



**SLOVENSKI STANDARD**  
**kSIST prEN 820-4:2009**

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Advanced technical ceramics - Thermomechanical properties of monolithic ceramics - Part 4: Determination of flexural creep deformation at elevated temperatures

Hochleistungskeramik - Thermomechanische Eigenschaften monolithischer Keramik - Teil 4: Bestimmung der Kriechverformung unter Biegebeanspruchung bei erhöhten Temperaturen

Céramiques techniques avancées - Propriétés thermomécaniques des céramiques monolithiques - Partie 4 : Détermination de la déformation par fluage en flexion à températures élevées

**Ta slovenski standard je istoveten z: prEN 820-4**

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English Version

## Advanced technical ceramics - Thermomechanical properties of monolithic ceramics - Part 4: Determination of flexural creep deformation at elevated temperatures

Céramiques techniques avancées - Propriétés  
thermomécaniques des céramiques monolithiques - Partie  
4 : Détermination de la déformation au fluage en flexion, à  
températures élevées

Hochleistungskeramik - Thermomechanische  
Eigenschaften monolithischer Keramik - Teil 4:  
Bestimmung der Kriechverformung unter  
Biegebeanspruchung bei erhöhten Temperaturen

This draft European Standard is submitted to CEN members for unique acceptance procedure. It has been drawn up by the Technical Committee CEN/TC 184.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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## Foreword

This document (prEN 820-4:2008) has been prepared by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

This document is currently submitted to the Unique Acceptance Procedure.

This document will supersede ENV 840-4:2001.

EN 820 consists of five parts, under the general title "Advanced technical ceramics - Methods of testing monolithic ceramics – Thermomechanical properties":

Part 1: Determination of flexural strength at elevated temperatures;

Part 2: Determination of self-loaded deformation;

Part 3: Determination of resistance to thermal shock by water quenching;

Part 4: Determination of flexural creep deformation at elevated temperatures;

Part 5: Determination of elastic moduli at elevated temperatures.

**prEN 820-4:2008 (E)****1 Scope**

This Part of EN 820 describes a procedure for undertaking flexural creep tests at elevated temperatures on advanced technical ceramics, mainly for the purposes of comparison of deformation behaviour of materials under stressed conditions and under any appropriate atmospheric condition.

NOTE This European Standard does not provide a method of acquiring engineering performance data since the stress distribution under flexural loading is indeterminate.

**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 820-1, *Advanced technical ceramics – Methods of testing monolithic ceramics - Thermomechanical properties - Part 1: Determination of flexural strength at elevated temperatures*

EN 843-1, *Advanced technical ceramics – Mechanical properties of monolithic ceramics at room temperature - Part 1: Determination of flexural strength*

EN 1006, *Advanced technical ceramics - Monolithic ceramics - Guidance on the selection of test pieces for the evaluation of properties*

EN 10002-2, *Metallic materials - Tensile testing - Part 2: Verification of the force measuring system of the tensile testing machines*

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

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

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

ISO 3611, *Micrometer callipers for external measurement*

### 3 Terms and definitions

For the purposes of this Part of EN 820 the following terms and definitions apply.

#### 3.1

**creep**

time-dependent non-elastic deformation of a material under an applied stress

#### 3.2

**creep rupture**

failure of a test piece under nominally constant loading conditions resulting from an accumulation of microstructural damage

#### 3.3

**stress rupture**

catastrophic extension of a flaw having previously grown subcritically under constant nominal stress leading to failure of the test piece

#### 3.4

**subcritical crack growth**

extension of existing cracks or flaws under stress which does not produce instant failure

### 4 Significance and use

The test is intended to evaluate the deformation of a test piece under nominally constant force as a function of time at elevated temperatures. In particular it can be used for materials comparison, or for determining the temperature at which creep deformation becomes significant for a prospective engineering use.

During the course of such a test, the test piece can fracture. This can be due either to a subcritical crack growth process unrelated to the mechanism of creep (stress rupture), or to the accumulation of creep damage leading to acceleration of creep rate and the linking of damage to form cracks (creep rupture). In some circumstances it is not possible to distinguish the mechanism of failure. In either case, the test piece lifetime under the imposed temperature and stress conditions can be an important aspect of a material's performance.

