnifying glass show that at least 66 % of the width of the zero graduation mark on the barrel coincides with at least 66 % of the width of the reference mark.