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ADVANCED TECHNICAL CERAMICS - MECHANICAL PROPERTIES OF CERAMIC COMPOSITES AT HIGH TEMPERATURE UNDER AIR AT ATMOSPHERIC PRESSURE - DETERMINATION OF FLEXURAL STRENGTH

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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. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

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Foreword

This document (EN 12789:2002) 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of an identical text or by endorsement, at the latest by April 2003, and conflicting national standards shall be withdrawn at the latest by April 2003.

This document supersedes ENV 12789:1998.

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

1 Scope

This European Standard specifies the conditions for determination of the flexural strength of ceramic matrix composite materials with continuous fibre reinforcement under three-point or four-point bending for temperatures up to 1 700 °C in air at atmospheric pressure.

This standard applies to all ceramic matrix composites with a continuous fibre reinforcement, unidirectional (1D), bidirectional (2D), and tridirectional (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 antioxidation coating.

NOTE 2 The purpose of this standard is to determine the flexural strength of a material under an oxidizing environment but not to measure material oxidation.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN ISO 7500-1, *Metallic materials - Verification of static uniaxial testing machines - Part 1: Tension/compression testing machines (ISO 7500-1:1999)*.

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)*.

ISO 3611, *Micrometer callipers for external measurement.*

3 Principle

A test piece of specified dimensions is heated to the testing temperature. It is subsequently loaded in flexure to fracture in such a way that failure occurs in tension or in compression along one principal axis of reinforcement.

The test is performed at constant crosshead displacement rate.

The test duration is limited to reduce any time dependent effects (creep, etc.).

4 Terms and definitions

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

4.1
test temperature, *T*
temperature at the centre of the test piece

4.2
maximum flexural force, F_m
highest recorded force in a flexural test on the test piece when tested to failure

4.3
flexural stress, σ
the nominal stress on the outer surface of the test piece, calculated at mid-span

NOTE This stress is conventionally calculated according to the simple beam theory, whose basic assumptions cannot be met by ceramic matrix composite materials.

4.4
flexural strength, $\sigma_{f,m}$
maximum flexural stress applied to a test piece that fractures during a flexural test

two flexural strengths can be distinguished:

— apparent flexural strength, $\sigma_{f,m,a}$, when the apparent dimensions are used

— effective flexural strength, $\sigma_{f,m,e}$, when the dimensions are corrected by a factor to account for the presence of the antioxidative protection

5 Apparatus

5.1 Test machine

The machine shall be equipped with a system for measuring the force applied to the test piece. The system shall conform to grade 1 according to EN ISO 7500-1.

5.2 Test jig

The test jig is composed of two parts, linked to the fixed and mobile parts of the machine. It has two outer support rollers and one (three-point bending) or two (four-point bending) inner support rollers.

The material of the jig and that of the rollers shall not react with that of the specimen, nor with the environment.

The cylindrical rollers shall have a diameter of 4 mm to 10 mm. Their length shall be at least equal to the width of the specimen. They shall be made of a material with a hardness at least equal to that of the specimen. The axes of the rollers shall be parallel to within 0,01 mm/mm.

The outer rollers (three and four-point bending) and inner rollers (four-point bending) shall be free to rotate (see Figure 1).

Either two or three rollers, for three-point or four-point bending respectively, shall be free to pivot around an axis parallel to the longitudinal direction of the test piece, in order to adapt to the non-parallelism of the upper and lower faces of unmachined test pieces(see Figure 1).

The rolling and pivoting ability of the rollers shall not be affected by heating. The distance between rollers shall be in accordance to clause 6.

The inner roller(s) shall be centred with respect to the outer rollers to within 0,2 mm. In the case of four-point bending a levelling system shall be used to ensure symmetrical loading of the test piece.

The performance shall not change because of heating.

5.3 Set-up for heating

The set-up for heating shall be constructed in such a way that the variation of temperature of part of the test piece which is between the outer support rollers is less than 50 °C at test temperature.