SLOVENSKI STANDARD

SIST EN 13235:2007

01-januar-2007

Nadomeģļ a:

SIST ENV 13235:2000

Sodobna tehniļ na keramika - Mehanske lastnosti keramiļ nih kompozitov pri visoki temperaturi v pogojih inertne atmosfere - Doloļ anje lezenja

Advanced technical ceramics - Mechanical properties of ceramic composites at high temperature under inert atmosphere - Determination of creep behaviour

Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei hoher Temperatur in inerter Atmosphäre - Bestimmung des Kriechverhaltens

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Céramiques techniques avancées - Propriétés mécaniques des céramiques composites a haute température sous atmosphère inerte - Détermination du comportement au fluage

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Ta slovenski standard je istoveten z: EN 13235:2006

ICS:

81.060.30	Sodobna keramika	Advanced ceramics

SIST EN 13235:2007 **en**

2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13235

October 2006

ICS 81.060.30

Supersedes ENV 13235:1998

English Version

Advanced technical ceramics - Mechanical properties of ceramic composites at high temperature under inert atmosphere - Determination of creep behaviour

Céramiques techniques avancées - Propriétés mécaniques des céramiques composites à haute température sous atmosphère inerte - Détermination du comportement au fluage

Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei hoher Temperatur in inerter Atmosphäre - Bestimmung des Kriechverhaltens

This European Standard was approved by CEN on 10 September 2006.

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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
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Foreword

This document (EN 13235:2006) 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 April 2007, and conflicting national standards shall be withdrawn at the latest by April 2007.

This document supersedes ENV 13235:1998.

ENV 13235 was approved by CEN/TC 184 for development into a full European Standard. The principal changes to the ENV are in the normative references, as follows:

- in 6.1.1, reference to EN 10002-2 has been replaced by reference to EN ISO 7500-1;

- in 6.2, reference to WI 136 has been removed;

- references to ENV 1892 have been replaced by references to EN 1892.

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, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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1 Scope

This European Standard specifies the conditions for the determination of the tensile creep deformation and failure behaviour of ceramic matrix composite materials with continuous fibre reinforcement for temperatures up to 2 000 °C under vacuum or in a gas atmosphere which is inert to the material under test. The purpose of these test conditions is to prevent changes to the material as a result of chemical reaction with the test environment.

This European Standard applies to all ceramic matrix composites with a continuous fibre reinforcement, unidirectional (1 D), bidirectional (2 D), and tridirectional (x D, where $2 < x \leq 3$), loaded along one principal axis of reinforcement.

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 1892, *Advanced technical ceramics — Mechanical properties of ceramic composites at high temperature under inert atmosphere — Determination of tensile properties*

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*

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3 Principle

A test specimen of specified dimensions is heated to the test temperature, and loaded under tension to a specified level of force. This force is maintained at a constant level for a specified time or until rupture. The variation in gauge length is recorded in relation to time.

4 Terms, definitions and symbols

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

4.1
creep
total time-dependent increase of gauge length starting from the time when the constant specified level of force is reached

4.2
test temperature, T
temperature of the test specimen at the centre of the gauge length

4.3
calibrated length, l
part of the test specimen which has uniform and minimum cross-section area

4.4
gauge length, L_0
initial distance between reference points on the test specimen in the calibrated length at test temperature, at the moment when loading is completed

4.5
controlled temperature zone
part of the calibrated length including the gauge length where the temperature is within 50 °C of the test temperature

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4.6
initial cross section area, A_0
initial cross section area of the test specimen within the calibrated length, at test temperature

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4.7
applied tensile force
constant force applied to the test specimen during the test

4.8
applied tensile stress
applied tensile force divided by the initial cross section area

4.9
longitudinal deformation, ΔL
change in the gauge length caused by creep

4.10
tensile creep strain, ε_{cr}
relative change in the gauge length at time t, caused by creep

NOTE The value corresponding to rupture is denoted $\varepsilon_{cr,m}$.

4.11
creep rupture time, $t_{cr,m}$
time elapsed from the moment when loading is completed until the moment of rupture

