



Institut luxembourgeois de la normalisation  
de l'accréditation, de la sécurité et qualité  
des produits et services

**ILNAS-EN 1007-6:2007**



## National Foreword

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**Advanced technical ceramic - Ceramic composites - Methods of  
test for reinforcements - Part 6: Determination of tensile  
properties of filaments at high temperature**

Céramiques techniques avancées - Céramiques  
composites - Méthodes d'essai pour renforts - Partie 6 :  
Détermination des propriétés en traction du filament à  
haute température

Hochleistungskeramik - Keramische Verbundwerkstoffe -  
Verfahren zur Prüfung der Faserverstärkungen - Teil 6:  
Bestimmung der Zugeigenschaften von Fasern bei hoher  
Temperatur

This European Standard was approved by CEN on 13 October 2007.

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## Foreword

This document (EN 1007-6:2007) 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of an identical text or by endorsement, at the latest by **May 2008**, and conflicting national standards shall be withdrawn at the latest by **May 2008**.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes ENV 1007-6:2002.

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## 1 Scope

This European Standard specifies the conditions for measurement of tensile properties of a single filament of ceramic fibres at high temperatures in air or inert atmosphere (vacuum or controlled atmosphere). The method applies to continuous ceramic filaments taken from tows, yarns, staple fibre, braids and knitting, that have strain to fracture less than or equal to 5 % and show linear elastic behaviour to fracture.

The method does not apply to testing for homogeneity of strength properties of fibres, nor does it assess the effects of volume under stress. Statistical aspects of fibre failure are not included.

Two methods are proposed depending on the temperature of the filament end:

- Hot end method: this method allows determination of tensile strength, of Young's modulus and of the stress strain curve.

NOTE 1 Current experience with this technique is limited to 1 300 °C, because of the application temperature of ceramic glue.

- Cold end method.

NOTE 2 This method is limited to 1 700 °C in air and 2 000 °C in inert atmosphere because of the limits of furnaces.

## 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 1007-3, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 3: Determination of filament diameter and cross-section area*

EN 1007-4, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 4: Determination of tensile properties of filaments at ambient temperature*

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)*

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

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)*

## 3 Terms and definitions

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

### 3.1 test temperature

*T*

temperature of the filament at the centre of the gauge length

## 3.2 Lengths

### 3.2.1

#### gauge length

$L_0$

initial distance between two reference points on the filament, where the temperature variation is within 20 °C at test temperature

### 3.2.2

#### test specimen length

$L_f$

initial distance between the gripped ends of the filament

### 3.2.3

#### uniformly heated length

$L_h$

length of the heated zone at the test temperature, where the temperature variation is within 20 °C (see Figure A.2)

### 3.2.4

#### gradient zone length

$L_d$

length of each part of the test specimen where the temperature decreases from the temperature at the end of the uniformly heated length to room temperature (see Figure A.2)

### 3.2.5

#### room temperature zone length

$L_c$

length of each part of the test specimen where the temperature is equal to room temperature

## 3.3

#### initial cross-section area

$A_0$

initial cross-section area of the filament within the gauge length determined at room temperature

## 3.4

#### maximum tensile force

$F_m$

highest recorded tensile force on the test specimen when tested to failure

## 3.5

#### tensile stress

$\sigma$

tensile force supported by the test specimen divided by the initial cross-section area

## 3.6

#### tensile strength

$\sigma_m$

ratio of the maximum tensile force to the initial cross-section area

## 3.7

#### longitudinal deformation

$\Delta L$

increase of the gauge length during the tensile test

## 3.8 Compliance

### 3.8.1

#### total compliance

$C_t$

reciprocal of the slope in the linear part of the force/displacement curve

**3.8.2****load train compliance** $C_l$ 

ratio of the force displacement excluding any test specimen contribution to the corresponding force during the tensile test

**3.8.3****gradient zone compliance** $C_d$ 

ratio of the test specimen elongation in the temperature gradient zone length  $L_d$  to the corresponding force during the tensile test

**3.8.4****cold zone compliance** $C_c$ 

ratio of the test specimen elongation at room temperature  $L_c$  to the corresponding force during the tensile test

**3.8.5****hot zone compliance** $C_h$ 

ratio of the test specimen elongation in the uniformly heated length  $L_h$  to the corresponding force during the tensile test

**3.9****strain** $\varepsilon$ 

ratio of the longitudinal deformation to the gauge length

**3.10****fracture strain** $\varepsilon_m$ 

strain at failure of the test specimen

**3.11****elastic modulus** $E$ 

slope of the linear part of the tensile stress-strain curve

**4 Principle**

A ceramic filament is heated to the test temperature and loaded in tension. The test is performed at constant force/displacement rate up to failure. Force and cross-head displacement are measured and recorded simultaneously. When required, the elongation is derived from the cross-head displacement using a compliance correction. The test duration is limited to reduce time dependent effects.

Subjecting the whole length of a fibre to temperatures well above 1 000 °C makes it difficult to fix the ends of the specimen into appropriate temperature proof extensions. In high temperature cold end tests this problem is avoided by keeping the junction at the ends of the test specimen at room temperature, allowing organic resins to be used as in the room temperature tests (EN 1007-4).

Two methods can thus be used:

- one consists of heating the filament over its total length (hot end method);
- one consists of heating only the central part of the filament (cold end method).