
**Thermal spraying — Characterization and
testing of thermally sprayed coatings**

*Projection thermique — Caractérisation et essais des revêtements
obtenus par projection thermique*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 14923:2003

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 14923:2003

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

© ISO 2003

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

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 14923 prepared by the European Committee for Standardization (CEN) in collaboration with Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this document, read “...this European Standard...” to mean “...this International Standard...”.

[ISO 14923:2003](https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003)

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

Contents

	Page
Foreword.....	v
1 Scope	1
2 Normative references	1
3 Terms and definitions.....	3
4 Manufacturing the coating	4
4.1 General	4
4.2 Coating materials.....	4
4.3 Coating properties.....	5
4.4 Technological and physical properties.....	5
5 Tests.....	7
5.1 General.....	7
5.2 Non-destructive test methods	7
5.3 Destructive test methods	9

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 14923:2003](https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003)

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

Foreword

This document (EN ISO 14923:2003) has been prepared by Technical Committee CEN/TC 240 "Thermal spraying and thermally sprayed coatings", the secretariat of which is held by DIN, in collaboration with Technical Committee ISO/TC 107 "Metallic and other inorganic coatings".

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 January 2004, and conflicting national standards shall be withdrawn at the latest by January 2004.

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, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 14923:2003

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 14923:2003

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

1 Scope

This European Standard gives guidance on tests used for characterizations of coatings produced by thermal spraying. It is not possible in this document to go into details regarding the different types of coatings and large numbers of coatings due to the fact that all meltable materials can be processed by thermal spraying and that so many and varied thermal spraying processes exist.

The tests listed are procedures and test criteria in general use for thermally sprayed coatings. Test methods not mentioned here are only used in special cases or under laboratory conditions.

NOTE Continuous further development and technical improvements mean that this standard cannot make any claim to completeness.

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 571-1, *Non destructive testing — Penetrant testing — Part 1: General principles (identical with ISO/DIS 3452-1:1996)*.

EN 582, *Thermal spraying — Determination of tensile adhesive strength*.

EN 623-2, *Advanced technical ceramics — Monolithic ceramics — General and textural properties — Part 2: Determination of density and porosity*.

EN 657, *Thermal spraying — Terminology, classification*.

EN 821-2, *Advanced technical ceramics — Monolithic ceramics — Thermo-physical properties — Part 2: Determination of thermal diffusivity by the laser flash (or heat pulse) method*.

EN 993-14, *Methods of testing dense shaped refractory products — Part 14: Determination of thermal conductivity by the hot-wire (cross-array) method*.

ENV 1071-1, *Advanced technical ceramics — Methods of test for ceramic coatings — Part 1: Determination of coating thickness by contact probe profilometer*.

EN 1071-2, *Advanced technical ceramics — Methods of test for ceramic coatings — Part 2: Determination of coating thickness by the crater grinding method*.

ENV 1071-3, *Advanced technical ceramics — Methods of test for ceramic coatings — Part 3: Determination of adhesion by a scratch test*.

ENV 1159-2, *Advanced technical ceramics — Ceramic composites — Thermophysical properties — Part 2: Determination of thermal diffusivity*.

EN 1274, *Thermal spraying — Powders — Composition — Technical supply conditions*.

EN 24624, *Paints and varnishes — Pull-off test (ISO 4624:1978)*.

EN ISO 1463, *Metallic and oxide coatings — Measurement of coating thickness — Microscopical method (ISO 1463:1982)*.

ISO 14923:2003(E)

EN ISO 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness (ISO 2064:1996).*

EN ISO 2178, *Non-magnetic coatings on magnetic substrates — Measurement of coating thickness — Magnetic method (ISO 2178:1982).*

EN ISO 2360, *Non-conductive coatings on non-magnetic basis metals — Measurement of coating thickness — Eddy current method (ISO 2360:1982).*

EN ISO 3543, *Metallic and non-metallic coatings — Measurement of thickness — Beta backscatter method (ISO 3543:2000).*

EN ISO 3868, *Metallic and other non-organic coatings — Measurement of coating thicknesses — Fizeau multiple-beam interferometry method (ISO 3868:1976).*

EN ISO 3882, *Metallic and other non-organic coatings — Review of methods of measurement of thickness (ISO 3882:1986).*

EN ISO 4518, *Metallic coatings — Measurement of coating thickness — Profilometric method (ISO 4518:1980).*

EN ISO 4541, *Metallic and other non-organic coatings — Corrodokote corrosion test (CORR test) (ISO 4541:1978).*

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1:1997).*

EN ISO 6507-2, *Metallic materials — Vickers hardness test — Part 2: Verification of testing machines (ISO 6507-2:1997).*

EN ISO 6507-3, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks (ISO 6507-3:1997).*

EN ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T) (ISO 6508-1:1999).*

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

EN ISO 6988, *Metallic and other non-organic coatings — Sulfur dioxide test with general condensation of moisture (ISO 6988:1985).*

EN ISO 9220, *Metallic coatings — Measurement of coating thickness — Scanning electron microscope method (ISO 9220:1988).*

EN ISO 14919, *Thermal spraying — Wires, rods and cords for flame and arc spraying — Classification — Technical supply conditions (ISO 14919:2001).*

