

Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor¹

This standard is issued under the fixed designation D2583; 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 the determination of indentation hardness of both reinforced and nonreinforced rigid plastics using a Barcol Impressor, Model No. 934-1 and Model No. 935.

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

NOTE 1—There is no known ISO equivalent to this test method.

2. Referenced Documents

2.1 ASTM Standards:²

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D4000 Classification System for Specifying Plastic Materials

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this test method, see Terminology D883.

4. Summary of Test Method

4.1 A material's surface hardness is determined through the use of a Barcol Impressor. The relative depth of penetration of

the Impressor's indenter provides a comparative measure of the material's hardness. The Model No. 934-1 and Model No. 935 Barcol Impressors are designated for use with plastics. Within the range of hardness measured by these Impressors the Model No. 934-1 is used for measuring harder materials and the Model No. 935 is used for measuring softer materials.

5. Significance and Use

5.1 The Barcol Impressor is portable and therefore suitable for testing the hardness of fabricated parts and individual test specimens for production control purposes.

5.2 Before proceeding with this test method, reference shall be made to the specification of the material being tested. Table 1 of Classification System D4000 lists the ASTM material standards that currently exist. Any test specimen preparation, conditioning, dimensions, or testing parameters or combination thereof covered in the relevant ASTM material specification shall take precedence over those mentioned in this test method. If there are no relevant ASTM material specifications, then the default conditions apply.

6. Apparatus (Fig. 1 and Fig. 2)

6.1 *Indenter*³—The indenter shall consist of a hardened steel truncated cone having an angle of 26° with a flat tip of 0.157 mm (0.0062 in.) in diameter. It shall fit into a hollow spindle and be held down by a spring-loaded plunger. See Fig. 2.

6.2 *Indicating Device*—The indicating dial shall have 100 divisions, each representing a depth of 0.0076-mm (0.0003-in.) penetration. The higher the reading is, the harder the material is.

6.3 *Calibration Standards*—"Hard" and "soft" aluminum alloy disks supplied by the manufacturer of the instrument. Other disks should not be used, even if they are of the same

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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 The sole source of supply of the apparatus known to the committee at this time is Eurotherm/Barber-Colman, 741-F Miller Drive, Leesburg, VA 20175-8993. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

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



FIG. 1 Barcol Impressor

alloy and temper as the manufacturer's disks, as the hardness of aluminum varies within any given alloy-temper parameter.

6.4 A smooth glass plate is also needed.

7. Test Specimens

7.1 The testing area shall be smooth and free from mechanical defects.

7.2 *Dimensions*—Test specimens shall be at least 1.5 mm ($\frac{1}{16}$ in.) thick and large enough to ensure a minimum distance of 3 mm ($\frac{1}{8}$ in.) in any direction from the indenter point to the edge of the specimen, as well as from test point to test point.

8. Preparation and Operation of Apparatus

8.1 The preparation and operation of Models 934-1 and 935 are identical. Place the Impressor and the material to be tested (or the calibration disk) on a solidly supported, flat, hard, firm surface such as stone, metal, or ceramic. If softer supporting surfaces are used, a false low instrument reading may occur.

8.2 Set the point sleeve on the surface to be tested. Set the legs on the same surface or on solid material of the same thickness, so that the indenter is perpendicular to the surface being tested. Grasp the instrument firmly between the legs and point sleeve. Apply a uniform downward force quickly, by hand, increasing the force on the case until the dial indication reaches a maximum (Note 3). Take care to avoid sliding or scraping while the indenter is in contact with the surface being tested. Record the maximum reading.

NOTE 2—It is recommended that measurements be made with the Model 934-1 Impressor when values above 90 are obtained with the Model 935 Impressor and that measurements be made with the Model 935 Impressor when values less than 20 are obtained with the Model No. 934-1 Impressor. Values below 10 using the Model 935 Impressor are inexact and should not be reported.

NOTE 3—Drift in readings from the maximum occurs in some materials and can be nonlinear with time.

9. Calibration

9.1 With the plunger upper guide backed out until it just engages the spring, place the Impressor on a glass surface and press down until the point is forced all the way back into the

lower plunger guide. The indicator should now read 100. If it does not, loosen the lock-nut and turn the lower plunger guide in or out to obtain a 100 reading. Next, read the "hard" aluminum alloy disk supplied by the manufacturer of the Impressor and, if necessary, adjust so that the reading is within the range marked on the disk. Then do the same with the "soft" disk. If these readings cannot be obtained, subsequent measurements are not valid.

10. Conditioning

10.1 *Conditioning*—Condition the test specimens at $23 \pm 2^\circ\text{C}$ ($73.4 \pm 3.6^\circ\text{F}$) and $50 \pm 10\%$ relative humidity for at least 40 h prior to test in accordance with Procedure A of Practice D618, unless otherwise specified by the contract or relevant ASTM material specification. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) and $\pm 5\%$ relative humidity.

10.2 *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 $50 \pm 10\%$ relative humidity, unless otherwise specified by the contract or relevant ASTM material specification. In cases of disagreement, the tolerances shall be $\pm 1^\circ\text{C}$ ($\pm 1.8^\circ\text{F}$) and $\pm 5\%$ relative humidity.

11. Procedure

11.1 Observing the precautions of Section 8, make measurements on the specimens to be tested (Note 4). Indentations should not be made within 3 mm ($\frac{1}{8}$ in.) of the edge of the specimen or of other indentations.

NOTE 4—Curved surfaces are more difficult to support. When the load is applied, bending and spring action in the specimen should be avoided.

