DRAFT INTERNATIONAL STANDARD

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Thermal spraying — Classification method of adhesive strength by indentation

Projection thermique — Méthode de classification de la résistance adhésive par indentation

ICS: 25.220.01

Reference number
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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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. International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2. The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote. Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. ISO was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*.

Introduction

Adhesion of coatings specified here is required for three reasons:

— for selection of coating material and spray method.

— for quality assurance of thermal spraying.

— for product design and performance assessment of coatings.

This International Standard provides the classification method of adhesive strength for thermal spray coatings by using Vickers hardness testing machine generally and widely used. In the present test method, a pyramidal Vickers diamond indenter is indented with test force at the interface of coatings. When the test force exceeds the threshold value corresponding to the adhesive strength, an interfacial crack is generated. Accordingly, it is possible to evaluate the adhesive strength of coatings by the test force applied as discrete values when using conventional Vickers testing machine. This International Standard classifies the adhesive strength, called adhesion index, evaluated from the maximum indentation force without visible cracking, and can be also applied to evaluate coatings with a high adhesive such as cermet coatings. The present test method can be applied to sprayed coatings if the crack initiated by the indentation can be observed by using optical microscope.

The maximum indentation force does not therefore require much more effort in the experimental procedure and can describe the property of system combination (substrate chemistry, pre-preparation/roughness of substrate surface, coating chemistry and spraying related coating properties), provided the measurements are obtained carefully in line with the methods proposed in this International Standard. This International Standard recommends good practice to minimize levels of uncertainty in the measurement process. The procedure has been validated through underpinning technical work within the Round-Robin test program conducted by the Subcommittee on Standard Development, Japan Thermal Spray Society.

Thermal spraying — Classification method of adhesive strength by indentation

1 Scope

This International Standard specifies the classification method of adhesive strength for thermal spray coatings at room temperature by using Vickers hardness testing machine. This International Standard classifies the adhesive strength, called adhesion index, evaluated from the maximum indentation force without visible cracking, and it is applicable for relative dense metal coatings, ceramic coatings and cermet coatings.

NOTE The indentation method is not recommended for very thin and very porous coatings.

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 6507-1:2005, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6507-2:2005, *Metallic materials — Vickers hardness test — Part 2: Verification and calibration of testing machines*

ISO 14917:1999, *Thermal spraying — Terminology, classification*

ISO 14923:2003, *Thermal spraying — Characterization and testing of thermally sprayed coatings*

3 Terms and definitions

For the purposes of this document, terms and definitions given in ISO 14917 and ISO 14923 and the following apply.

