Shore A and Shore D hardness testing of rubber

DIN 53505

ICS 83.060

Prüfung von Kautschuk und Elastomeren – Härteprüfung nach Shore A und Shore D

This standard, together with DIN EN ISO 868, January 1998 edition, supersedes June 1987 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Foreword

This standard has been prepared by Technical Committee *Prüfung der physikalischen Eigenschaften von Kautschuk und Elastomeren* of the *Normenausschuss Materialprüfung* (Materials Testing Standards Committee). It conforms largely with DIN EN ISO 868 and ISO 7619 : 1997.

The precision data given here were obtained in a 1985 interlaboratory test in which 14 laboratories participated. Test pieces of three qualities of rubber were prepared in a central laboratory, and then each laboratory tested five test pieces of each rubber quality over four successive days. Each test comprised three measurements, the median of which was given to the nearest Shore unit. The results are shown in table 3.

It was shown that a shorter reading interval of one second and the use of a hand-held instrument had no influence on the precision data. However, the level of the test (cf. table 3) was influenced by the measurement procedure itself, particularly in the lower hardness range (around 40 Shore A). Here, an increase by 0,8 units was observed for a reading time of one second, and an increase by 1,2 units occurred where a hand-held instrument was used. Repeatability and reproducibility can therefore only be ensured if the test parameters specified in this standard (a reading interval of three seconds and the use of a stand) are maintained.

Amendments

This standard differs from the June 1987 edition in that it no longer deals with plastics, as these are covered in DIN EN ISO 868, and references have been updated.

Previous editions

DIN 53503-2: 1943-03; DIN 53503: 1948-08; DIN 53505: 1953-09, 1957-06, 1960-05, 1967-04, 1973-03, 1973-08, 1987-06.

1 Scope

This standard specifies the hardness testing of rubber test pieces and products. The hardness of a rubber is determined by its viscoelastic properties, particularly the elastic modulus as determined in DIN 53504. Type A durometers are suitable for testing in the hardness range from 10 to 90 Shore A, while type D durometers are to be used in the high hardness range.

The ball indentation method can be used for the middle hardness range, either using a 2,5 mm diameter ball as specified in DIN 53519-1 or – for softer test pieces – with a 5 mm diameter ball as specified in DIN EN ISO 2039-1. Test pieces which are too small to be tested as in DIN 53519-1 may be tested in accordance with DIN 53519-2.

An overview of the ranges of application for the different hardness testing methods is given in Appendix A.

Continued on pages 2 to 5.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

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2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 51220	General requirements for materials testing machines, including verification and calibration
DIN 53504	Determination of tensile stress/strain properties of rubber
DIN 53519-1	Determination of indentation hardness (IRHD) of soft rubber using standard specimens
DIN 53519-2	Determination of indentation hardness (IRHD) of soft rubber using small specimens
DIN 53541	Determination of crystallization effects by measuring the hardness of rubber
DIN 53545	Determination of low-temperature behaviour of rubber – Principles and test methods
DIN 53598-1	Statistical evaluation of random samples with examples from tests on elastomers and plastics
DIN EN ISO 868	Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness) (ISO 868 : 1985)
DIN EN ISO 2039-1	Plastics – Determination of hardness – Part 1: Ball indentation method (ISO 2039-1 : 1993)
ISO 5725-1 : 1994	Accuracy (trueness and precision) of measurement methods and results – Part 1: General principles and definitions
ISO 7619 : 1997	Rubber – Determination of indentation hardness by means of pocket hardness meters

3 Concepts

Shore hardness

The resistance to indentation by a body of defined shape and under a specified load.

The Shore hardness scale ranges from 0 to 100, with 0 being the lowest and 100 the highest value.

4 Designation

Designation of the method of testing the hardness of rubber using a type A durometer:

Test DIN 53505 – A

Designation of the method of testing the hardness of rubber using a type D durometer:

Test DIN 53505 – D

5 Apparatus

5.1 Durometers

Durometers shall meet the following requirements and shall be marked either 'Type A durometer, DIN 53505' or 'Type D durometer, DIN 53505', together with the manufacturer's trademark and serial number.

The scale interval shall correspond to one Shore hardness unit, and the scale spacing shall be at least 1 mm.

The shape and dimensions of the indenter and pressure foot shall be as shown in figure 1.

The loading characteristics shall be determined by applying forces to the indenter by means of weights, and shall comply with the nominal values given in table 1 to the nearest 5 mN.

Instruments shall be capable of measuring to an accuracy of ±1 Shore A or Shore D unit. Instruments used for in-house testing shall be inspected regularly by the user, while those used for conformity assessment (e.g. in acceptance tests or as a basis for certification) shall be verified annually according to DIN 51220 by an accredited test laboratory.