12. Number of Readings

12.1 Make a minimum of ten determinations of hardness at different positions on the specimen, spaced according to the guidelines defined in 11.1.

NOTE 5—Application of the Barcol Impressor to reinforced plastic (non-homogeneous) materials will produce greater variation in hardness readings than on non-reinforced (homogeneous) materials. This greater variation is mainly caused by the difference in hardness between resin and filler materials in contact with the small diameter indenter.

13. Report

13.1 Report the following information:

- 13.1.1 Identification of material tested,
- 13.1.2 Conditioning of specimen,
- 13.1.3 Model number of Impressor,
- 13.1.4 Number of readings taken,
- 13.1.5 Average of hardness values rounded to the nearest whole scale reading,
- 13.1.6 Date of test, and
- 13.1.7 Test method number and published/revision date.

14. Precision and Bias⁴

14.1 No precision statement using Model 935 can be offered at this time.

⁴ Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D20-1087.

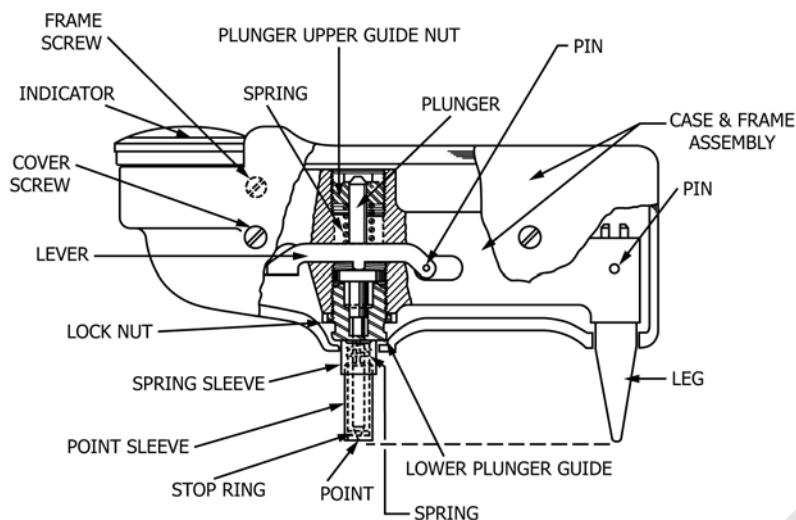


FIG. 2 Diagram of Barcol Impressor

14.2 Table 1 is based on a round robin conducted in 1981, in accordance with Practice E691, involving five materials tested by nine laboratories using Model No. 934-1. For each material, all the samples were prepared at one source. Each laboratory obtained three test results for each material. For the materials shown, the indicated number of individual determinations were averaged to calculate each test result as follows:

Material	No. of Determinations using Model No. 934-1
SAN	8
BMC	22
SAN reinforced with 20 % glass	22
Polyester Mat Laminate (thermoset)	16
SMC (sheet molding compound)	16

(Warning—The following explanations of I_r and I_R (14.3 – 14.3.3) are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Table 1 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, materials, or laboratories. Users of this test method should apply the principles outlined in Practice E691 to generate data specific to their laboratory and materials, or between specific laboratories. The principles of 14.3 – 14.3.3 would then be valid for such data.)

14.3 Concept of I_r and I_R —If S_r and S_R were calculated from a large enough body of data, and for test results that were averages from the numbers of determinations stated in 14.2:

14.3.1 Repeatability, I_r (Comparing two test results for the same material, obtained by the same operator using the same Barcol Impressor on the same day)—The samples represented

TABLE 1 Precision Data for Model No. 934-1

Material	Values in Units of Barcol Hardness				
	Average	S_r^A	S_R^B	I_r^C	I_R^D
SAN	35	1.04	2.93	3	8
BMC	39	0.95	3.75	3	11
Reinforced SAN	44	1.11	2.25	3	6
Polyester laminate	55	1.45	1.93	4	5
SMC	61	1.14	2.15	3	6

^A S_r = within-laboratory standard deviation of the average.

^B S_R = between-laboratories standard deviation of the average.

^C I_r = $2.83 S_r$.

^D I_R = $2.83 S_R$.

by the two test results should be regarded as not having equivalent hardness if the test results differed by more than the I_r value for that material and condition.

14.3.2 Reproducibility, I_R (Comparing two test results for the same material, obtained by different operators using different Barcol Impressors on different days)—The samples represented by the two test results should be regarded as not having equivalent hardness if the test results differed by more than the I_R value for that material and condition.

14.3.3 Any judgment in accordance with 14.3.1 and 14.3.2 would have an approximate 95 % (0.95) probability of being correct.

14.4 Bias—There are no recognized standards on which to base an estimate of bias for this test method.

15. Keywords

15.1 Barcol Hardness Impressor; Models 934-1 and 935; hardness; indentation hardness; rigid plastics



Committee D20 has identified the location of selected changes to this standard since the last issue (D2583 - 13) that may impact the use of this standard. (September 1, 2013)

(1) Revised **Note 5** regarding expected variation between homogeneous and non-homogeneous materials.

Committee D20 has identified the location of selected changes to this standard since the last issue (D2583 - 07) that may impact the use of this standard. (March 15, 2013)

(1) Revised **10.1** and **10.2** to reflect current tolerances for standard temperature and relative humidity conditions for laboratory atmospheres according to Practice **D618** (Procedure A).

(2) Revised **12.1** and **Note 5** on the “Number of Readings” to reflect a simplified “minimum of 10” measurement.

(3) Deleted old Table 1.

(4) Renumbered Table 2 and corrected the reference in **14.2**.

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