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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for determining elastic modulus and bending strength of thick ceramic coatings

Céramiques techniques — Méthode d'essai relative à la détermination du module élastique et de la résistance en flexion des revêtements de céramique épais

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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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The committee responsible for this document is ISO/TC 206, *Fine ceramics*.

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Test method for determining elastic modulus and bending strength of thick ceramic coatings

1 Scope

This document specifies a testing method for determining the elastic modulus and bending strength of thick ceramic coatings at ambient temperature by three-point bending tests. Procedures for test piece preparation, test modes and load rates, data collection and reporting are given.

This document applies to thick, brittle coatings on metal or ceramic substrates. This test method can be used for material research, quality control, characterization and design data-generation purposes.

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*

3 Terms and definitions

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

3.1
elastic modulus
ratio of stress to strain

Note 1 to entry: Also known as Young's modulus.

3.2
bending strength
maximum tensile stress at fracture under bending load

3.3
modulus ratio
ratio of the coating modulus to the substrate modulus

3.4
thickness ratio
ratio of the coating thickness to the substrate thickness

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3.5
deflection ratio
ratio of the deflection increment of uncoated substrate to the deflection increment of coated test piece under a given load increment for three-point bending test

4 Symbols

For the purposes of this document, the symbols and designations given in Table 1 apply.

Table 1 — Symbols and designations

Symbol	Designation	Unit	References
H	Thickness of substrate	mm	Figure 1 Formula (1)
h	Thickness of coating	mm	Figure 1
B	Width of test piece	mm	Figure 1
P	Peak load	N	Figure 2
L	Span of test piece	mm	Formula (1) Formula (5)
E	Elastic modulus	GPa	Formula (1)
E_c	Elastic modulus of coating	GPa	Formula (2)
E_s	Elastic modulus of substrate	GPa	Formula (2)
α	Ratio of the elastic modulus of the coating to that of the substrate		Formula (2) Formula (5)
f	Deflection	mm	Formula (1)
σ_c	Bending strength of coating	MPa	Formula (5)
P_c	Critical fracture load	N	Formula (5)
y_c	Distance from the tensile surface to the neutral axis	mm	Formula (5)
I	Moment of inertia of the test pieces	mm^4	Formula (5)
ΔP	Load increment	N	Formula (1)
Δf	Deflection increment	mm	Formula (1)
n	Effective test number	numerical	Formula (3) Formula (4) Formula (6) Formula (7)
$\bar{\sigma}$	Mean value of bending strength	MPa	Formula (6) Formula (7)
σ_i	Bending strength of the ith test piece	MPa	Formula (6) Formula (7)
$\bar{E}$	Mean value of elastic modulus	GPa	Formula (3) Formula (4)
E_i	Elastic modulus of the ith test piece	GPa	Formula (3) Formula (4)
s_e	Standard deviation of measured elastic modulus	GPa	Formula (4)
s_σ	Standard deviation of measured bending strength	MPa	Formula (7)

5 Principle

The elastic modulus and bending strength of thick ceramic coatings on metal or ceramic substrates can be evaluated using three-point bending tests. The elastic modulus of the coating is deduced by comparing the deformation of a coated test piece and of the uncoated substrate under identical loads. A precondition of this method is that the elastic modulus of the substrate is known or can be measured

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