SLOVENSKI STANDARD
SIST EN 1893:2005

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Nadomeščа:
SIST ENV 1893:2000

Sodobna tehniļ na keramika ï Mehanske lastnosti keramiļ nih kompozitov pri visoki temperaturi v zraku v pogojih atmosferskega tlaka ï Ugotavljanje nateznih lastnosti

Advanced technical ceramics - Mechanical properties of ceramic composites at high temperature in air at atmospheric pressure - Determination of tensile properties

Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei hoher Temperatur in Luft bei Atmosphärendruck - Bestimmung der Eigenschaften unter Zug

Céramiques techniques avancées - Propriétés mécaniques des céramiques composites a haute température sous air a la pression atmosphérique - Détermination des caractéristiques en traction

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81.060.30	Sodobna keramika	Advanced ceramics

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This European Standard was approved by CEN on 15 March 2005.

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Contents

Foreword

This document (EN 1893:2005) has been prepared 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of an identical text or by endorsement, at the latest by October 2005, and conflicting national standards shall be withdrawn at the latest by October 2005.

This document supersedes ENV 1893:1996.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This document specifies the conditions for determination of tensile properties of ceramic matrix composite materials with continuous fibre reinforcement for temperatures up to 1 700 °C in air at atmospheric pressure.

This document applies to all ceramic matrix composites with a continuous fibre reinforcement, unidirectional (1D), bi-directional (2D), and tri-directional (xD, with $2 < x \leq 3$), loaded along one principal axis of reinforcement.

NOTE 1 In most cases, ceramic matrix composites to be used at high temperature in air are coated with an anti-oxidation coating.

NOTE 2 The purpose of this document is to determine the tensile properties of a material when it is placed under an oxidizing environment but not to measure material oxidation.

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.

EN 60584-1, *Thermocouples; Part 1: Reference tables (IEC 60584-1:1995)*

EN 60584-2, *Thermocouples; Part 2: Tolerances (IEC 60584-2:1982 + A1:1989)*

EN 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 (ISO 7500-1:2004)*

ISO 3611, *Micrometer callipers for external measurement*

3 Terms, definitions and symbols

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

3.1
test temperature, T
temperature of the test piece at the centre of the gauge length

3.2
calibrated length, l
part of the test specimen that has uniform and minimum cross-section area

3.3
gauge length, L_0
initial distance between reference points on the test specimen in the calibrated length

3.4
controlled temperature zone
part of the calibrated length including the gauge length where the temperature is controlled to within 50 °C of the test temperature

3.5
initial cross-section area, S_0
initial cross-section areas of the test specimen within the calibrated length, at test temperature

3.6
apparent cross-section area, $S_{o\ app}$
total area of the cross-section

3.7
effective cross-section area, $S_{o\ eff}$
total area corrected by a factor, to account for the presence of an anti-oxidative protection

3.8
longitudinal deformation, A
increase in the gauge length between reference points under a tensile force

3.9
longitudinal deformation under maximum tensile force, A_m
increase in the gauge length between reference points under maximum tensile force

3.10
tensile strain, $\in$
relative change in the gauge length defined as the ratio A/L_o

3.11
tensile strain under maximum force, $\in_m$.
relative change in the gauge length defined as the ratio A/L_o under the maximum force

3.12
tensile stress, σ
tensile force supported by the test specimen at any time in the test divided by the initial cross-section area (S_o)

3.13
apparent tensile stress, σ_{app}
tensile force supported by the test specimen at any time in the test divided by the apparent cross-section area (or total cross-section area)

3.14
effective tensile stress, σ_{eff}
tensile force supported by the test specimen at any time in the test divided by the effective cross-section area ($S_{o\ eff}$)

3.15
maximum tensile force, F_m
highest recorded tensile force in a tensile test on the test specimen when tested to failure

3.16

3.16.1
tensile strength, σ_m
ratio of the maximum tensile force to the initial cross-section area (S_o)

3.16.2
apparent tensile strength, $\sigma_{m\ app}$
ratio of the maximum tensile force to the apparent cross-section area (or total cross-section area)

