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**Vickers hardness test—
Part 1: Test method**

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Foreword

This Japanese Industrial Standard has been established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal for establishment of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with a draft being attached, based on the provision of Article 12, paragraph (1) of the Industrial Standardization Act. This Standard partially replaces **JIS Z 2244**:2009, which has been withdrawn.

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JIS 2244 series consists of the following 2 parts under the general title *Vickers hardness test*:

Part 1: Test method

Part 2: Tables of hardness values

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Vickers hardness test—Part 1: Test method

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 6507-1:2018**, Edition 4, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the Vickers hardness test method for the three different ranges of test force for metallic materials including hardmetals and other cemented carbides (see Table 1).

Table 1 Ranges of test force

Ranges of test force, F N	Hardness symbol	Designation
$F \geq 49.03$	$\geq \text{HV } 5$	Vickers hardness test
$1.961 \leq F < 49.03$	HV 0.2 to $< \text{HV } 5$	Low-force Vickers hardness test
$0.009\,807 \leq F < 1.961$	HV 0.001 to $< \text{HV } 0.2$	Vickers microhardness test

The Vickers hardness test specified in this Standard is for lengths of indentation diagonals between 0.020 mm and 1.400 mm; it may be used for lengths of indentation diagonals < 0.020 mm and/or test force of $< 0.009\,807$ N upon agreement between the parties involved.

A periodic verification method is specified for routine checking of the testing machine in service by the user.

For specific materials and/or products, particular standards exist.

NOTE 1 Using the method specified in this Standard for determination from indentations < 0.020 mm in diagonal length may cause large uncertainties in the results.

NOTE 2 The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 6507-1:2018 *Metallic materials—Vickers hardness test—Part 1: Test method* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS B 7725 *Vickers hardness test—Verification and calibration of testing machines*

JIS B 7735 *Vickers hardness test—Calibration of reference blocks*

JIS Z 2244-2 *Vickers hardness test—Part 2: Tables of hardness values*

NOTE Corresponding International Standard: ISO 6507-4:2018 *Metallic materials—Vickers hardness test—Part 4: Tables of hardness values* (IDT)

3 Terms and definitions

No terms and definitions are listed in this Standard.

4 Principle

A diamond indenter, in the form of a right pyramid with a square base and with the angle α between opposite faces at the vertex being 136° is forced into the surface of a test piece followed by measurement of the diagonal length of the indentation left in the surface after removal of the test force, F (see Figure 1).

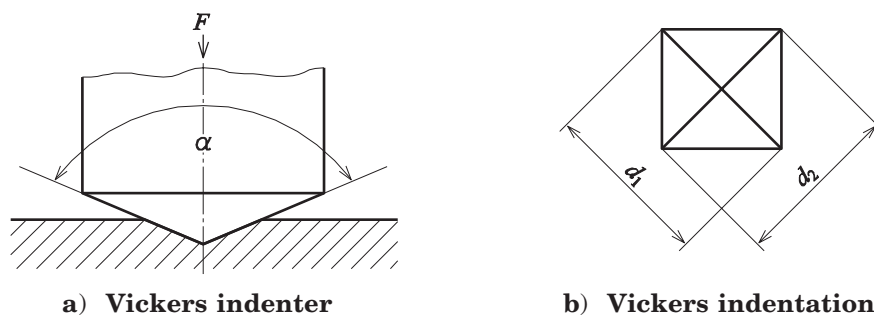


Figure 1 Principle of the test, geometry of indenter and Vickers indentation

The Vickers hardness is proportional to the quotient obtained by dividing the test force by the area of the sloped surface of indentation, which is assumed to be a right pyramid with a square base and having at the vertex the same angle as the indenter.

NOTE 1 A right pyramid has its apex aligned with the centre of the base.

NOTE 2 As applicable, this Standard has adopted hardness test parameters as defined by the Working Group on Hardness (CCM-WGH) under the framework of the International Committee of Weights and Measures (CIPM) Consultative Committee for Mass and Related Quantities (CCM) (see Annex F).

5 Symbols and designation of hardness number

5.1 Symbols and designations

See Table 2 and Figure 1.

