DRAFT INTERNATIONAL STANDARD

ISO/DIS 19477

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Metallic and other inorganic coatings — Measurement of Young's modulus of thermal barrier coatings by beam bending

Revêtements métalliques et autres revêtements inorganiques — Mesurage du module de Young des revêtements barrières thermiques par flexion de poutre

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Foreword

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ISO 19477 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC , .

This second/third/... edition cancels and replaces the first/second/... edition (), [clause(s) / subclause(s) / table(s) / figure(s) / annex(es)] of which [has / have] been technically revised.

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Introduction

Thermal barrier coatings are highly advanced material systems, generally applied to surfaces of hot-section components made of nickel or cobalt-based superalloys, such as combustors, blades, and vanes of power-generation gas turbines in thermal power plants and aero-engines operated at elevated temperatures.

The function of these coatings is to protect metallic components for extended periods at elevated temperatures by employing thermally insulating materials which can sustain an appreciable temperature difference between load bearing alloys and coating surfaces. These coatings permit the high-temperature operation by shielding these components, thereby extending their lives.

Although Young's modulus is one of the important properties of thermal barrier coatings, the existing ISO standard includes only the method for measuring the Young's modulus of monolithic ceramics.

This international standard specifies the method for measuring the Young's modulus of thermal barrier coatings that consist of multilayers formed on substrate by thermal spray.

The measuring procedure of this standard is applicable for measurement of the Young's modulus of various thermally sprayed coatings.

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Metallic and other inorganic coatings — Measurement of Young's modulus of thermal barrier coatings by beam bending

1 Scope

This international standard specifies the method for measuring the in-plane Young's modulus, at room temperature, of thermal barrier coatings formed on substrates by thermal spray.

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.

ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method*

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

ISO 4287, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters*

ISO 6906, *Vernier callipers reading to 0,02 mm*

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 14188, *Metallic and other inorganic coatings — Test methods for measuring thermal cycle resistance and thermal shock resistance for thermal barrier coatings*

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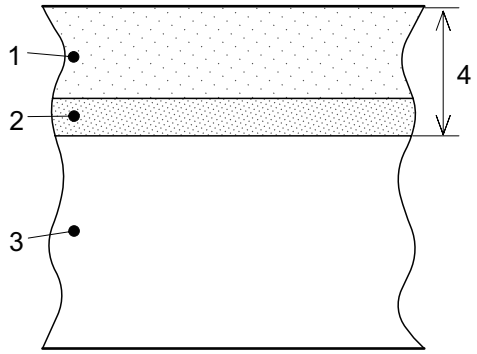
3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14188 and the following apply.

3.1
Thermal barrier coating (TBC)
a two-layer coating consisting of a metallic bond coat (BC) and a ceramic top coat (TC), in order to reduce heat transfer from outside of the TC through the coating to the substrate (Figure 1)



Key
1 top coat (TC)
2 bond coat (BC)
3 substrate
4 TBC

Figure 1 — Diagrammatic view of a section of TBC

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3.2
composite beam
beam consisting of multiple layers

4 Principle

The fundamental procedures for measuring the Young's moduli of the substrate, BC, and TC consist of the measurement of the force - strain diagram of three types of specimens (substrate, substrate with BC, and substrate with TBC) by the four-point bending method, and of calculations according to the theory of composite beam.[1] –[5]

5 Apparatus for measuring Young's modulus

An example of the apparatus for measuring the Young's modulus is schematically shown in Figure 2.

The apparatus consists of four-point bending jig, testing machine, and strain measuring epuipment.

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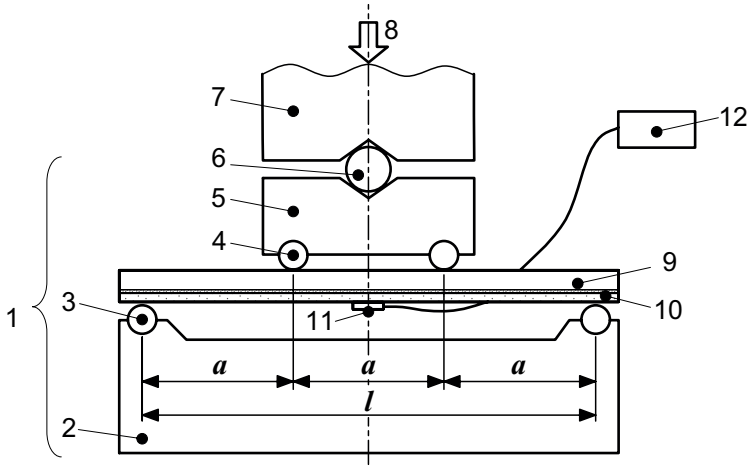

Key

1	four-point bending jig	8	force
2	support bed	9	specimen
3	support roller	10	TBC
4	load roller	11	strain gauge
5	load bed	12	strain measuring equipment
6	ball	a	distance between load rollers
7	testing machine	l	distance between support rollers

Figure 2 — Typical apparatus for measuring the Young's modulus (In the case that the tensile force is applied to the TBC)

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5.1 Testing machine

The testing machine is specified according to ISO 7500-1.

