SLOVENSKI STANDARD
SIST EN ISO 18756:2005

01-november-2005

Fine ceramics (advanced ceramics, advanced technical ceramics) - Determination of fracture toughness of monolithic ceramics at room temperature by the surface crack in flexure (SCF) method (ISO 18756:2003)

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Hochleistungskeramik - Bestimmung der Bruchzähigkeit monolithischer Keramik bei Raumtemperatur für Biegeproben mit Oberflächenriss (Knoop-Riss) (SCF-Verfahren) (ISO 18756:2003)

Céramiques techniques - Détermination de la ténacité a la rupture des céramiques monolithiques a température ambiante par fissuration superficielle en flexion (ISO 18756:2003)

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English Version

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This European Standard was approved by CEN on 2 June 2005.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

The text of ISO 18756:2003 has been prepared by Technical Committee ISO/TC 206 "Fine ceramics" of the International Organization for Standardization (ISO) and has been taken over as EN ISO 18756:2005 by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2006, and conflicting national standards shall be withdrawn at the latest by January 2006.

This document is part of a series:

CEN/TS 14425-1 *Advanced technical ceramics — Test methods for determination of fracture toughness of monolithic ceramics — Part 1: Guide to test method selection*

CEN/TS 14425-3 *Advanced technical ceramics — Test methods for determination of fracture toughness of monolithic ceramics — Part 3: Chevron notched beam (CNB) method*

CEN/TS 14425-5 *Advanced technical ceramics — Test methods for determination of fracture toughness of monolithic ceramics — Part 5: Single-edge V-notch beam (SEVNB) method*

EN ISO 15732 *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for fracture toughness of monolithic ceramics at room temperature by single edge precracked beam (SEPB) method*

EN ISO 18756 *Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of fracture toughness of monolithic ceramics at room temperature by the surface crack in flexure (SCF) method*

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Endorsement notice

The text of ISO 18756:2003 has been approved by CEN as EN ISO 18756:2005 without any modifications.

INTERNATIONAL STANDARD

ISO 18756

First edition
2003-12-01

Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of fracture toughness of monolithic ceramics at room temperature by the surface crack in flexure (SCF) method

Céramiques techniques — Détermination de la ténacité à la rupture des céramiques monolithiques à température ambiante par fissuration superficielle en flexion

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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 18756 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of fracture toughness of monolithic ceramics at room temperature by the surface crack in flexure (SCF) method

1 Scope

This International Standard describes a test method that covers the determination of fracture toughness of monolithic ceramic materials at room temperature by the surface crack in flexure (SCF) method.

This International Standard is intended for use with monolithic ceramics and whisker- or particulate-reinforced ceramics that are regarded as macroscopically homogeneous. It does not include continuous-fibre reinforced ceramic composites.

The test method is applicable to materials with either flat or rising crack growth resistance curves. This method is similar to ISO 15732 except that precracks are smaller and are made by a different procedure. The methods should produce similar or identical results for materials with a flat R-curve.

NOTE This test method is usually applicable to ceramic materials with a fracture toughness less than ≈ 10 MPa $m^{1/2}$. It may be difficult to form precracks with a Knoop indenter for materials with greater fracture toughness or those materials which are soft (low hardness) such as some zirconias, or for porous ceramics.

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 3611:1978, *Micrometer callipers for external measurement*

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

ISO 14704:2000, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for flexural strength of monolithic ceramics at room temperature*

3 Terms and definitions

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

1) To be published. (Revision of ISO 7500-1:1999)

3.1
stress intensity factor
K_I
magnitude of the elastic stress field singularity at the tip of a crack subjected to opening mode displacement

NOTE It is a function of applied force and test specimen size, geometry and crack length, and has dimensions of force times length to the power of three over two.

3.2
fracture toughness
generic term for measures of resistance of extension of a crack

3.3
fracture toughness value
K_{Isc}
fracture toughness value measured by the SCF method

NOTE This is the measured stress intensity factor corresponding to the crack extension resistance of a semi-elliptical small crack formed underneath a Knoop indentation. The measurement is performed to the operational procedure herein and satisfies all the validity requirements.

3.4
precrack
crack introduced into the test specimen artificially prior to testing the specimen to fracture

3.5
crack front line
line to indicate the position of the tip of the crack

3.6
critical stress intensity factor
K_{Ic}
critical value of K_I at which fast fracture occurs

3.7
critical crack
crack at fracture at maximum load and whose stress intensity factor just reaches the critical stress intensity factor

3.8
critical crack size
size of the critical crack at fracture

NOTE The critical crack will be larger than the precrack if stable crack extension occurs due to environmentally-assisted slow crack growth or rising R-curve behaviour.

