SLOVENSKI STANDARD
oSIST prEN ISO 14705:2020

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Fina keramika (sodobna keramika, sodobna tehnična keramika) - Preskus trdote za monolitno keramiko pri sobni temperaturi (ISO 14705:2016)

Fine ceramics (advanced ceramics, advanced technical ceramics) - Test method for hardness of monolithic ceramics at room temperature (ISO 14705:2016)

Hochleistungskeramik - Härteprüfung von monolithischer Keramik bei Raumtemperatur (ISO 14705:2016)

Céramiques techniques - Méthode d'essai de dureté des céramiques monolithiques à température ambiante (ISO 14705:2016)

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INTERNATIONAL STANDARD

ISO 14705

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for hardness of monolithic ceramics at room temperature

Céramiques techniques — Méthode d'essai de dureté des céramiques monolithiques à température ambiante

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

The committee responsible for this document is ISO/TC 206, *Fine ceramics*.

This third edition cancels and replaces the second edition (ISO 14705:2008), which has been technically revised.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for hardness of monolithic ceramics at room temperature

1 Scope

This document specifies a test method for determining the Vickers and Knoop hardness of monolithic fine ceramics at room temperature.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 4545-1, *Metallic materials — Knoop hardness test — Part 1: Test method*

ISO 4545-2, *Metallic materials — Knoop hardness test — Part 2: Verification and calibration of testing machines*

ISO 4545-4, *Metallic materials — Knoop hardness test — Part 4: Table of hardness values*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6507-2, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
Vickers hardness
value obtained by dividing the applied force by the surface area of the indentation computed from the mean of the measured diagonals of the indentations, assuming that the indentation is an imprint of the undeformed indenter

Note 1 to entry: Vickers hardness may be expressed in two different units:

a) with unit GPa, obtained by dividing the applied force in N by the surface area of the indentation in mm^2;

b) Vickers hardness number, obtained by dividing the applied force in kgf by the surface area of the indentation in mm^2.

3.2
Vickers indenter
indenter in the shape of a right-angle pyramid with a square base and an angle between opposite faces of 136°

Note 1 to entry: See Table 1 and Figure 1.

3.3
Knoop hardness
value obtained by dividing the applied force by the projected area of the indentation computed from the measurement of the long diagonal of the indentation, assuming that the indentation is an imprint of the undeformed indenter

Note 1 to entry: The Knoop hardness may be expressed in two different units:

a) with units of GPa, obtained by dividing the applied force in N by the projected area of the indentation in mm^2;

b) Knoop hardness number, obtained by dividing the applied force in kgf by the projected area of the indentation in mm^2, without units specified.

3.4
Knoop indenter
indenter in the shape of a rhombic-based pyramid with the two angles between the opposite edges at 172,5° and 130°

Note 1 to entry: See Table 3 and Figure 6.

4 Vickers hardness

4.1 Principle

Forcing a diamond indenter in the form of a right-angle pyramid with a square base, and with a specified angle between opposite faces at the vertex into the surface of a test piece and measuring the length of the diagonals of the indentation left in the surface after removal of the test force, *F*. See Figure 1 and Figure 2.

4.2 Symbols, abbreviated terms and designations

4.2.1 See Table 1, Figure 1 and Figure 2.

4.2.2 The Vickers hardness is denoted by the symbol HV, preceded by the hardness value and followed by a number representing the test force (see Table 2).

Examples:

a) Use of SI unit (GPa):

15,0 GPa HV 9,807 N represents a Vickers hardness of 15,0 GPa, determined with a test force of 9,807 N (1 kgf)

b) Use of the Vickers hardness number (no units specified):

1 500 HV 1 represents a Vickers hardness number of 1 500, determined with a test force of 9,807 N (1 kgf).

