BS ISO 17170:2015

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for spherical indentation of porous ceramics

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for spherical indentation of porous ceramics

Céramiques techniques — Méthode d'essai d'indentation des céramiques poreuses avec un indenteur sphérique

Reference number
ISO 17170:2015(E)

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Foreword

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

INTERNATIONAL STANDARD ISO 17170:2015(E)

Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for spherical indentation of porous ceramics

1 Scope

This International Standard describes the test methods for determining spherical indentation strength of porous ceramics, such as those employed for filters and catalyst carriers, that are carried out in air at room temperature.

2 Normative references

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

ISO 463, *Geometrical Product Specifications (GPS) — Dimensional measuring equipment — Design and metrological characteristics of mechanical dial gauges*

ISO 683-1, *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Non-alloy steels for quenching and tempering·*

ISO 683-3, *Heat-treatable steels, alloy steels and free-cutting steels — Part 3: Case-hardening steels*

ISO 1101, *Geometrical product specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 3290-1, *Rolling bearings — Balls — Part 1: Steel balls*

ISO 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

3 Terms and definitions

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

3.1
porous ceramics
ceramics with porosity of 30 % to 60 %, and pore diameter of 1 μm to 100 μm, for applications such as filters, catalyst carriers, humidity sensors, or molecular sieves, excluding structured honeycomb cellular channels

3.2
spherical indenter
sphere through which a compressive load is applied to the specimen

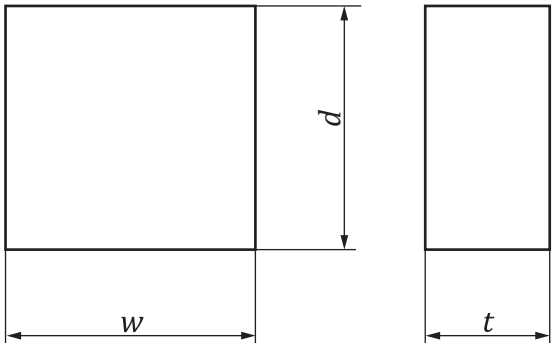
3.3
fracture by spherical indentation
fracture is the separation of a specimen into more than two pieces, or many small flakes or powder-like pieces, accompanied by a large drop or disappearance of force

3.4
strength by spherical indentation
maximum load measured in the period from start of test to the fracture of the test specimen when the compressive load is applied to the specimen through the spherical indenter

4 Test specimens

4.1 Specimen size

The shape of a test specimen shall be a flat plate with a regular square cross section. Its standard dimensions shall be 20,0 mm ± 0,1 mm in horizontal length, 20,0 mm ± 0,1 mm in vertical length, and 10,0 mm ± 0,1 mm in thickness. The parallelism between the upper and lower surfaces of the specimen shall be at most 0,01 mm specified in ISO 1101. When the dimensions are different from the standard one, they shall be stated in a report.



Key

d vertical length (*d* = 20,0 mm ± 0,1 mm)
w horizontal length (*w* = 20,0 mm ± 0,1 mm)
t thickness (*t* = 10,0 mm ± 0,1 mm)

Figure 1 — Specimen dimensions

4.2 Specimen preparation

The specimen surface shall be finished by grinding with a wheel whose grain number is at least 800. Contamination by fixatives (e.g. wax) or grinding fluids employed during grinding processes, if any, should be removed by organic dissolution, or by heating at a sufficiently high temperature.

4.3 Number of specimens

The number of specimens shall be at least 10.

5 Testing machine and equipment

5.1 Testing machine

A testing machine shall be so constructed that compressive stress can be applied to a test specimen at a constant crosshead speed. The testing machine shall be equipped with an apparatus measuring

or indicating the load with an accuracy of at most ±1 % of the maximum load in accordance with ISO 7500-1 or have better precision.

5.2 Spherical indenter

A steel sphere with 3/4 inch (19,05 mm) or 19 mm diameter specified in ISO 3290-1 shall be used as an indenter.

5.3 Pedestal

A pedestal placed below the specimen shall be made of carbon steel for mechanical use with a carbon content of 0,4 % to 0,6 % defined by in ISO 683-1 and ISO 683-3 or materials with the hardness over 150 Hv. The thickness of the pedestal shall be at least 10 mm, and the surface area of the pedestal contacting with the specimen is at least four times of the specimen cross-section area. The surface of the pedestal contacting the specimen shall be at most Ra = 0,40 µm determined in accordance with ISO 4287, and the parallelism shall be at most 0,01 mm specified in ISO 1101.

5.4 Micrometer calipers

Micrometer calipers shall be those for external measurement in accordance with ISO 3611 or have better precision.

5.5 Dial gauges

Dial gauges shall be those with a scale of 0,01 mm in accordance with ISO 463 or have a better precision.

5.6 Humidity measuring device

Humidity measuring device shall be equipped with a performance measuring or indicating the humidity with an accuracy of at most ±5 % RH.