3.9
four-point 1/4-point flexure
specific configuration of four-point flexural strength testing where the inner bearings are situated one quarter of the support span away from the two outer bearings

3.10
four-point 1/3-point flexure
specific configuration of four-point flexural strength testing where the inner bearings are situated one third of the support span away from the two outer bearings

3.11
flexural strength
maximum nominal stress at fracture of a specified elastic beam loaded in bending

4 Symbols

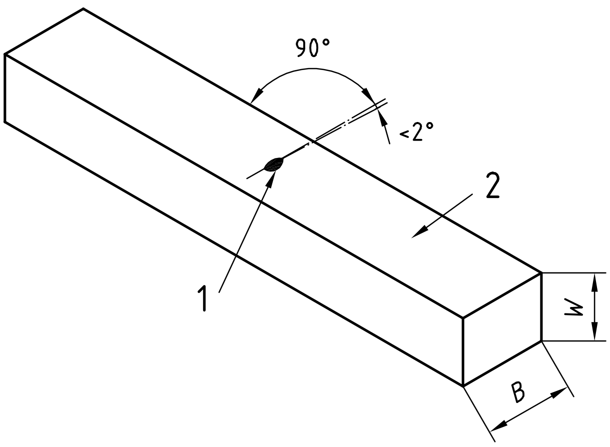
a	Crack depth
A	Flexure fixture moment arm
B	Specimen width, the cross section dimension perpendicular to the direction of loading in bending
c	Crack half width
C	Chamfer size
d	Length of Knoop indentation long diagonal
h	Depth of Knoop indentation
F	Knoop indentation load
F_c	Chamfer correction factor
$H_1\ (a/c,\ a/W)$	A polynomial in the stress intensity factor coefficient, for the point on the crack periphery where it intersects the specimen surface
$H_2\ (a/c,\ a/W)$	A polynomial in the stress intensity factor coefficient, for the deepest part of the surface crack
K_I	Stress intensity factor, Mode I
K_{Ic}	Critical stress intensity factor, Mode I
K_{Isc}	Fracture toughness value, surface crack in flexure method
L	Flexure fixture support span
L_T	Specimen length
$M\ (a/c,\ a/W)$	A polynomial in the stress intensity factor coefficient
P	Load at fracture
$Q\ (a/c)$	A polynomial function of the surface crack ellipticity
$S\ (a/c,\ a/W)$	Factor in the stress intensity factor coefficient
W	Specimen depth, the cross section dimension parallel to the direction of loading in bending
Y	Stress intensity factor coefficient
Y_d	Stress intensity factor coefficient at the deepest part of the surface crack
Y_{max}	The maximum stress intensity factor coefficient along the boundary of the surface crack
Y_s	Stress intensity factor coefficient at the intersection of the surface crack with the specimen surface

5 Principle

This International Standard is for material development, material comparison, quality assurance, characterization, reliability, and design data generation. The method determines the fracture toughness value, K_{Isc} by fracturing a common flexure specimen which has a small surface precrack (see Figure 1). The specimen is indented with a Knoop indenter in order to make a small, semi-elliptical surface crack. The specimen is polished or ground carefully until the indentation and associated residual stress field are removed. The specimen is fractured in four-point flexure. The fracture toughness, K_{Isc}, is calculated from the fracture load and the measured critical crack size. Fractography is required to measure the precrack size and to determine whether the crack has grown in size. Fracture toughness as a function of crack size may be evaluated by varying the Knoop indentation load that is used to make the precrack. Background information concerning this test method may be found in References [1] and [2]. An international interlaboratory comparison study (round robin) project on this method is described in References [3], [4] and [5].

If the ceramic is too soft (low hardness) or has too great a fracture toughness, it may be difficult to create a precrack by the SCF method. In addition, for some materials (particularly those with coarse grain or heterogeneous microstructures), it may be difficult to detect the crack on the fracture surface. If the user is not sure of the applicability of this method, then a single trial specimen may be tested with an abbreviated procedure. Indent the specimen and fracture it without removal of the indentation and residual stresses. Inspect the fracture surface to confirm that the specimen fractured from the precrack (and not from a material flaw) and that the precrack can be detected on the fracture surface.

Precracking is by Knoop indentation only in this International Standard. Residual stresses underneath the indentation are removed in this test method. There is some limited experience with SCF precracking by Vickers indentation [3, 4, 5, 6, 7]



Key

1 indentation and precrack

2 polished or lapped surface

Figure 1 — Indentation and precrack in a flexural specimen