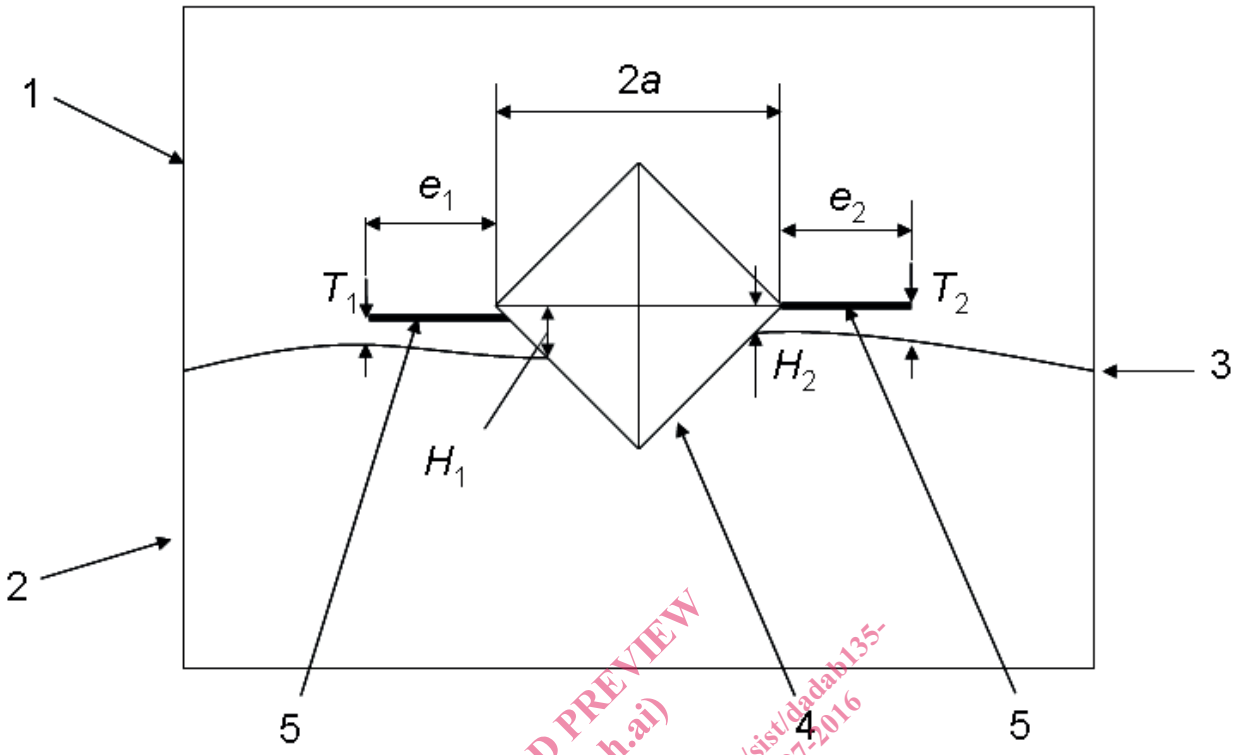
3.1
Critical indentation force
The maximum indentation force without visible cracking between substrate and coating.

3.2
Adhesion index (AI)
The index of adhesive strength of coatings defined by the critical indentation force.

4 Symbols and units

For the purposes of this document, the following symbols and units apply (see Figure 1 and Figure 2).

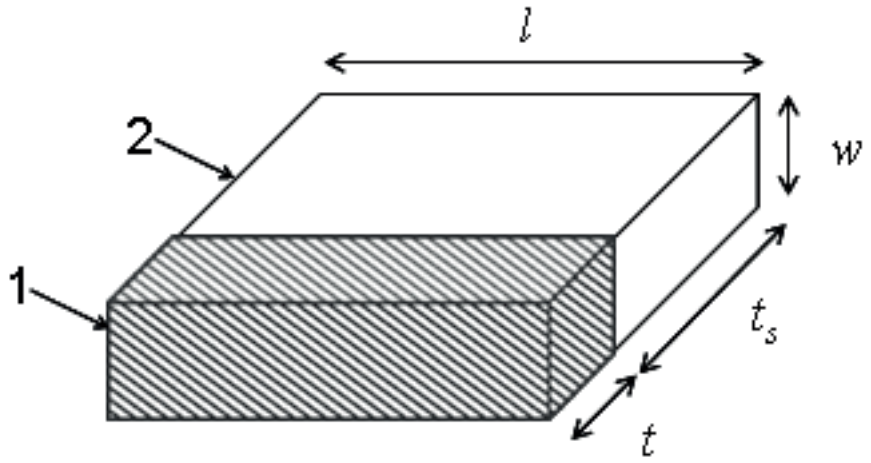
Symbol	Designation	Unit
a	Impression -diagonal half-length parallel to interface	mm
e	Visible crack length mean value	mm
e_1, e_2	Individual crack lengths at corner of an impression (lengths from crack tip to edge of impression diagonal, parallel with the macroscopic interface)	mm
F	Test force (Indentation force)	N
F_{eq}	Equivalent indentation force when using the special conical indenter	N
H	Mean value in impression position	mm
H_1, H_2	Individual impression position	mm
l	Sample length	mm
T	Mean value in crack tip position	mm
T_1, T_2	Individual crack tip position	mm
t	Coating thickness	mm
t_s	Substrate thickness	mm
w	Sample width	mm
CF	Visible cracking frequency	%
N_c	Number of indentations with visible cracking	-
N_t	Total number of indentations	-



