

GcXcVbUhm b] bU_YfUa]_U!`?YfUa] b]`_ca dcn]h]!`DfYg_i gbY`a YfcXY`nU`c`U]hj Y
!`+`"XY. ! [cHuj `Ub`Y`dcfUnXY]hj Y`bUnYnbY`fXbcgh]`b`XYZ`fa UW`%VfYa Yb]hYj
j`U_Yb]j`gj Yyb`A`df]j]gc_]`hYa dYfUi f]

Advanced technical ceramics - Ceramic composites. Methods of test for reinforcements -
Part 7: Determination of the distribution of tensile strength and of tensile strain to failure
of filaments within a multifilament tow at high temperature

Hochleistungskeramik - Keramische Verbundwerkstoffe. Verfahren zur Prüfung von
Verstärkungen - Teil 7: Bestimmung der Verteilung von Zugfestigkeit und Zugdehnung
von Fasern im Faserbündel bei hoher Temperatur

Céramiques techniques avancées - Céramiques composites - Méthodes d'essai pour
renforts - Partie 7: Détermination de la distribution de la résistance en traction et de la
déformation de traction à la rupture des filaments dans un fil à haute température

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test for reinforcements - Part 7: Determination of the distribution
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Verfahren zur Prüfung von Verstärkungen - Teil 7:
Bestimmung der Verteilung von Zugfestigkeit und
Zugdehnung von Fasern im Faserbündel bei hoher
Temperatur

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Foreword

This document (FprEN 1007-7:2009) 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 CEN/TS 1007-7:2006.

EN 1007, *Advanced technical ceramics — Ceramic composites. Methods of test for reinforcements*, has been prepared in 7 parts:

- *Part 1: Determination of size content;*
- *Part 2: Determination of linear density;*
- *Part 3: Determination of filament diameter and cross-section area;*
- *Part 4: Determination of tensile properties of filaments at ambient temperature;*
- *Part 5: Determination of distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at ambient temperature;*
- *Part 6: Determination of tensile properties of filaments at high temperature;*
- *Part 7: Determination of the distribution of tensile strength and tensile strain to failure of filaments within a multifilament tow at high temperature.*

1 Scope

This European standard specifies the conditions, apparatus and procedure for determining the distribution of tensile strength and tensile strain to failure of ceramic filaments in multifilament tows at high temperature in air, vacuum or a controlled inert atmosphere.

This part of EN 1007 applies to tows of continuous ceramic filaments, which are assumed to act freely and independently under loading and behave linearly elastic up to failure.

Two methods are proposed depending on the temperature of the ends of the tow:

- a) hot end method;

NOTE 1 The application of the hot end method is restricted by ceramic glues with sufficient shear strengths at the test temperature. Current experience with this technique is limited to 1 300 °C, because of the maximum application temperature of ceramic glues.

- b) cold end method.

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

Both methods allow for a failure rate in the determination of distribution of tensile strain and tensile strength.

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 843-5, *Advanced technical ceramics — Mechanical properties of monolithic ceramics at room temperature — Part 5: Statistical analysis*

EN 1007-2, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 2: Determination of linear density*

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 7500-1:2004, *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)*

CEN/TR 13233:2007, *Advanced technical ceramics — Notations and symbols*

ISO 10119, *Carbon fibre — Determination of density*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CEN/TR 13233:2007 and the following apply.

3.1

test temperature

T

temperature of the filament at the centre of the gauge length

3.2

lengths

initial distances between two reference points on the tow, disregarding thermal and mechanical strains

3.2.1

gauge length

L_0

part of the tow between the gripped ends, where the temperature variation is within 20 K of the test temperature

3.2.2

test specimen length

L_f

initial distance between the gripped ends of the tow

3.2.3

uniformly heated length

L_h

length of the heated zone within which the temperature variation is within 20 K of the test temperature

3.2.4

cold zone length

L_c

length of the tow, which is not uniformly heated

3.3

initial cross sectional area

A_0

sum of the cross sectional areas of all the filaments in the tow

3.4

tow elongation

ΔL

increase of the gauge length between the two reference points on the tow

3.5

tow strain

ε

ratio of the tow elongation ΔL to the gauge length L_0

3.6

tow maximum tensile force

F_{tow}

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

FprEN 1007-7:2009 (E)**3.7****tow strength** σ_{tow}

ratio of the tow maximum tensile force to the cross sectional area of all unbroken filaments at maximum tensile force, F_{tow}

3.8**force at step j** F_j

force applied on the test specimen at step j

3.9**filament strain** ε_j

strain at step j in the non-linear parts of the force-displacement curve

3.10**filament strength** σ_j

ratio of the tensile force to the cross sectional area of all unbroken filaments at step j in the non-linear parts of the force-displacement curve

3.11**average filament rupture strain** $\overline{\varepsilon_r}$

statistical average rupture strain of the filaments in the tow for each test determined from the Weibull strain distribution parameters of the filaments

3.12**overall average filament rupture strain** $\overline{\overline{\varepsilon_r}}$

arithmetic mean of the average filament rupture strains

3.13**average filament strength** $\overline{\sigma_r}$

statistical average strength of the filaments in the tow for each test determined from the Weibull strength distribution parameters of the filaments

3.14**overall average filament strength** $\overline{\overline{\sigma_r}}$

arithmetic mean of the average filament strengths

3.15 Compliances**3.15.1****initial total compliance** C_t

inverse slope of the linear part of the force-displacement curve