



Designation: D 2240 – 00

Standard Test Method for Rubber Property—Durometer Hardness¹

This standard is issued under the fixed designation D 2240; 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 Department of Defense.

1. Scope

1.1 This test method describes eight types of rubber hardness measurement devices known as durometers: types A, B, C, D, DO, O, OO and M. The procedure for determining indentation hardness of substances classified as thermoplastic elastomers, vulcanized (thermoset) rubber, elastomeric materials, cellular materials, and some plastics is also described.

1.2 This test method is not equivalent to other indentation hardness methods and instrument types, specifically those described in ASTM D 1415.

1.3 This test method is not applicable to the testing of coated fabrics.

1.4 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only. Many of the stated dimensions in SI are direct conversions from the U. S. Customary System to accommodate the instrumentation, practices and procedures that existed prior to the Metric Conversion Act of 1975.

1.5 All materials, instruments, or equipment used for the determination of mass, force or dimension shall have traceability to the National Institute for Standards and Technology, or other internationally recognized organization parallel in nature.

1.6 *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 374 Standard Test Method for Thickness of Solid Electrical Insulation²

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing³

D 785 Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials²

¹ This test method is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.10 on Physical Tests.

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² Annual Book of ASTM Standards, Vol 10.01.

³ Annual Book of ASTM Standards, Vol 08.01.

D 1349 Practice for Rubber—Standard Temperatures For Testing⁴

D 1415 Standard Test Method for Rubber Property – International Hardness⁴

D 4483 Practice for Determining Precision for Test Method Standards in the Rubber and Carbon Black Industries⁴

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

3. Summary of Test Method

3.1 This test method permits hardness measurements based on either initial indentation or indentation after a specified period of time, or both. Durometers with maximum reading indicators used to determine maximum hardness values of a material may yield lower hardness when the maximum indicator is used.

3.2 The procedures for Type M, or micro hardness durometers, accommodate specimens that are, by their dimensions or configuration, ordinarily unable to have their durometer hardness determined by the other durometer types described. Type M durometers are intended for the testing of specimens having a thickness or cross sectional diameter of 1.25 mm (0.050 in) or greater, although specimens of lesser dimensions may be successfully accommodated under the conditions specified in Section 6, and have a Type M durometer hardness range of between 20 and 90. Those specimens which have a durometer hardness range other than specified shall use another suitable procedure for determining durometer hardness.

4. Significance and Use

4.1 This test method is based on the penetration of a specific type of indenter when forced into the material under specified conditions. The indentation hardness is inversely related to the penetration and is dependent on the elastic modulus and viscoelastic behavior of the material. *The geometry of the indenter and the applied force influence the measurements such that no simple relationship exists between the measurements obtained with one type of durometer and those obtained with another type of durometer or other instruments used for measuring hardness.* This test method is an empirical test intended primarily for control purposes. No simple relationship

⁴ Annual Book of ASTM Standards, Vol 09.01.

⁵ Annual Book of ASTM Standards, Vol 14.02.

exists between indentation hardness determined by this test method and any fundamental property of the material tested. For specification purposes it is recommended that ASTM Test Method D 785 be used for materials other than those described in 1.1.

5. Apparatus

5.1 Hardness measuring apparatus, or durometer, and an operating stand, Type 1, Type 2, or Type 3, refer to Section 5.1.2, consisting of the following components:

5.1.1 Durometer

5.1.1.1 Presser Foot, with an orifice (to allow for the protrusion of the indenter) having a diameter as specified in Fig. 1a, Fig. 1b, or Fig. 1c, with the center a minimum of 6.0 mm (0.24 in) from any edge of the foot.

5.1.1.2 Presser Foot, Type M, with an orifice (to allow for the protrusion of the indenter) having a diameter as specified in Fig. 1d, with the center a minimum of 1.60 mm (0.063 in) from any edge of the flat circular presser foot.

5.1.1.3 Indentor, formed from steel rod and hardened to 500 HV10 and shaped in accordance with Fig. 1a, Fig. 1b, or Fig. 1c, polished over the contact area so that no flaws are visible under $20\times$ magnification, with an indenter extension of 2.50 ± 0.04 mm (0.098 ± 0.002 in).

5.1.1.4 Indentor, Type M, formed from steel rod and hardened to 500 HV10 and shaped in accordance with Fig. 1d, polished over the contact area so that no flaws are visible under $50\times$ magnification, with an indenter extension of 1.25 ± 0.02 mm (0.049 ± 0.001 in).

5.1.1.5 Indentor Extension Indicator, (analog or digital electronic), having a display that is an inverse function of the indenter extension. The display shall indicate from 0 to 100 with equal divisions throughout the range at a rate of one hardness point for each 0.025 mm (0.001 in) of indenter movement, for Type M durometers, the display shall indicate from 0 to 100 with no less than 100 equal divisions at a rate of one hardness point for each 0.0125 mm (0.0005 in) of indenter movement.