5.2 Durometer stand

The durometer may be placed on a stand to ensure that a load of up to (12,5 ± 0,5) N for type A durometers or (50 ± 0,5) N for type D durometers can be evenly applied to the test piece, and that the pressure foot is parallel to the test piece surface.

Table 1: Loading characteristics for type A and type D durometers

Shore hardness value	Indenter travel, in mm	Force, F, in mN	
		Shore A (± 40)	Shore D (± 200)
0	2,5 ± 0,02	550	0
10	Linear characteristics	1 300	[1]
20		2 050	8 900
30		2 805	13 350
40		3 555	17 800
50		4 305	22 250
60		5 060	26 700
70		5 810	31 150
80		6 560	35 600
90		7 310	40 050
100	0	8 065	44 500

[1]) No value is specified here because the required linearity cannot be achieved in the micro-range (0 to 10 Shore D) since there is no preload for Shore D testing.

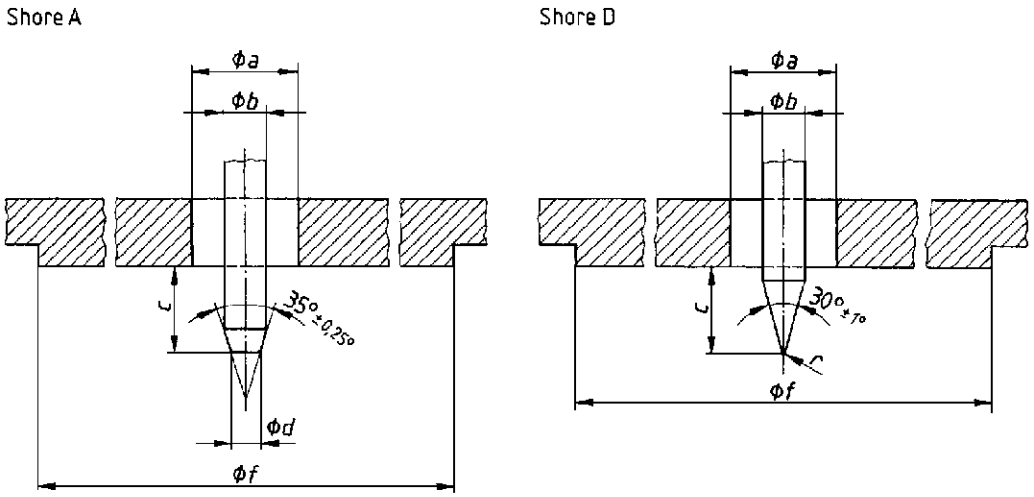

Figure 1: Indenter and pressure foot (notation; see table 2 for dimensions)

Table 2: Indenter and pressure foot dimensions (see figure 1)

a	⌀ (3 ± 0,10) mm	Indenter hardened and polished
b	⌀ (1,25 ± 0,15) mm	
c	(2,5 ± 0,02) mm	
d	(0,79 ± 0,01) mm	
r	(0,1 ± 0,01) mm (spherical)	
f	⌀ (18 ± 0,50) mm	

5.3 Conditioning chamber

If measurements are to be carried out above or below ambient temperature, a chamber may be provided in which the test temperature is maintained and in which measurements are to be carried out. For instance, the test piece, test piece support, indenter and pressure foot may be placed in the chamber, while the indicating device remains outside at ambient temperature, or the entire apparatus may be conditioned in the chamber.

6 Test pieces

6.1 Shape

Test pieces shall be at least 35 mm in diameter, at least 6 mm thick, and have a smooth, flat surface. Test pieces for Shore A testing shall be lightly dusted with talcum before measurements are performed.

Testing of thin materials may be carried out using stacked test pieces comprised of no more than three layers, each layer being at least 2 mm thick. Care shall be taken that no air is trapped between the layers. The use of stacked test pieces and the number of layers shall be noted in the test report.

Measurements may be made on products of any shape, although in the case of curved products, details are to be given as to the location of the measurement points. Note that results for a product which does not have the dimensions specified above only apply to products having the same shape as that tested, and are not to be deemed material constants.

6.2 Number of test pieces

One test piece shall be tested, unless otherwise specified.

7 Procedure

7.1 Testing shall be carried out on test pieces which have not been subjected to mechanical stress, at a temperature of (23 ± 2) °C, and at least 16 hours after vulcanization. If necessary, other test temperatures may be agreed upon, in which case the test piece temperature shall not deviate from the nominal value by more than ± 1 °C. This applies especially to testing at low temperatures.

Prior to testing, condition the test pieces in the chamber at test temperature for at least 30 minutes. For low temperature testing as in DIN 53541 or DIN 53545, the conditioning time shall be agreed.

