



# Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor<sup>1</sup>

This standard is issued under the fixed designation D 2583; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

<sup>ε1</sup> NOTE—Editorial changes were made throughout in November 2001.

## 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 the 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 currently no ISO standard that duplicates this test method.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 618 Practice for Conditioning Plastics for Testing<sup>2</sup>
- D 883 Terminology Relating to Plastics<sup>2</sup>
- D 4000 Classification System for Specifying Plastic Materials<sup>3</sup>
- D 4805 Terminology for Plastics Standards<sup>3</sup>
- E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method<sup>4</sup>

## 3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this test method, see Terminology D 883 or Terminology D 4805.

## 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. 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 should be made to the specification of the material being tested. Any test specimen preparation, conditioning, dimensions, or testing parameters or combination thereof covered in the relevant ASTM materials specification shall take precedence over those mentioned in this test method. If there are no relevant ASTM material specifications, then the default conditions apply. Table 1 of Classification System D 4000 lists the ASTM materials standards that currently exist.

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

6.1 *Indenter*<sup>5</sup>—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 the harder the material.

6.3 *Calibration Standards*—"Hard" and "soft" aluminum alloy disks supplied by the manufacturer of the instrument.

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.10 on Mechanical Properties. Current edition approved October 10, 1995. Published December 1995. Originally published as D 2583 – 67. Last previous edition D 2583 – 93.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 08.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>5</sup> Apparatus is available from Eurotherm/Barber-Colman, 741-F Miller Drive, Leesburg, VA 20175-8993.

**TABLE 1 Recommended Sample Sizes to Equalize the Variance of the Average for Model No. 934-1**

Homogeneous Material				
Hardness M-934 Scale	Reading Variance	Coefficient of Variation, %	Variance of Average	Minimum Number of Readings
20	2.47	2.6	0.27	9
30	2.20	1.7	0.28	8
40	1.93	1.3	0.27	7
50	1.66	1.1	0.28	6
60	1.39	0.9	0.28	5
70	1.12	0.8	0.28	4
80	0.85	0.7	0.28	3
Nonhomogeneous Material (Reinforced Plastics)				
30	22.4	2.9	0.77	29
40	17.2	2.2	0.78	22
50	12.0	1.7	0.75	16
60	7.8	1.5	0.78	10
70	3.6	1.2	0.75	5



**FIG. 1 Barcol Impressor**

Other disks should not be used, even if they are of the same alloy and temper as the manufacturer’s disks, as the hardness of aluminum may vary 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 (1/16 in.) thick and large enough to ensure a minimum distance of 3 mm (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 falsely 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 may occur 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 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity for not less than 40 h prior to test in accordance with Procedure A of Practice D 618, unless otherwise specified by the contract or relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±2 % relative humidity.

10.2 *Test Conditions*—Conduct tests in the standard laboratory atmosphere of 23 ± 2°C (73.4 ± 3.6°F) and 50 ± 5 % relative humidity, unless otherwise specified by the contract or relevant ASTM material specification. In cases of disagreement, the tolerances shall be ±1°C (±1.8°F) and ±2 % relative humidity.

**11. Procedure**

11.1 Observing the precautions of Section 8, make measurements on the specimens to be tested (Note 4). Impressions should not be made within 3 mm (1/8 in.) of the edge of the specimen or of other impressions.

NOTE 4—Curved surfaces may be 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 Application of the Barcol Impressor to reinforced plastic (nonhomogeneous) materials will produce greater variation in hardness readings than on nonreinforced (homogeneous) materials. This greater variation may be caused mainly by the difference in hardness between resin and filler materials

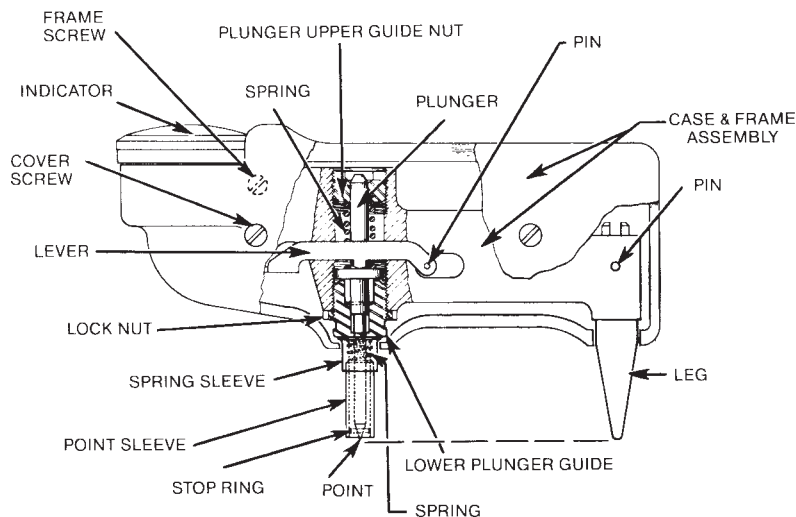


FIG. 2 Diagram of Barcol Impressor

in contact with the small diameter indenter. There is less variation in hardness readings on harder materials in the range of 50 Barcol and higher and considerably more variation in the readings of softer materials. On homogeneous materials, five readings are needed to maintain a variance-of-average of 0.28 at a 60 Barcol reading; for the same variance-of-average at 30 Barcol, eight readings are needed. On reinforced plastics, in order to maintain a variance-of-average of 0.78 at 60 Barcol, ten readings are needed; and 29 readings are needed for the same variance at the 30 Barcol level (Table 1).

NOTE 5—These findings were obtained with a round robin conducted in a workshop with all participants present. Eight plastic materials of different hardness were evaluated with six different Barcol (934-1) Impressors.

### 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 Bias <sup>6</sup>

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

14.2 Table 2 is based on a round robin conducted in 1981, in accordance with Practice E 691, 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:

TABLE 2 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

<sup>A</sup>  $S_r$  = within-laboratory standard deviation of the average.

<sup>B</sup>  $S_R$  = between-laboratories standard deviation of the average.

<sup>C</sup>  $I_r = 2.83 S_r$ .

<sup>D</sup>  $I_R = 2.83 S_R$ .

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

NOTE 6—**Caution:** 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 2 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 E 691 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 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

<sup>6</sup> Supporting data are available from ASTM Headquarters. Request RR: D20-1087.

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

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).*