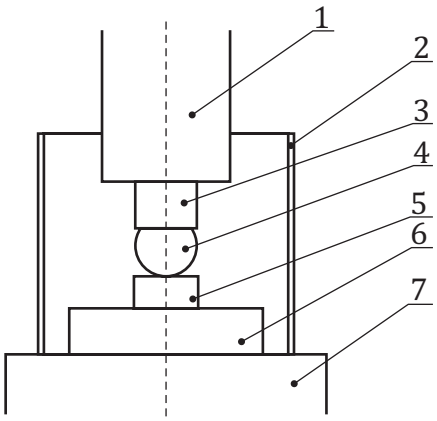
6 Testing method

6.1 Measurement of specimen dimension

The horizontal and vertical lengths and thickness of the specimen shall be measured to a precision of 0,01 mm by using micrometer calipers for external measurement or a measuring instrument at least equal in precision thereto.

6.2 Specimen positioning and loading method

The specimen is positioned at the centre of the pedestal. The central axis of the pedestal, specimen and spherical indenter are aligned along the load line. The specimen shall be loaded by forcing the spherical indenter into the test specimen. Figure 2 illustrates a testing setup.



Key

1 loading jig
2 scattering prevention cover
3 spherical folder
4 spherical indenter
5 test specimen
6 pedestal
7 base of testing machine

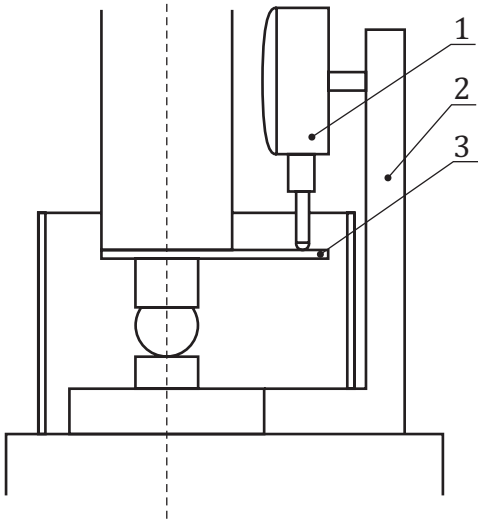
Figure 2 — Testing setup for small spherical indentation

6.3 Crosshead speed

The crosshead speed shall be 0,5 mm/min.

6.4 Measurement of load and load-point displacement

Load and load-point displacement shall be measured from the start of the test to the specimen fracture. The load point displacement shall be measured with a displacement meter such as an electronic dial gauge or transducer, as shown in Figure 3, or from the crosshead displacement of testing machine.



Key

1 dial gauge
2 support of dial gauge
3 contact plate for load point displacement

Figure 3 — Measurement of load-point displacement

6.5 Reuse of pedestal

When the pedestal is reused, dimples or flaws shall be completely removed.

6.6 Measurement of temperature and humidity

When indentation tests are carried out, the temperature and humidity of the test environment shall be measured.

6.7 Reuse of spherical indenter

If a spherical indenter is to be reused, inspect it for damage. If dimples or flaws have been generated by prior use, an unused region of the sphere shall be used as the contact area with the test specimen.

6.8 Number of tests

The minimum number of successful tests shall be 10. Test specimens shall be used only for a single test.

7 Treatment of test result

7.1 Load vs. load-point displacement curve

A load vs. load-point displacement curve shall be drawn from the start of the test to the fracture of the test specimen.

7.2 Strength of spherical indentation

The maximum load which is determined from load vs. load-point displacement curve shall be the strength of spherical indentation. Also, the load-point displacement at the maximum load shall be recorded.

7.3 Calculation of mean value and standard variation

The mean value and the standard deviation of the fracture strength by spherical indentation shall be calculated using Formulae (1) and (2), and rounded to three significant figures:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n} \tag{1}$$

$$S = \sqrt{\sum_{i=1}^{n} \frac{\left(x_i - \bar{x}\right)^2}{n-1}} \tag{2}$$

where

x_i indentation fracture strength of each specimen (N);

$\bar{x}$ mean of indentation fracture strength (N);

S standard deviation of indentation fracture strength (N);

n number of specimens.

8 Test report

8.1 Items to be reported

The test report shall include following items:

a) the name and class of material;

b) the dimensions (mean value) of the specimen;

c) the material and diameter of the spherical indenter;

d) the name of testing machine and its type;

e) the material and dimension of pedestal;

f) the loading condition (crosshead speed);

g) the conditions of temperature and humidity at test;

h) the number of specimens tested;

i) the list of test results (indentation fracture strength and its load point displacement);

j) the mean and standard variation of indentation fracture strength;

k) the load vs. load-point displacement curves;

l) a reference to this International Standard, i.e. ISO 17170.

8.2 Items preferred to be reported

Where appropriate, the following items may supplement the test report:

a) the manufacturer's name of material and its date of manufacture;

b) the name of material, kinds of additive, and sintering method;

c) the porosity and mean pore size of material;

d) the chemical composition of material;

e) the sampling conditions of specimen from material and its machining conditions (when a specimen is heat treated, its conditions are included);

f) the mechanical properties of material such as bending strength, elastic modulus, fracture toughness value, etc.;

g) the date of test, test place, and name of test person.

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