INTERNATIONAL

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Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials[1]

This standard is issued under the fixed designation D785; 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 U.S. Department of Defense.

1. Scope*

1.1 This test method covers two procedures for testing the indention hardness of plastics and related plastic electrical insulating materials by means of the Rockwell hardness tester.

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

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—This test method and ISO 2039-2 are equivalent. Procedure A of this test method is equivalent to the test method in the main body of ISO 2039-2. Procedure B of this test method is equivalent to the test method in the integral annex part of ISO 2039-2.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D618 Practice for Conditioning Plastics for Testing
D883 Terminology Relating to Plastics
D2240 Test Method for Rubber Property—Durometer Hardness
D4000 Classification System for Specifying Plastic Materials
E18 Test Methods for Rockwell Hardness of Metallic Materials
E456 Terminology Relating to Quality and Statistics
E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method
E2935 Practice for Evaluating Equivalence of Two Testing Processes

2.2 *ISO Standards*[3]

ISO 2039-2 Plastics—Determination of Hardness—Part 2: Rockwell Hardness

3. Terminology

3.1 Definitions used in this test method are in accordance with Terminology D883.

3.2 For definitions of terms that appear in this practice relating to quality and statistics (such as precision and bias), refer to Terminology E456.

3.3 *Definitions of Terms Specific to This Standard:*

3.3.1 *indentation hardness*—the resistance of a material to surface penetration or plastic deformation.

4. Significance and Use

4.1 A Rockwell hardness number is a number derived from the net increase in depth impression as the load on an indenter is increased from a fixed minor load to a major load and then returned to a minor load (Procedure A). A Rockwell alpha (α) hardness number represents the maximum possible remaining travel of a short-stroke machine from the net depth of impression, as the load on the indenter is increased from a fixed minor load to a major load (Procedure B). Indenters are round steel balls of specific diameters. Rockwell hardness numbers are always quoted with a scale symbol representing the indenter size, load, and dial scale used. This test method is based on Test Methods E18. Procedure A (Section 11) yields the indentation of the specimen remaining 15 s after a given major load is released to a standard 10-kg minor load. Procedure B (Section 12) yields the indentation of the indenter

[1] This method is under the jurisdiction of ASTM Committee D20 on Plastics and is 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**

into the specimen after a 15-s application of the major load while the load is still applied. Each Rockwell scale division represents 0.002-mm (0.00008-in.) vertical movement of the indenter. In practice, the Rockwell hardness number is derived from the following relationship:

$$HR = 130 - e \quad (1)$$

where:

HR = the Rockwell hardness number, and
e = the depth of impression after removal of the major load, in units of 0.002 mm. This relation only holds for the E, M, L, R, and K scales.

4.2 A Rockwell hardness number is directly related to the indentation hardness of a plastic material, with the higher the reading the harder the material. An α hardness number is equal to 150 minus the instrument reading. Due to a short overlap of Rockwell hardness scales by Procedure A, two different dial readings on different scales may be obtained on the same material, both of which may be technically correct.

4.3 For certain types of materials having creep and recovery, the time factors involved in applications of major and minor loads have a considerable effect on the results of the measurements.

4.4 The results obtained by this test method are not generally considered a measure of the abrasion or wear resistance of the plastic materials in question.

4.5 Indentation hardness is used as an indication of cure of some thermosetting materials at room temperature. Generally, an uncured specimen has a hardness reading below normal.

4.6 Each Rockwell hardness scale in Table 1 is an extension of the proceeding less severe scale, and while there is some overlap between adjacent scales, a correlation table is not desirable. Readings on one material may be satisfactory for such a table, but there is no guarantee that other plastic materials will give corresponding readings because of differences in elasticity, creep, and shear characteristics.

4.7 Before proceeding with this test method, reference should be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, and/or testing parameters covered in the materials specification shall take precedence over those mentioned in this test method. If there are no material specifications, then the default conditions apply.

TABLE 1 Rockwell Hardness Scales

Rockwell Hardness Scale (Red Dial Numbers)	Minor Load, kg	Major Load, kg[A]	Indenter Diameter in.	Indenter Diameter mm
R	10	60	0.5000 ± 0.0001	12.700 ± 0.0025
L	10	60	0.2500 ± 0.0001	6.350 ± 0.0025
M	10	100	0.2500 ± 0.0001	6.350 ± 0.0025
E	10	100	0.1250 ± 0.0001	3.175 ± 0.0025
K	10	150	0.1250 ± 0.0001	3.175 ± 0.0025

[A] This major load is not the sum of the actual weights at the back of the frame but is a ratio of this load, depending on the leverage arm of machine. One make and model has a 25 to 1 leverage arm.

5. Factors Affecting Reproducibility and Accuracy

5.1 Rockwell hardness readings have been found reproducible to ±2 divisions for certain homogeneous materials with a Young's modulus in compression over 3400 MPa (5×10^5 psi). Softer plastics and coarse-filled materials will have a wider range of variation. A large ball indenter will distribute the load more evenly and decrease the range of test results (Note 2). The sensitivity of the instrument decreases with an increase in the dial reading and becomes very poor for readings of 100 and over due to the shallow indentation of the steel ball. It is desirable to use the smallest ball and highest load that is practical because of this loss of sensitivity. Rockwell hardness readings over 115 are not satisfactory and shall not be reported. Readings between zero and 100 are recommended, but readings to 115 are permissible. For comparison purposes, it may be desirable to take readings higher than 115 or lower than zero on any single scale. In such cases, Rockwell hardness readings may be reported, but the corresponding correct readings shall follow in parentheses, if possible. Such alternate readings are not always feasible when the specimen is subjected to constantly changing conditions or irreversible reactions.

NOTE 2—Molded specimens containing coarse fiber fillers, such as woven glass fabric, will influence the penetration obtained. These variations in hardness may be reduced by testing with the largest ball indenter consistent with the overall hardness of the material.

5.2 If the bench or table on which a Rockwell hardness tester is mounted is subject to vibration, such as is experienced in the vicinity of other machines, the tester should be mounted on a metal plate with sponge rubber at least 25 mm (1 in.) thick, or on any other type of mounting that will effectually eliminate vibration from the machine. Otherwise the indenter will indent further into the material than when such vibrations are absent.

5.3 Dust, dirt, grease, and scale or rust should not be allowed to accumulate on the indenter, as this will affect the results. Steel ball indenters that have nicks, burrs, or are out of round shall not be used.

5.4 The condition of the test equipment is an important factor in the accuracy of the test results. Dust, dirt or heavy oil act as a cushion to the load supporting members of the test equipment and cause erroneous readings of the instrument dial. The shoulders of the instrument housing, indenter chuck, ball seat in the instrument housing, capstan, capstan screw, and anvil shoulder seat should be kept clean and true. The capstan and screw should be lightly oiled. Pitted anvil surfaces may be refinished with 600 grit paper.

5.5 Surface conditions of the specimen have a marked effect on the readings obtained in a test. Generally, a molded finish will give a higher Rockwell reading than a machined face due to the high resin content or filled materials or better orientation and lower plasticizer content of unfilled plastic materials. Injection mold specimens in such a way that sink marks and