5.2 Four-point bending jig

The four-point bending jig consists of the load bed, load roller, support bed, support roller, and ball, as follows.

a) The load bed, load roller, support bed, support roller, and ball shall have sufficient rigidity to prevent their plastic deformation during testing.

b) The width of load bed, load roller, support bed, and support roller shall be larger than that of specimen.

c) The distance between load rollers shall be from 15 mm up to and including 30 mm.

d) The distance between support rollers shall be three times that between load rollers.

e) The radii of support rollers and load rollers shall be the same, and from 2,0 mm up to and including 3,0 mm.

f) The surface roughness of rollers shall be ≤ 0,4 μm Ra according to ISO 4287.

g) The ball is used to apply even force on the left and right load rollers.

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5.3 Strain measuring equipment

The strain measuring equipment shall be specified as follows.

a) The strain measuring equipment shall be capable of identifying, to the accuracy of ± 1 %, the strain to be measured with the strain gauge.

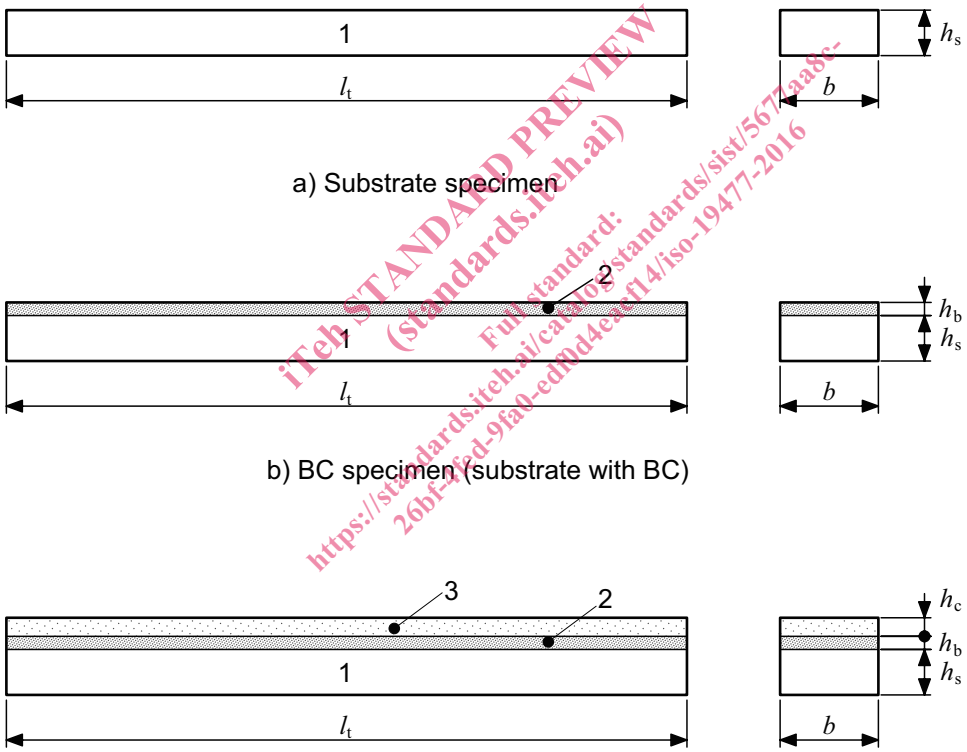
b) The strain gauge length should normally be ≤ 5 mm.

6 Specimen

The specimens shall be specified as follows.

a) The three types of specimens, the substrate, BC, and TBC specimens shall be used.

b) The specimen shape is a beam type (Figure 3) and the dimensions of the specimen shall be as given in Table 1.



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Key

1 substrate
2 BC
3 TC
l_t total length
b width
h_s substrate thickness
h_b BC thickness
h_c TC thickness

Figure 3 — Shape of specimens

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