The analysis given in this European Standard (see 8.6) produces purely nominal data, assuming that the actual maximum nominal stress in the test piece is linearly proportional to the test force applied and is constant during the test. Moreover, an additional assumption of linear dependence of strain on stress is made for some deflection measurement methods. Furthermore, it does not give engineering creep data equivalent to separate pure tensile or compressive conditions. In many cases, the creep rate dependence is to the maximum stress, and can differ in tension and compression. Typically, the true maximum stress in the test piece is less than that calculated using Equation 1 because of faster relaxation at higher stress levels, and the true surface strain rate can be greater than a linear prediction in certain geometrical arrangements for determining the deformation, particularly if this is done using the relative displacement of the loading system. The Bibliography contains references to more detailed theoretical analyses of flexural creep accounting for such non-linearities.

## 5 Principle

The method involves supporting a bar test piece on two supports near its ends, heating it to the required elevated temperature which is maintained constant, applying a force to two loading points spaced symmetrically between the support points, and recording the deflection of the test bar with time.

The deflection of the test piece is measured indirectly and continuously or at appropriate time intervals during the test using the displacement of the loading system (see e.g. Figure 1a), or by using contacting extensometer rods at given positions on the test piece (see e.g. Figures 1b to 1e). The indirect measurement of deflection (Figure 1a) is converted into a nominal maximum surface strain in the test piece assuming a linear relationship between stress and accumulated strain. Similar assumptions are involved in analysing deflections between support points and the span centre (Figure 1b and 1c). When employing displacement measurement between the loading points and the span centre (Figures 1d and 1e), the analysis assumes uniform curvature of the test piece, a linear relationship between strain and distance from the neutral axis, and equal behaviour in tension and compression. The slope of the strain/time curve can be converted to a creep strain rate.

## 6 Apparatus

### 6.1 Creep test loading jig

The test jig is essentially a four-point bend flexural test jig similar to that described in EN 820-1 for flexural strength testing at elevated temperatures. It comprises a pair of parallel 5 mm diameter support rods positioned 40 mm apart on a refractory supporting structure. These rods shall be free to roll to eliminate friction effects. In contrast to the articulating requirement in EN 820-1, articulation is not required provided that the rods are accurately parallel in the horizontal plane to within 0,001 mm per mm length of rod.

The loading assembly comprises a similar pair of freely rolling rods positioned on a loading block. The spacing between these rods shall be between 30 % and 50 % of the spacing of the support rods. The loading block shall be free to articulate relative to the loading column in order to permit alignment of the loading rods on the test piece upper surface.

**NOTE 1** Subject to agreement between parties, other test piece support and loading spans can be employed. This can be particularly advantageous for creep-resistant materials. In addition, in some conditions it is recognized that freely rolling rollers, although preferred, may not be feasible. Such deviations from this method should be reported. The effect of restricted roller rotation may or may not be significant depending on the test material and the testing conditions. There is some evidence to suggest that the surface of glass-phase containing materials, or materials which oxidize to give a viscous glassy surface layer, can have a low coefficient of friction against the roller material at the test temperature, such that over the period of the test any friction becomes negligible. However, this situation cannot always be guaranteed.

The loading block shall be guided appropriately such that the loading rods are positioned mid-way between the support rods, thus centrally loading a test piece when placed on the support rods.

The parts of the loading jig shall be constructed from a ceramic material which is anticipated to be more resistant to deformation than the materials under test. In addition the support and loading rods shall be of a material which does not chemically react with the test piece.

**NOTE 2** Suitable materials include high-purity alumina for use with most oxide-based test pieces, or sintered silicon carbide for most non-oxide ceramics.

**NOTE 3** Test jig parts manufactured from sintered silicon carbide or other silicon-based non-oxide ceramics develop oxidation films in a short period of time when exposed to temperatures typically above 1 300 °C in an oxygen-containing atmosphere. This can cause prevention of rolling of rollers and impairment of jig function.