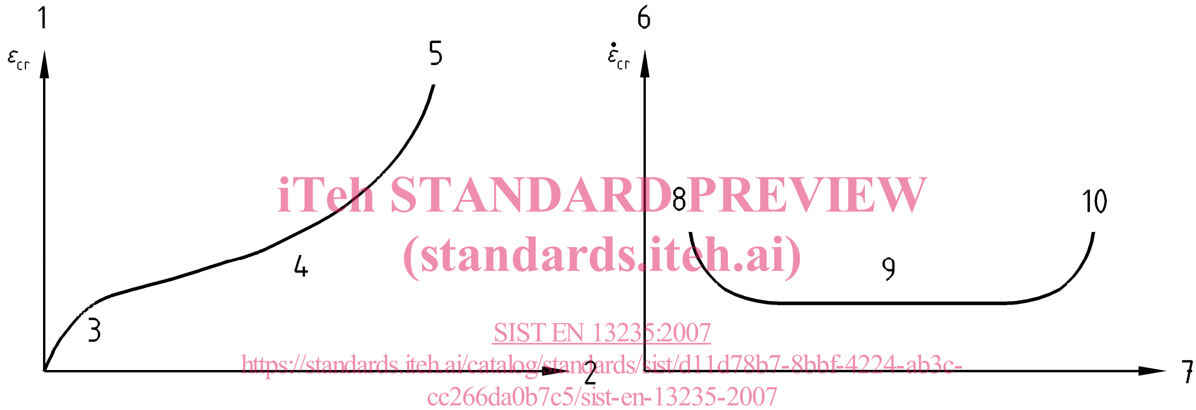
4.12
creep strain rate, $\dot{\varepsilon}_{cr}$
change in creep strain per unit time at time t

4.13
Creep types

4.13.1
primary creep
part of the creep strain versus time curve which represents a decreasing creep strain rate, as illustrated by Figure 1

4.13.2
secondary creep
part of the creep strain versus time curve which represents a constant creep strain rate, as illustrated by Figure 1

4.13.3
tertiary creep
part of the creep strain versus time curve which represents an increasing creep strain rate, as illustrated by Figure 1



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a) b)

Key

1 creep strain ε_{cr}
2 time t
3 primary creep
4 secondary creep
5 tertiary creep
6 creep strain rate ε_{cr} (creep strain with time)
7 time t
8 primary creep
9 secondary creep
10 tertiary creep

Figure 1 — Representations of a) creep strain versus time and b) creep strain rate versus time

5 Significance and use

Several mechanisms may be responsible for time-dependent deformation of fibre-reinforced ceramic matrix composites at high temperature. These may be creep of the fibre and/or the matrix, or may be caused by the composite nature of the material (matrix micro-cracking, fibre-matrix interface sliding). Creep is characterised by the total time-dependent increase of the gauge length, starting from the time when the specified force level is reached, whatever the mechanism responsible.

During the loading phase, the loading rate up to the specified force level can have a dramatic effect on the subsequent accumulation of creep strain. This is particularly the case when the fibres and the matrix have very different creep strengths. Upon fast application of the force, the load is distributed between the fibres and the matrix according to their elastic modulus and their volume fraction. With increasing time, the load redistributes between the fibres and the matrix whereby the constituent with the higher resistance against creep deformation takes up more load at the expense of the constituent with the lower creep resistance.

When the force is applied at a lower rate, such load redistribution between the fibres and the matrix can already occur during the loading phase. For the same applied force, this results in a lower load in the weaker constituent. When the matrix has the lower creep resistance, fast loading may hence cause matrix cracking, which in turn exposes the bridging fibres to a higher load, and causes them, as well as the composite to creep at a higher rate. By applying the force at a sufficiently low rate, matrix micro-cracking may be avoided, and the creep life of the composite may increase considerably.

It is therefore necessary to select the loading rate for which the phenomenon is negligible.

6 Apparatus

6.1 Test installations

NOTE Two different types of installation can be used, as described in 6.1.1 and 6.1.2.

6.1.1 Universal test machine

The machine shall be equipped with a system for measuring the force applied to the test specimen, which, when tested in accordance with EN ISO 7500-1, shall meet the requirements of grade 1 or better of that standard, for all test conditions of pressure and temperature.

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6.1.2 Creep testing rig

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When a creep testing rig is used, the force application system shall be calibrated. The testing rig shall be equipped with a system to allow smooth loading of the specimen(s). In the case where multiple specimens are tested in the test rig, precautions shall be taken to avoid shock loading the other specimens when one of the specimens fails. Whichever system is used, care shall be taken to ensure that the force applied to the specimen remains constant to within ± 1 % even when the environmental conditions (temperature, pressure) fluctuate.

6.2 Load train

The gripping system shall align the test specimen axis with that of the applied force. The alignment shall be verified and documented.

The choice of a hot or cold gripping system depends on the material to be tested, on the geometry of specimen and on the heating system, and it affects the alignment performance as well as the axial temperature distribution on the specimen.

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. This can be achieved in two ways. The most straightforward procedure consists of mounting the load cell inside the test chamber. When this is not possible, a pre-calibration of the response of pressure variation in the test chamber on the load cell signal shall be made. Pressure variation during testing shall not induce variations of the load experienced by the specimen larger than those indicated in 6.1.

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