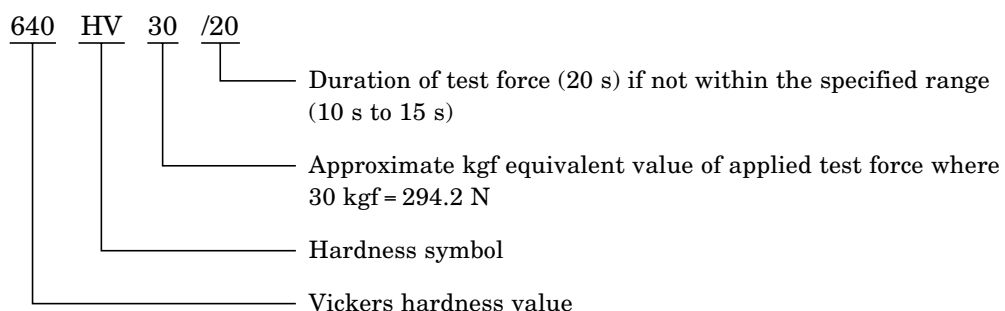
Table 2 Symbols and designations

Symbol	Designation
α	Mean angle between the opposite faces at the vertex of the pyramidal indenter (nominally 136°) (see Figure 1)
F	Test force (N)
d	Arithmetic mean of the two diagonal lengths d_1 and d_2 (mm) (see Figure 1)
HV	Vickers hardness = $\frac{\text{Test force (kgf)}}{\text{Surface area of indentation (mm}^2\text{)}}$ = $\frac{1}{g_n} \times \frac{\text{Test force (N)}}{\text{Surface area of indentation (mm}^2\text{)}}$ = $\frac{1}{g_n} \times \frac{F}{d^2 / \left(2 \sin \frac{\alpha}{2}\right)} = \frac{1}{g_n} \times \frac{2F \sin \frac{\alpha}{2}}{d^2}$ Nominal angle $\alpha = 136^\circ$ Standard acceleration due to gravity $g_n = 9.806\,65 \text{ m/s}^2$ Vickers hardness $\approx 0.189\,1 \times \frac{F}{d^2}$ To reduce uncertainty, the Vickers hardness can be calculated using the actual mean indenter angle, α. NOTE Standard acceleration due to gravity is the conversion factor from kgf to N.

5.2 Designation of hardness number

Vickers hardness is designated as shown in the following example.

Example



6 Testing machine

6.1 Testing machine The testing machine shall be capable of applying a predetermined force or forces within the desired range of test forces, in accordance with **JIS B 7725**.

6.2 Indenter The indenter shall be a diamond in the shape of a right pyramid with a square base, as specified in **JIS B 7725**.

6.3 Diagonal measuring system The diagonal measuring system shall satisfy the requirements in **JIS B 7725**.

Magnifications should be provided so that the diagonal can be enlarged to greater than 25 % but less than 75 % of the maximum possible optical field of view. Many objective lenses are non-linear towards the edge of the field of view.

A diagonal measuring system using a camera for measurement can use 100 % of the camera's field of view, provided it is designed to consider field of view limitations of the optical system.

The resolution required of the diagonal measuring system depends on the size of the smallest indentation to be measured, and shall be in accordance with Table 3. In determining the resolution of the measuring system, the resolution of the microscope optics, the digital resolution of the measuring scale and the step-size of any stage movement, where applicable, should be taken into account.

Table 3 Resolution of the measuring system ^{a)}

Diagonal length, d mm	Resolution of the measuring system
$0.020 \leq d < 0.080$	0.000 4 mm
$0.080 \leq d \leq 1.400$	0.5 % of d
Note ^{a)} The resolution for determination from indentations < 0.020 mm in diagonal length shall be as agreed between the parties involved.	

7 Test piece

7.1 Test surface

The test shall be carried out on a surface which is smooth and even, free from oxide scale and foreign matter and, in particular, free from lubricants, unless otherwise specified in product standards. The finish of the surface shall permit accurate determination of the diagonal length of the indentation.

For hardmetal samples, the thickness of the layer removed from the surface should be not less than 0.2 mm.

7.2 Preparation

Surface preparation shall be carried out in such a way as to prevent surface damage or alteration of the surface hardness due to excessive heating or cold-working.

Due to the small depth of Vickers microhardness indentations, it is essential that special precautions be taken during preparation. It is recommended to use a polishing/electropolishing process which is suitable for the material to be measured.

7.3 Thickness

The thickness of the test piece or of the layer under test shall be at least 1.5 times the diagonal length of the indentation. No deformation shall be visible at the back of the test piece after the test (see Annex A).

The thickness of a hardmetal test piece should be at least 1 mm.

NOTE The depth of the indentation is approximately $1/7$ of the diagonal length ($0.143 d$).

7.4 Tests on curved surfaces

For tests on curved surfaces, the corrections given in Tables B.1 to B.6 shall be applied.

7.5 Support of unstable test pieces

For a test piece of small cross-section or of irregular shape, either a dedicated support should be used or it should be mounted in a similar manner to a metallographic micro-section in appropriate material so that it is adequately supported and does not move during the force application.

NOTE If resin is used for mounting a test piece, attention should be paid to the hardness of the test piece as it may be affected by the heat generated in curing of resin, pressure and temperature of pressure moulding, etc.

