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Fine ceramics (advanced ceramics, advanced technical ceramics) — Mechanical properties of ceramic composites at ambient temperature in air atmospheric pressure — Determination of the resistance to crack propagation by notch sensitivity testing

Céramiques techniques — Propriétés mécaniques des céramiques composites à température ambiante sous pression atmosphérique — Détermination de la résistance à la propagation de fissure par un essai de sensibilité à l'entaille

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Mechanical properties of ceramic composites at ambient temperature in air atmospheric pressure — Determination of the resistance to crack propagation by notch sensitivity testing

1 Scope

This document describes a method for the classification of ceramic matrix composite (CMC) materials with respect to their sensitivity to crack propagation using tensile tests on notched specimens with different notch depths. Two classes of ceramic matrix composite materials can be distinguished: materials whose strength is sensitive to the presence of notches and materials whose strength is not affected. For sensitive materials, this document defines a method for determining equivalent fracture toughness.

The parameter, K_{eq}, is defined as the fracture toughness of a homogeneous material which presents the same sensitivity to crack propagation as the ceramic matrix composite material which is being considered. The definition of the K_{eq} parameter offers the possibility to compare ceramic matrix composite materials with other materials with respect to sensitivity to crack propagation.

For notch insensitive materials, the concept of K_{eq} does not apply.

This document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 3611, *Geometrical product specifications (GPS) — Dimensional measuring equipment: Micrometers for external measurements — Design and metrological characteristics*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 15733:2015, *Fine ceramics (advanced ceramics, advanced technical ceramics) — Mechanical properties of ceramic composites at ambient temperature in air atmospheric pressure — Determination of tensile properties*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15733 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

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3.1
ligament
part of the double edge notched specimen that is located between the notches

Note 1 to entry: The width of the ligament is denoted b; the cross-section of the ligament is denoted A.

3.2
notch depth
a
distance between the side of the specimen and the tip of the notch

3.3
notched specimen width
b_n
width of the notched specimen outside the notched cross-section

3.4
maximum tensile force
F_m
highest recorded tensile force on the test specimen when tested to failure

3.5
un-notched specimen tensile strength
$\sigma_{t,m}$
tensile strength determined by measurement according to ISO 15733

Note 1 to entry: The value of this parameter is designated σ_r.

3.6
notched specimen tensile strength
$\sigma_{t,m,n}$
ratio of the maximum tensile force to the ligament cross-section area

Note 1 to entry: The value of this parameter is designated σ_n.

3.7
equivalent fracture toughness
K_{eq}
fracture toughness of a homogeneous and isotropic material which presents the same dependence of the stress ratio σ_n/σ_r on the notch depth as the investigated composite

4 Principle

Tensile tests are carried out on double edge notched test specimens with notches of different depths. The results of these tests are compared with the results of tensile tests on specimens without notches. The cross-sectional dimensions of the notched specimens between the notches are equal to those of the un-notched specimens.

The strength values observed on both types of specimens as a function of notch depth allow the determination of the range of notch size for which the tested composite is sensitive to the presence of notches.

5 Significance and use

The fracture toughness is a material property which characterizes the initiation of fracture from a sharp crack (usually obtained by fatigue cracking under plane strain conditions). The fracture toughness of

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