7.2 On each test piece, measurements shall be made at three or more points spaced at least 5 mm apart and at least 13 mm from the edge of the test piece.

7.3 Place the durometer on the test piece, without shock, so that the pressure foot is in firm contact with the test piece. If a stand as in subclause 5.2 is not used (e.g. due to the shape of the test piece), the durometer may be held by hand, although this will increase the uncertainty of measurement, as will the failure to keep the pressure foot parallel to the test piece surface.

7.4 Once the pressure foot comes in contact with the test piece, wait three seconds and then read off the hardness value. For test pieces with strong flow characteristics, the reading may also be taken after 15 seconds. Note the time interval between application of the pressure foot and the reading.

8 Test report

The test report shall refer to this standard and include the following information:

a) type and designation of the product tested;

b) method by which the product was manufactured;

c) Shore A or Shore D hardness, given as a whole unit, the number of single results, median of results, and span (as in DIN 53598-1);

d) test temperature (where necessary);

e) time interval after which reading was taken (where necessary);

f) any deviations from this standard;

g) date of test.

9 Expression of results

EXAMPLES:

- 75 Shore A hardness (or, 75 Shore A, for short)
- 67 to 69 Shore A at 28 °C and 15 s
- 58 Shore A after 72 h at –30 °C

In technical drawings:
Elastomer, (75 ± 5) Shore A hardness as in DIN 53505

10 Precision

The following applies when evaluating results of Shore hardness testing (see also ISO 5725-1).

The precision data for the range from 40 to 80 Shore A are only slightly dependent on the level. The repeatability limit is 1,7 Shore A and the reproducibility limit is 2,6 Shore A. Since Shore hardness values are given in whole units, these limits are rounded off, giving a repeatability, r, of 2 Shore A and a reproducibility, R, of 3 Shore A.

NOTE: For further calculations, for instance, if several results are to be jointly evaluated, either the exact values (1,7 and 2,6 Shore A) or values taken from table 3 are to be used.

Table 3: Precision data for Shore A hardness testing

Level, m	Repeatability limit			Reproducibility limit		
	s_r^2	r	100 r/m	s_R^2	R	100 R/m
41,4 Shore	0,22	1,33	3,2 %	0,68	2,33	5,6 %
60,1 Shore	0,46	1,92	3,2 %	0,86	2,62	4,4 %
77,7 Shore	0,40	1,79	2,3 %	1,01	2,84	3,7 %
59,7 Shore	0,36	1,70	2,8 %	0,85	2,61	4,4 %

Repeatability

(same operator, same laboratory)

The difference between two single results, obtained under repeatability conditions by one operator over a period of one to four days, will exceed 2 Shore A on average no more than once in twenty cases.

Reproducibility

(different operators, different laboratories)

The difference between two independently measured results, obtained under reproducibility conditions by two observers in different laboratories, will exceed 3 Shore A on average no more than once in twenty cases.

Appendix A

Ranges of application for hardness testing methods

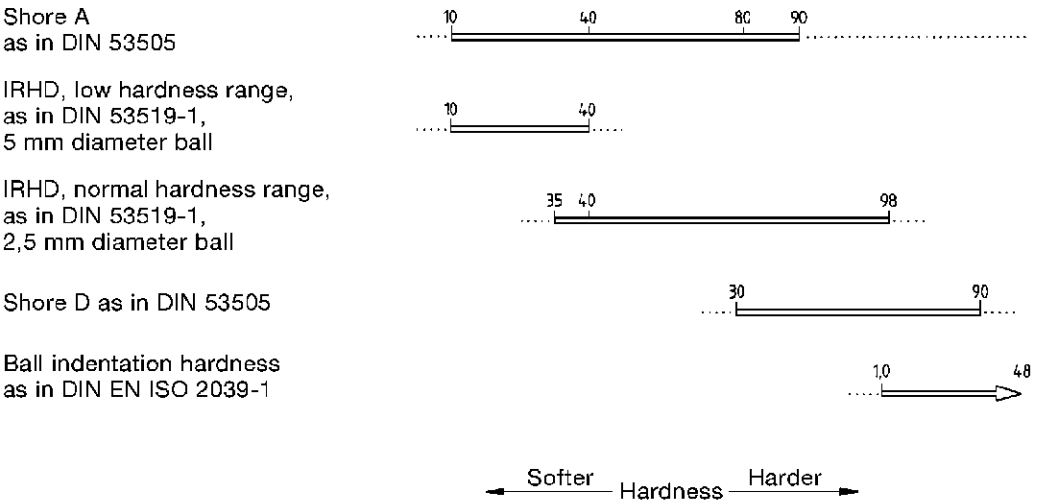

Figure A.1: Ranges of application for different hardness testing methods
(there is no linear correlation between the methods)