3.16.3
effective tensile strength, $\sigma_{m\ eff}$
ratio of the maximum tensile force to the effective cross-section area

3.17
proportionality ratio or pseudo-elastic modulus EP
slope of the linear section of the stress-strain curve, if any

NOTE Examination of the stress-strain curves for ceramic matrix composites allows definition of the following cases:

a) material with a linear section in the stress-strain curve;

For ceramic matrix composites that have a mechanical behaviour characterized by a linear section, the proportionality ratio is defined as:

$$EP(\sigma_1, \sigma_2) = \frac{(\sigma_2 - \sigma_1)}{(\in_2 - \in_1)} \quad (1)$$

where

$(\in_1, \sigma_2)$ and $(\in_2, \sigma_2)$ lie near the lower and the upper limits of the linear section of the stress-strain curve.

The proportionality ratio or pseudo-elastic modulus is termed the elastic modulus, E, in the single case where the linearity starts near the origin.

b) material with no-linear section in the stress-strain curve.

In this case only stress-strain couples can be fixed.

3.18
apparent proportionality ratio, EP_{app}
slope of the linear section of the stress-strain curve, if any, when the apparent tensile stress is used

3.19
effective proportionality ratio, EP_{eff}
slope of the linear section of the stress-strain curve, if any, when the effective tensile stress is used

4 Principle

A test specimen of specified dimensions is heated to the test temperature, and loaded in tension. The test is performed at constant crosshead displacement rate, or constant deformation rate (or constant loading rate). Force and longitudinal deformation are measured and recorded simultaneously.

NOTE 1 The test duration is limited to reduce creep effects.

NOTE 2 When constant loading rate is used in the non-linear region of the tensile curve, only the tensile strength can be obtained from the test. In this region constant crosshead displacement rate or constant deformation rate is recommended to obtain the complete curve.

5 Apparatus

5.1 Test machine

The test machine shall be equipped with a system for measuring the force applied to the test specimen conforming to grade 1 or better according to EN ISO 7500-1.

NOTE This prevails during actual test conditions, e.g. gas pressure, temperature.

5.2 Load train

The load train configuration shall ensure that the load indicated by the load cell and the load experienced by the test specimen are the same.

The load train performance, including the alignment system and the force transmitting system, shall not change because of heating.

The attachment fixtures shall align the test specimen axis with the applied force direction.

NOTE 1 The alignment should be verified and documented in accordance with, for example, the procedure described in the HTMTC code of practice [1].

The grip design shall prevent the test specimen from slipping.

There are two types of gripping systems:

— hot grips where the grips are in the hot zone of the furnace;

— cooled grips where the grips are outside the hot zone.

NOTE 2 The choice of gripping system will depend on material, on test specimen design and on alignment requirements.

NOTE 3 The hot grip technique is limited in temperature because of the nature and strength of the materials that can be used for grips.

NOTE 4 In the cooled grip technique, a temperature gradient exists between the centre which is at the prescribed temperature and the ends which are at the same temperature as the grips.

5.3 Set-up for heating

The set-up for heating shall be constructed in such a way that the temperature gradient within the gauge length is less than 20 °C at test temperature.

5.4 Extensometer

The extensometer shall be capable of continuously recording the longitudinal deformation at test temperature.

NOTE 1 The use of an extensometer with the greatest gauge length is recommended.

The linearity tolerances shall be lower than 0,05 % of the extensometer range used.

Two commonly used types of extensometer are the mechanical extensometer and the electro-optical extensometer.

If a mechanical extensometer is used, the gauge length shall be the longitudinal distance between the two locations where the extensometer rods contact the test specimen.

The rods may be exposed to temperatures higher than the test specimen temperature. Temperature induced structural changes in the rod material shall not affect the accuracy of deformation measurement. The material used for the rods shall be compatible with the test specimen material.

NOTE 2 Care should be taken to correct for changes in calibration of the extensometer that may occur as a result of operating under conditions different from calibration.

NOTE 3 Rod pressure onto the test specimen should be the minimum necessary to prevent slipping of the extensometer rods.