8 Test procedure

8.1 Test temperature

The test is normally carried out at ambient temperature within the limits of $10\text{ }^{\circ}\text{C}$ to $35\text{ }^{\circ}\text{C}$. If the test is carried out at a temperature outside this range, it shall be noted in the test report. Tests carried out under controlled conditions shall be made at a temperature of $(23 \pm 5)\text{ }^{\circ}\text{C}$.

8.2 Test force

The test forces given in Table 4 are typical. Other test forces may be used including greater than 980.7 N , but not less than $0.009\,807\text{ N}$ unless otherwise agreed between the parties involved. Test forces shall be chosen that result in indentations with diagonals greater than 0.020 mm .

For hardmetals, the preferred test force is 294.2 N (HV 30).

Table 4 Typical test forces

Hardness test		Low-force hardness test		Microhardness test	
Hardness symbol	Nominal value of the test force, F N	Hardness symbol	Nominal value of the test force, F N	Hardness symbol	Nominal value of the test force, F N
HV 5	49.03	HV 0.2	1.961	HV 0.001	0.009 807
HV 10	98.07	HV 0.3	2.942	HV 0.002	0.019 61
HV 20	196.1	HV 0.5	4.903	HV 0.003	0.029 42
HV 30	294.2	HV 1	9.807	HV 0.005	0.049 03
HV 50	490.3	HV 2	19.61	HV 0.01	0.098 07
HV 100	980.7	HV 3	29.42	HV 0.015	0.147 1
—	—	—	—	HV 0.02	0.196 1
—	—	—	—	HV 0.025	0.245 2
—	—	—	—	HV 0.03	0.294 2
—	—	—	—	HV 0.05	0.490 3
—	—	—	—	HV 0.1	0.980 7

8.3 Periodic verification

The periodic verification defined in Annex C shall be performed within a week prior to use for each test force used but is recommended on the day of use. The periodic verification is recommended whenever the test force is changed. The periodic verification shall be done whenever the indenter is changed.

8.4 Test piece support and position

The test piece shall be placed on a rigid support. The support surfaces shall be clean and free from foreign matter (scales, oil, dirt, etc.). It is important that the test piece lies firmly on the support so that any displacement that affects the test result cannot occur during the test.

For anisotropic materials, for example, those which have been heavily cold-worked, there could be a difference between the lengths of the two diagonals of the indentation. Therefore, where possible, the indentation should be made so that the diagonals are oriented in plane at approximately 45° to the direction of cold-working. The specification for the product could indicate limits for the differences between the lengths of the two diagonals.

8.5 Focus on the test surface

The diagonal measuring system microscope shall be focused so that the specimen surface and the desired test location can be observed.

NOTE Some testing machines do not require that the microscope be focused on the specimen surface.

8.6 Test force application

The indenter shall be brought into contact with the test surface and the test force shall be applied in a direction perpendicular to the surface, without shock, vibration or overload, until the applied force attains the specified value. The time from the initial application of the force until the full test force is reached shall be 7_{-5}^{+1} s.

NOTE 1 The requirements for the time durations are given with asymmetric limits. For example, 7_{-5}^{+1} s indicates that 7 s is the nominal time duration, with an acceptable range of not less than 2 s (calculated as $7\text{ s} - 5\text{ s}$) to not more than 8 s (calculated as $7\text{ s} + 1\text{ s}$).

For the Vickers hardness range and low-force Vickers hardness range tests, the indenter shall contact the test piece at a velocity of $\leq 0.2\text{ mm/s}$. For microhardness tests, the indenter shall contact the test piece at a velocity of $\leq 70\text{ }\mu\text{m/s}$.

The duration of the test force is 14_{-4}^{+1} s, except for tests on materials whose time-dependent properties would make this an unsuitable range. For these tests, this duration shall be specified as part of the hardness designation (see 5.2).

NOTE 2 There is evidence that some materials are sensitive to the rate of straining which causes changes in the value of the yield strength. The corresponding effect on the termination of the formation of an indentation can make alterations in the hardness value.

8.7 Prevention of the effect of shock or vibration

Throughout the test, the testing machine shall be protected from shock or vibration.

8.8 Minimum distance between adjacent indentations

The minimum distance between adjacent indentations and the minimum distance between an indentation and the edge of the test piece are shown in Figure 2.

The distance between the centre of any indentation and the edge of the test piece shall be at least 2.5 times the mean diagonal length d of the indentation in the case of steel, nickel alloys, titanium alloys, copper and copper alloys and at least three times the mean diagonal length of the indentation in the case of light metals (excluding titanium alloys), lead and tin and their alloys.

The distance between the centres of two adjacent indentations shall be at least three times the mean diagonal length of the indentation in the case of steel, nickel alloys, titanium alloys, copper and copper alloys and at least six times the mean diagonal length in the case of light metals (excluding titanium alloys), lead and tin and their alloys. If two adjacent indentations differ in size, the spacing shall be based on the mean diagonal length of the larger indentation.