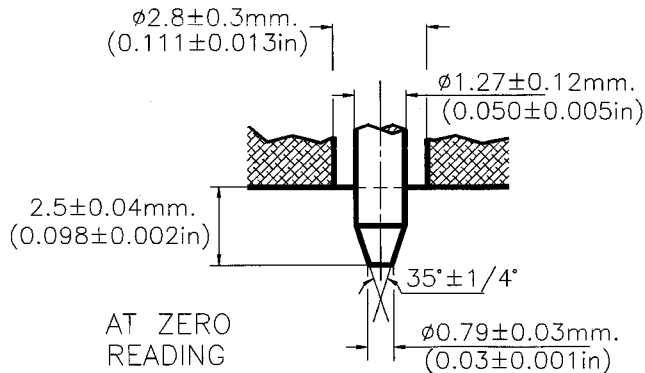


Figure 1a Type A and C Indentor

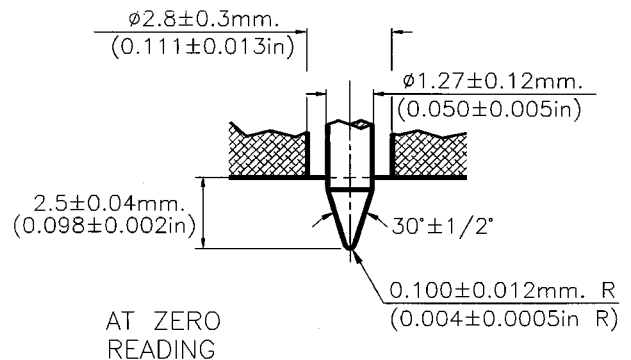


Figure 1b Type B and D Indentor

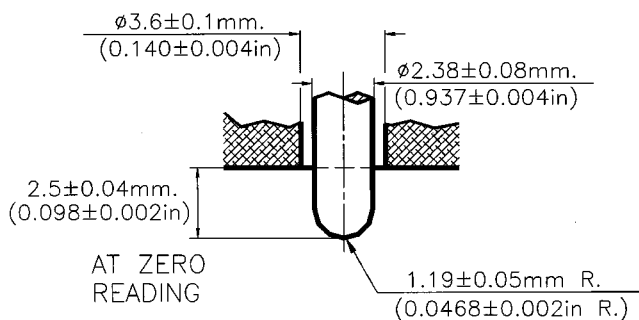


Figure 1c O, DO, and oo Indentor

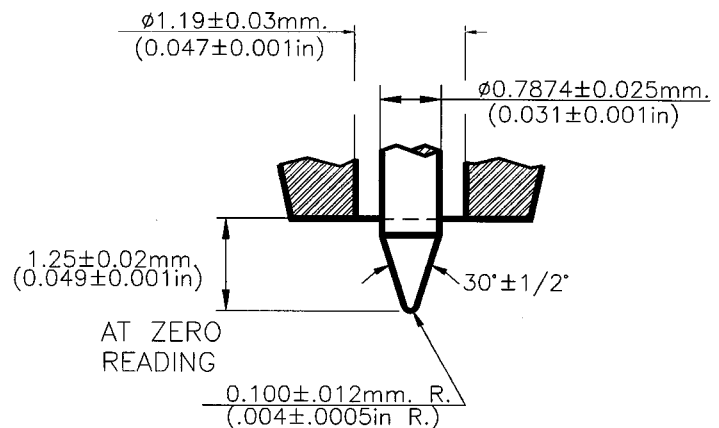


Figure 1d Type M Indentor

FIG. 1 Durometers

5.1.1.6 Timing Device (optional), capable of being set to a desired elapsed time, signaling the operator or holding the hardness reading when the desired elapsed time has been reached. The timer shall be automatically activated when the presser foot is in contact with the specimen being tested, e.g., the initial indenter travel has ceased. Digital electronic durometers may be equipped with electronic timing devices that shall not affect the indicated reading or determinations attained by more than one half the calibration tolerance stated in Table 1.

5.1.1.7 Maximum indicators (optional), maximum indicating pointers are auxiliary analog indicating hands designed to remain at the maximum hardness value attained until reset by the operator. Electronic maximum indicators are digital displays electronically indicating and maintaining the maximum value hardness value achieved, until reset by the operator.

5.1.1.8 Analog maximum indicating pointers have been shown to have a nominal affect on the values attained, however this affect is greater on durometers of lesser total mainspring loads, e.g., the affect of a maximum indicating pointer on Type D durometer determinations will be less than those determinations achieved using a Type A durometer. Analog style durometers may be equipped with maximum indicating pointers. The affect of a maximum indicating pointer shall be noted at the time of calibration in the calibration report, refer to Section 10.1.4, and when reporting hardness determinations, refer to Section 10.2.4. Analog Type M durometers shall not be equipped with maximum indicating pointers.

5.1.1.9 Digital electronic durometers may be equipped with electronic maximum indicators that shall not affect the indicated reading or determinations attained by more than one half of the spring calibration tolerance stated in Table 1.

