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Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)

Caoutchouc vulcanisé ou thermoplastique — Détermination de la dureté (dureté comprise entre 10 DIDC et 100 DIDC)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 48 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This fifth edition cancels and replaces the fourth edition (ISO 48:2007), of which it constitutes a minor revision intended to update the precision statements in Annex B. It also incorporates the Technical Corrigendum ISO 48:2007/Cor.1:2009.

Introduction

The hardness test specified in this International Standard is intended to provide a rapid measurement of rubber stiffness, unlike hardness tests on other materials which measure resistance to permanent deformation.

Hardness is measured from the depth of indentation of a spherical indentor, under a specified force, into a rubber test piece. An empirical relationship between depth of indentation and Young's modulus for a perfectly elastic isotropic material has been used to derive a hardness scale which can conveniently be used for most rubbers.

When it is required to determine the value of Young's modulus itself, it is expected that an appropriate test method be used, for example that described in ISO 7743.

The guide to hardness testing, ISO 18517, can also be a useful reference.

Rubber, vulcanized or thermoplastic — Determination of hardness (hardness between 10 IRHD and 100 IRHD)

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

CAUTION — Certain procedures specified in this International Standard may involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate documentation on safe handling and disposal after use.

1 Scope

This International Standard specifies four methods for the determination of the hardness of vulcanized or thermoplastic rubbers on flat surfaces (standard-hardness methods) and four methods for the determination of the apparent hardness of curved surfaces (apparent-hardness methods). The hardness is expressed in international rubber hardness degrees (IRHD). The methods cover the hardness range from 10 IRHD to 100 IRHD.

These methods differ primarily in the diameter of the indenting ball and the magnitude of the indenting force, these being chosen to suit the particular application. The range of applicability of each method is indicated in Figure 1.

This International Standard does not specify a method for the determination of hardness by a pocket hardness meter, which is described in ISO 7619-2.

This International Standard specifies the following four methods for the determination of standard hardness.

— Method N (normal test) is appropriate for rubbers with a hardness in the range 35 IRHD to 85 IRHD, but can also be used for hardnesses in the range 30 IRHD to 95 IRHD.

— Method H (high-hardness test) is appropriate for rubbers with a hardness in the range 85 IRHD to 100 IRHD.

— Method L (low-hardness test) is appropriate for rubbers with a hardness in the range 10 IRHD to 35 IRHD.

— Method M (microtest) is essentially a scaled-down version of the normal test method N, permitting the testing of thinner and smaller test pieces. It is appropriate for rubbers with a hardness in the range 35 IRHD to 85 IRHD, but can also be used for hardnesses in the range 30 IRHD to 95 IRHD.

NOTE 1 The value of the hardness obtained by method N within the ranges 85 IRHD to 95 IRHD and 30 IRHD to 35 IRHD might not agree precisely with that obtained using method H or method L, respectively. The difference is not normally significant for technical purposes.

NOTE 2 Because of various surface effects in the rubber and the possibility of slight surface roughness (produced, for example, by buffing), the microtest might not always give results agreeing with those obtained by the normal test.

This International Standard also specifies four methods, CN, CH, CL and CM, for the determination of the apparent hardness of curved surfaces. These methods are modifications of methods N, H, L and M, respectively, and are used when the rubber surface tested is curved, in which case there are two possibilities:

a) the test piece or product tested is large enough for the hardness instrument to rest upon it; or

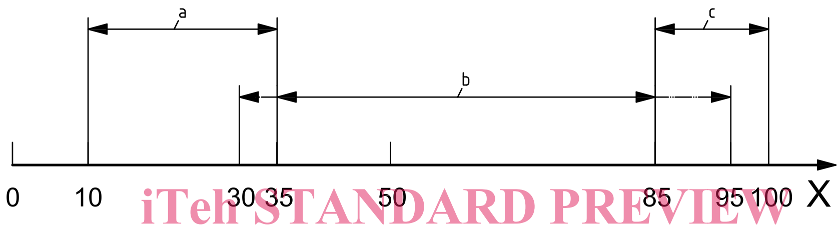
b) the test piece or product tested is small enough for both the test piece and the instrument to rest upon a common support.

A variant of b) would be where the test piece rests upon the specimen table of the instrument.

Apparent hardness can also be measured on non-standard flat test pieces using methods N, H, L and M.

The procedures described cannot provide for all possible shapes and dimensions of test piece, but cover some of the commonest types, such as O-rings.

This International Standard does not specify the determination of the apparent hardness of rubber-covered rollers, which is specified in ISO 7267 (all parts).



Key

X hardness (IRHD)

[a] Method L and method CL.

[b] Methods N and M and methods CN and CM.