Table 1 — Symbols, abbreviated terms and designations for Vickers hardness testing

Symbol or abbreviated term	Designation
α	Angle between the opposite faces at the vertex of the pyramidal indenter (136° ± 0,5°)
F	Test force, in newtons
d	Arithmetic mean, in millimetres, of the two diagonals, d_1 and d_2
HV	Vickers hardness $= \text{Constant} \times \frac{\text{Test force}}{\text{Surface area of indentation}}$ a) Units of GPa $= 0{,}001\,\frac{2F\sin\frac{136°}{2}}{d^2} = 0{,}001\ 854\,\frac{F}{d^2}$ b) Hardness number (no units specified) $= 0{,}102\,\frac{2F\sin\frac{136°}{2}}{d^2} = 0{,}189\,1\,\frac{F}{d^2}$
c	Arithmetic mean of the half of the two median crack lengths, $2c_1$ and $2c_2$
SD	Standard deviation $= \sqrt{\frac{\sum\left(\overline{\text{HV}} - \text{HV}_n\right)^2}{n-1}}$ where $\overline{\text{HV}}$ is the arithmetic mean of the Vickers hardness $= \frac{\sum \text{HV}_n}{n}$; HV_n is the HV obtained from nth indentation; n is the number of indentations.
NOTE Constant $= \frac{1}{g} = \frac{1}{9{,}807} = 0{,}102$, where g is the acceleration due to gravity.	

Table 2 — Hardness symbols and the nominal values of test forces, *F*, for Vickers hardness testing

Hardness symbol	**Test force**, F (nominal value)
HV 0,5	4,903 N
HV 1	9,807 N
HV 2	19,61 N
HV 3	29,42 N
HV 5	49,03 N
HV 10	98,07 N
HV 20	196,1 N

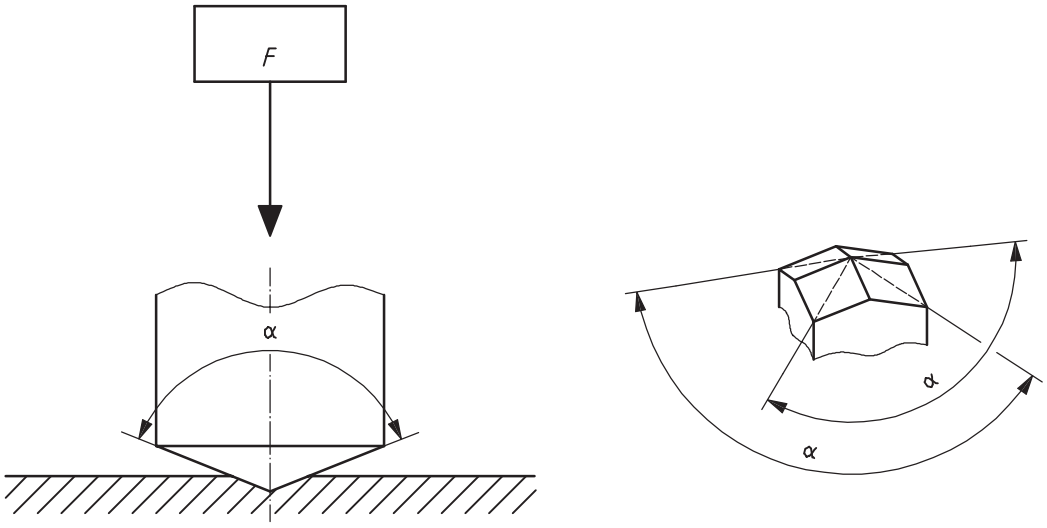

Figure 1 — Vickers indenter (diamond pyramid)