Key

1 coating
2 substrate (or bond coat)
3 interface
4 impression
5 visible crack

Figure 1 — Schematic diagram of indentation characteristics



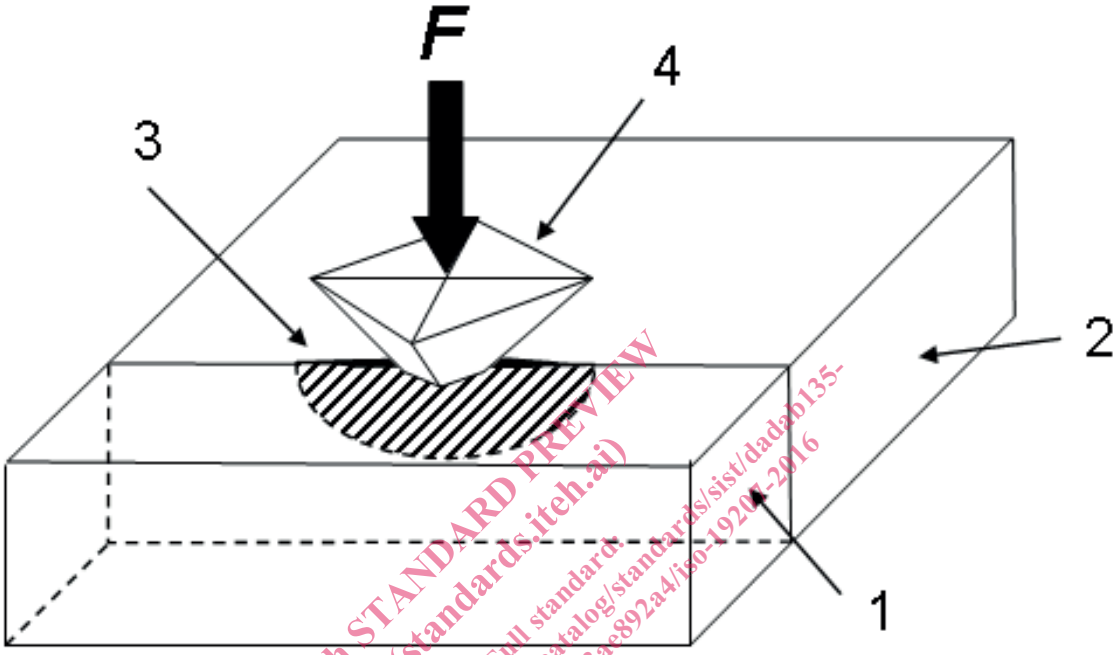
Key

1 coating
2 substrate (with bond coat)

Figure 2 — Sample geometry

5 Principle

When a pyramidal Vickers diamond indenter is indented with the indentation force at the interface (see Figure 3), an interfacial crack opening force that acts perpendicularly to the interface is generated. This crack opening force is proportional to the test force. When the crack opening force exceeds the adhesive strength of the test piece, an interfacial crack is generated. Accordingly, it is possible to classify the adhesive strength of the test piece by the indentation force applied using the Vickers indenter.



Key

1 coating
2 substrate (with bond coat)
3 visible crack
4 Vickers diamond indenter

Figure 3 — Interfacial indentation test

6 Test pieces and sample preparation

The spray surface of substrate should be a flat. After thermal spraying, samples are cut from sprayed plate. The sample shall be embedded in resin as test piece (see Figure 4).

In the samples, the thermal spray coating shall be adhered to the base material (or bond coating) and any cracking is not acceptable in the evaluation section before the test.