[c] Method H and method CH.

Figure 1 — Range of applicability

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 18898, *Rubber — Calibration and verification of hardness testers*

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
international rubber hardness degree scale
IRHD scale
hardness scale chosen so that 0 represents the hardness of material having a Young's modulus of zero and 100 represents the hardness of a material of infinite Young's modulus

NOTE The following characteristics applying over most of the normal range of hardnesses:

a) one international rubber hardness degree always represents approximately the same proportional difference in Young's modulus;

b) for highly elastic rubbers, the IRHD and Shore A scales are comparable.

3.2
standard hardness
hardness obtained using the procedures described in methods N, H, L and M on test pieces of the standard thickness and not less than the minimum lateral dimensions specified

NOTE Standard hardness is reported to the nearest whole number in IRHD.

3.3
apparent hardness
hardness obtained using the procedures described in methods N, H, L and M on test pieces of non-standard dimensions, as well as hardness values obtained using methods CN, CH, CL and CM

NOTE 1 Apparent hardness is reported to the nearest whole number in IRHD.

NOTE 2 Values obtained by methods CN, CH, CL and CM are always given as apparent hardnesses since tests are commonly made on the complete article where the thickness of the rubber can vary and, in many cases, the lateral dimensions might not provide the minimum distance between the indentor and the edge necessary to eliminate edge effects. Thus the readings obtained do not in general coincide with readings obtained on standard test pieces as defined in methods N, H, L and M or on a flat parallel-faced slab of the same thickness as the article. Moreover, the readings might depend appreciably on the method of support of the article and whether or not a presser foot is used. Therefore, results obtained on curved surfaces are arbitrary values applicable only to test pieces or articles of one particular shape and of particular dimensions, and supported in one particular way, and in extreme cases such values can differ from the standard hardness by as much as 10 IRHD. Furthermore, surfaces that have been buffed or otherwise prepared to remove cloth markings, etc., can give slightly different hardness values from those with a smooth, moulded finish.

4 Principle

The hardness test consists in measuring the difference between the depths of indentation of a ball into the rubber under a small contact force and a large (indenting) force. From this difference, multiplied when using the microtest by the scale factor 6, the hardness in IRHD is obtained from Tables 3 to 5 or from graphs based on these tables or from a scale, reading directly in IRHD, calculated from the tables and fitted to the indentation-measuring instrument. These tables and curves are derived from the empirical relationship between indentation depth and hardness given in Annex A.

5 Apparatus

5.1 General

Calibration and verification of the apparatus shall be performed in accordance with ISO 18898.

5.2 Methods N, H, L and M

The essential parts of the apparatus are as specified in 5.2.1 to 5.2.6, the appropriate dimensions and forces being shown in Table 1.

5.2.1 Vertical plunger, having a rigid ball or spherical surface on the lower end, and **means for supporting the plunger** so that the spherical tip is kept slightly above the surface of the annular foot prior to applying the contact force.

5.2.2 Means for applying a contact force and an additional indenting force to the plunger, making allowance for the mass of the plunger, including any fittings attached to it, and for the force of any spring acting on it, so that the forces actually transmitted through the spherical end of the plunger are as specified.

5.2.3 Means for measuring the increase in depth of indentation of the plunger caused by the indenting force, either in metric units or reading directly in IRHD.

The gauge employed may be mechanical, optical or electrical.

5.2.4 Flat annular foot, normal to the axis of the plunger and having a central hole for the passage of the plunger.

The foot rests upon the test piece and exerts a pressure on it of 30 kPa ± 5 kPa provided that the total load on the foot does not fall outside the values given in Table 1. The foot shall be rigidly connected to the indentation-measuring device, so that a measurement is made of the movement of the plunger relative to the foot (i.e. the top surface of the test piece), not relative to the surface supporting the test piece.

Table 1 — Forces and dimensions of apparatus

Test	Diameters mm	Force on ball Contact N	 Indenting N	 Total N	Force on foot N
Method N (normal test)	Ball 2,50 ± 0,01 Foot 20 ± 1 Hole 6 ± 1	0,30 ± 0,02	5,40 ± 0,01	5,70 ± 0,03	8,3 ± 1,5
Method H (high hardness)	Ball 1,00 ± 0,01 Foot 20 ± 1 Hole 6 ± 1	0,30 ± 0,02	5,40 ± 0,01	5,70 ± 0,03	8,3 ± 1,5
Method L (low hardness)	Ball 5,00 ± 0,01 Foot 22 ± 1 Hole 10 ± 1	0,30 ± 0,02	5,40 ± 0,01	5,70 ± 0,03	8,3 ± 1,5
Method M (microtest)	**Diameters** mm	**Contact** mN	**Indenting** mN	**Total** mN	**Force on foot** mN
	Ball 0,395 ± 0,005 Foot 3,35 ± 0,15 Hole 1,00 ± 0,15	8,3 ± 0,5	145 ± 0,5	153,3 ± 1,0	235 ± 30

NOTE 1 In the microtest, when using instruments in which the test piece table is pressed upwards by a spring, the values of the foot pressure and the force on the foot are those acting during the period of application of the total force. Before the indenting force of 145 mN is applied, the force on the foot is greater by this amount, and hence equals 380 mN ± 30 mN.