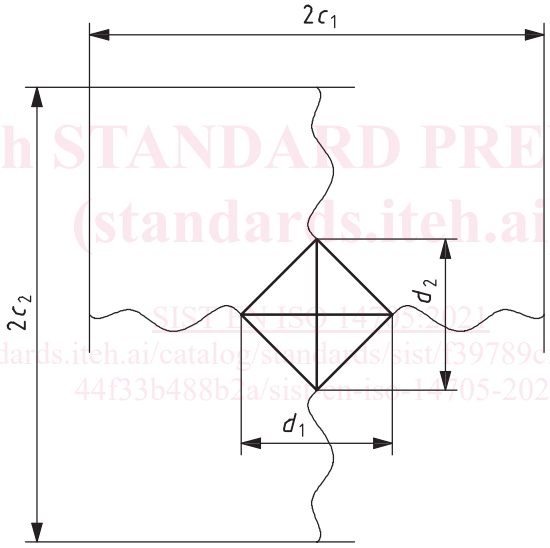

Figure 2 — Vickers indentation

4.3 Significance and use

Vickers indentation diagonal lengths are approximately 2,8 times shorter than the long diagonal of Knoop indentations, and the indentation depth is approximately 1,5 times deeper than Knoop indentations made at the same force. Vickers indentations are influenced less by the specimen surface flatness, parallelism of the diamond axis to the test piece surface normal, and surface finish than Knoop indentations, but these parameters should be considered nonetheless. Vickers indentations are much more likely to cause cracks in fine ceramics than Knoop indentations. Conversion between hardness scales shall not be made.

Vickers indentations on metallic materials are mainly formed by the plastic deformation. However, Vickers indentations on fine ceramics are formed by micro-cracking and micro-fracture, besides plastic deformation. This difference shall be noted for comparing the hardness of metals and ceramics.

4.4 Apparatus

4.4.1 Testing machine, capable of applying a predetermined test force in the range of 4,903 N (0,5 kgf) to 98,07 N (10 kgf), preferably 9,807 N (1 kgf), in accordance with ISO 6507-2. Verification of the test force shall be carried out in accordance with ISO 6507-2.

4.4.2 Diamond indenter, in the shape of a right-angle pyramid with a square base, as specified in ISO 6507-1 and ISO 6507-2. Verification of the indenter shall be carried out in accordance with ISO 6507-2.

4.4.3 Measuring device, capable of measuring the indentation diagonals with a readout resolution of ±0,2 µm or finer. A numerical aperture (NA) between 0,60 and 0,95 for the objective lens for the microscope is recommended. Verification of the measuring device shall be carried out in accordance with ISO 6507-2.

NOTE Indirect verification can be carried out by means of standardized blocks calibrated in accordance with ISO 6507-3, following ISO 6507-2, or other approved and traceable ceramic standard reference blocks.

4.5 Test pieces

4.5.1 The test shall be carried out on a surface which is smooth, flat and free from foreign matter. The test piece shall be polished to permit accurate measurement of the diagonal lengths of the indentation. Preparation shall be carried out in such a way that any alteration of the surface hardness is minimized. Surfaces shall not be thermally or chemically etched. If applicable, residual surface stresses shall be removed by suitable polishing or annealing procedures.

4.5.2 The thickness of the test piece shall be at least 0,5 mm. It shall be at least 1,5 times the diagonal of the indentation, *d*, and at least 2 times the crack length, *c*, whichever is greater. No indentation damage shall be visible at the back of the test piece upon completion of the test.

4.6 Procedure

4.6.1 In general, the test shall be carried out at room temperature within the limits of 10 °C to 35 °C. Tests carried out under controlled conditions shall be made at a temperature of 23 °C ± 5 °C.

4.6.2 The test force shall be 9,807 N (1 kgf). In cases where significant chipping or lateral crack-spalling occurs or where the impression is too faint, the test forces within the range 4,903 N (0,5 kgf) to 196,1 N (20 kgf), listed in Table 2, may be used. Other instances where a heavier load may be required are where the grain structure is very coarse and the indentation area at lower loads may contact only a few grains of the material (e.g. a multiphase material).

4.6.3 The following items shall be confirmed before the test.

a) Check the zero of the measuring system.

b) Check the measuring system using a calibrated scale or certified indentation in a test block.

c) Check the operation of the loading system by performing a test on a certified test block.

d) Check the condition of the indenter by examining the indentation made in the test block. Replace the indenter, if necessary, by taking into account the conditions given in 4.6.10.

e) A test block with high hardness has to be used in order to obtain impressions in the same size range as expected during tests on ceramics.

4.6.4 The indenter shall be cleaned prior to and during the test series, as ceramic powders or fragments from the ceramic test piece can adhere to the diamond indenter.