5.1.1.10 Calibrated Spring, for applying force to the indenter, in accordance with Fig. 1a through Fig. 1d and capable of applying the forces as specified in Table 1.

5.1.2 Operating Stand

5.1.2.1 Type 1, Type 2, and Type 3, shall be capable of supporting the durometer presser foot surface parallel to the specimen support table (Fig. 2) throughout the travel of each. The durometer presser foot to specimen support table parallelism shall be verified each time the test specimen support table is adjusted to accommodate specimens of varying dimensions. This may be accomplished by applying the durometer presser foot to the point of contact with the specimen support table and

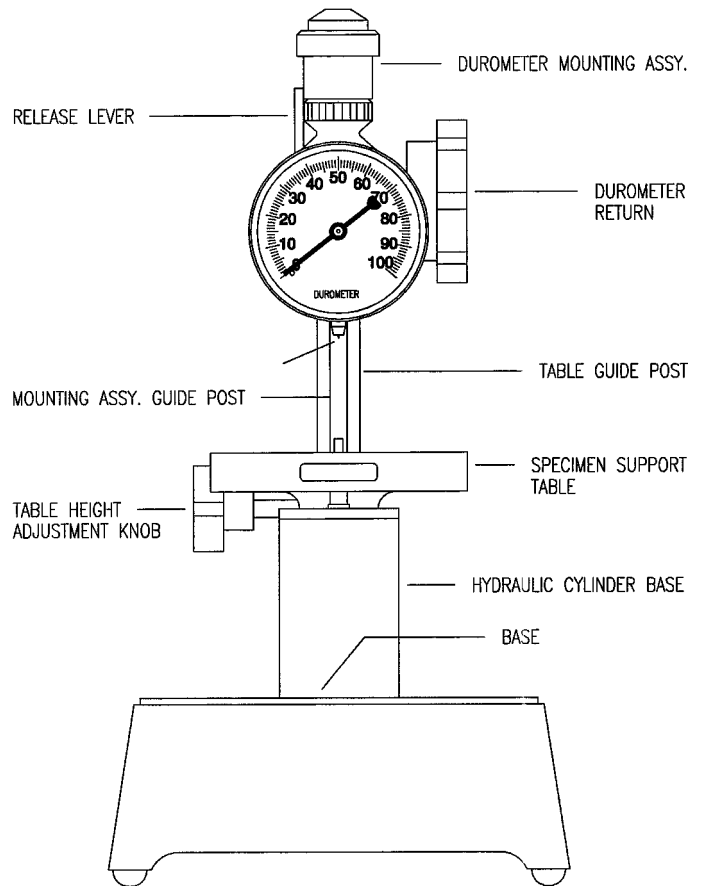


FIG. 2 Durometer Operating Stand

making adjustments by way of the durometer mounting assembly or as specified by the manufacturer.

5.1.2.2 Operating Stand, Type 1 (specimen to indenter type), shall be capable of applying the specimen to the indenter in a manner that minimizes shock.

5.1.2.3 Operating Stand, Type 2 (indenter to specimen type), shall be capable of controlling the rate of descent of the indenter to the specimen at a maximum of 3.20 mm/s (0.125 in/s) and applying a force sufficient to overcome the calibrated spring force as shown in Table 1.

5.1.2.4 Operating Stand, Type 3 (indenter to specimen type), hydraulic dampening, pneumatic dampening or electro-mechanical (required for the operation of Type M durometers) shall be capable of controlling the rate of descent of the indenter to the specimen at a maximum of 3.2 mm/s (0.125 in/s) and applying a force sufficient to overcome the calibrated spring force as shown in Table 1. Manual application, Type 1 or Type 2 operating stands are not acceptable for Type M durometer operation.

5.1.2.5 The entire instrument should be plumb and level, and resting on a surface that will minimize vibration. Operating the instrument under adverse conditions will negatively affect the determinations attained.

5.1.2.6 Specimen Support Table, (Fig. 2) integral to the operating stand, and having a solid flat surface. The specimen support platform may have orifices designed to accept various inserts or support fixtures (Fig. 3) to provide for the support of irregularly configured specimens. When used with a durometer, the specimen support table shall be capable of supporting the durometer presser foot throughout the travel of each.

TABLE 1 Durometer Spring Force Calibration
All Values are in N

Indicated Value	Type M	Type A, B, O	Type C, D, DO	Type OO
0	0.324	0.55		0.203
10	0.368	1.3	4.445	0.294
20	0.412	2.05	8.89	0.385
30	0.456	2.8	13.335	0.476
40	0.5	3.55	17.78	0.566
50	0.544	4.3	22.225	0.657
60	0.589	5.05	26.67	0.748
70	0.633	5.8	31.115	0.839
80	0.677	6.55	35.56	0.93
90	0.721	7.3	40.005	1.02
100	0.765	8.05	44.45	1.111
N/durometer unit	0.0044	0.075	0.4445	0.00908
Spring Calibration Tolerance	± 0.0176 N	± 0.075 N	± 0.4445 N	± 0.0182 N