NOTE 2 Not all possible combinations of dimensions and forces given in this table will meet the pressure requirements of 5.2.4.

5.2.5 Means for gently vibrating the apparatus, for example an electrically operated buzzer, to overcome any slight friction.

(This may be omitted in instruments where friction is effectively eliminated.)

5.2.6 Chamber for the test piece, when tests are made at temperatures other than a standard laboratory temperature.

This chamber shall be equipped with a means of maintaining the temperature within 2 °C of the desired value. The foot and vertical plunger shall extend through the top of the chamber, and the portion passing through the top shall be constructed from a material having a low thermal conductivity. A sensing device shall be located within the chamber near or at the location of the test piece, for measuring the temperature (see ISO 23529).

5.3 Methods CN, CH, CL and CM

The apparatus used shall be essentially that described in 5.2 but differing in the following respects.

5.3.1 Cylindrical surfaces of radius greater than 50 mm

The base of the instrument shall have a hole below the plunger, allowing free passage of the annular foot such that measurement may be made above or below the base.

The lower surface of the base shall be in the form of two cylinders parallel to each other and the plane of the base. The diameter of the cylinders and their distance apart shall be such as to locate and support the instrument on the curved surface to be tested. Alternatively, the modified base may be fitted with feet movable in universal joints so that they adapt themselves to the curved surface.

5.3.2 Surfaces with double curvature of large radius greater than 50 mm

The instrument with adjustable feet described in 5.3.1 shall be used.

5.3.3 Cylindrical surfaces of radius 4 mm to 50 mm or small test pieces with double curvature

On surfaces too small to support the instrument, the test piece or article shall be supported by means of special jigs or V-blocks so that the indentor is vertically above the test surface. Wax may be used to fix small items to the test piece table.

In general, an instrument as described for method M should be used only where the thickness of the rubber tested is less than 4 mm.

NOTE Instruments for method M in which the test piece table is pressed upwards by a spring are not suitable for use on large test pieces or articles with a large radius of curvature.

5.3.4 Small O-rings and articles of radius of curvature less than 4 mm

These shall be held in suitable jigs or blocks or secured by wax to the instrument table. Measurements shall be made using the instrument for method M.

No test shall be made if the smallest radius is less than 0,8 mm.

6 Test pieces

6.1 General

Test pieces shall be prepared in accordance with ISO 23529.

6.2 Methods N, H, L and M

6.2.1 General

The test pieces shall have their upper and lower surfaces flat, smooth and parallel to one another.

Tests intended to be comparable shall be made on test pieces of the same thickness.

6.2.2 Thickness

6.2.2.1 Methods N and H

The standard test piece shall be 8 mm to 10 mm thick and shall be made up of one or more layers of rubber, the thinnest of which shall not be less than 2 mm thick. All surfaces shall be flat and parallel.

Non-standard test pieces may be either thicker or thinner, but not less than 4 mm thick.

6.2.2.2 Method L

The standard test piece shall be 10 mm to 15 mm thick and shall be made up of one or more layers of rubber, the thinnest of which shall not be less than 2 mm thick. All surfaces shall be flat and parallel.

Non-standard test pieces may be either thicker or thinner, but not less than 6 mm thick.

6.2.2.3 Method M

The standard test piece shall have a thickness of 2 mm ± 0,5 mm. Thicker or thinner test pieces may be used, but in no case less than 1 mm thick. Readings made on such test pieces do not in general agree with those obtained on the standard test piece.

6.2.3 Lateral dimensions

6.2.3.1 Methods N, H and L

The lateral dimensions of both standard and non-standard test pieces shall be such that no test is made at a distance from the edge of the test piece less than the appropriate distance shown in Table 2.

Table 2 — Minimum distance of point of contact from test piece edge

Dimensions in millimetres

Total thickness of test piece	Minimum distance from point of contact to edge of test piece
4	7,0
6	8,0
8	9,0
10	10,0
15	11,5
25	13,0

6.2.3.2 Method M

The lateral dimensions shall be such that no test is made at a distance from the edge of less than 2 mm.