EN ISO 14922-1, *Thermal spraying — Quality requirements of thermally sprayed structures — Part 1: Guidance for selection and use (ISO 14922-1:1999).*

EN ISO 14922-2, *Thermal spraying — Quality requirements of thermally sprayed structures — Part 2: Comprehensive quality requirements (ISO 14922-2:1999).*

EN ISO 14922-3, *Thermal spraying — Quality requirements of thermally sprayed structures — Part 3: Standard quality requirements (ISO 14922-3:1999).*

EN ISO 14922-4, *Thermal spraying — Quality requirements of thermally sprayed structures — Part 4: Elementary quality requirements (ISO 14922-4:1999).*

IEC 60093, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.*

IEC 60167, *Methods of test for the determination of the insulation resistance of solid insulating materials.*

IEC 60345, *Method of test for electrical resistance and resistivity of insulating materials at elevated temperatures.*

IEC 60468, *Method of measurement of resistivity of metallic materials.*

ISO 2063, *Metallic and other inorganic coatings — Thermal spraying — Zinc, aluminium and their alloys.*

ISO 3274, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Nominal characteristics of contact (stylus) instruments.*

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

ISO 4516, *Metallic and related coatings — Vickers and Knoop microhardness tests.*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus.*

ISO 8894-1, *Refractory materials — Determination of thermal conductivity — Part 1: Hot-wire method (cross-array).*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests.*

ISO 13565-1, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Surface having stratified functional properties — Part 1: Filtering and general measurement conditions.*

ISO 13565-2, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Surface having stratified functional properties — Part 2: Height characterization using the linear material ratio curve.*

ISO 14577-1, *Metallic materials — Instrumentation indentation test for hardness and material parameters — Part 1: Test method.*

ISO 14577-2, *Metallic materials — Instrumentation indentation test for hardness and material parameters — Part 2: Verification and calibration of testing machines.*

ISO 14577-3, *Metallic materials — Instrumentation indentation test for hardness and material parameters — Part 3: Calibration of reference block.*

ITeH STANDARD PREVIEW
(standards.iteh.ai)

ISO 14923:2003

c2cb5411ebffiso-14923-2003

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 657 and the following apply.

3.1

coating structure

sprayed coating is built up of lamellae. Process dependent factors such as materials (auxiliary materials), type of material and spray parameters affect the coating structure. The lamella type and size, structure, cracks, segmentation and similar features have to be differentiated

3.2

crack

parting of the coating structure or separation of the sprayed particles from one another, or within a particle

NOTE They occur vertical and/or parallel to the substrate surface as macro- or microcracks, or mixed.

3.3

flaking

area detached from the coating due to insufficient cohesion resulting from external loads (thermal and/or mechanical) or internal loads (internal stresses from the spraying process)

3.4

inclusion of the same or different material

particle which did not melt, or which solidified before contacting the coating surface

ISO 14923:2003(E)

NOTE This can also be inclusions of blasting materials, nozzle/electrode burn-off, foreign powder particles or dust inclusions.

3.5 microstructure

crystal structure of single-component and/or material type two-component sprayed coatings in cross section, made visible by grinding, polishing, etching when viewing under the microscope

3.6 nodule

blister
local increase in height of the coating

NOTE They can be caused by covering over a cavity, unmelted or agglomerated spray particles, possibly mixed with debris removed from the nozzle by the spray action. The nodules or blisters are generally badly joined to the adjacent coating.

3.7 oxide

non-oxide spray particle, which in flight, whether desired or not, has reacted with oxygen due to contact with the atmosphere forming oxides

NOTE Such oxides frequently appear in the form of striations and/or segregates.

3.8 peeling

coating detached from the base material due to insufficient adhesion, resulting from external loads (thermal and/or mechanical) or internal loads (internal stresses from the spraying process)

3.9 pore

cavities of varying shapes and sizes within the sprayed coating, caused by the process used

[ISO 14923:2003](https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003)

<https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-c2cb5411ebff/iso-14923-2003>

4 Manufacturing the coating

4.1 General

The processes and categories for manufacturing thermally sprayed coatings are specified in EN 657.

4.2 Coating materials

4.2.1 Materials

The coating is produced by the spraying of spray materials, which can be in powder, wire, rod, or cord form. The technical delivery conditions of the spray additives are specified below:

- powder in EN 1274;
- wire in EN ISO 14919;
- rod in EN ISO 14919;
- cord in EN ISO 14919.

4.2.2 Chemical composition

Typical compositions are set out in EN 1274 for spray powders, and in EN ISO 14919 for wires, rods and cords. The compositions are given in mass fraction percent. Other compositions can be agreed on between the users, material manufacturers and suppliers.

4.3 Coating properties

4.3.1 General

Thermally sprayed coatings are more or less heterogeneous, anisotropic, microporous and contain microcracks, regardless of the spraying method employed and the materials used. Complete diffusion bonding of the sprayed material to the base material is not obtained. Adhesion of the sprayed particles generally takes place by mechanical adherence and anchoring of sprayed particles as they cool and contract, and by physical adhesion processes. Fusion or diffusion bonding of the sprayed coating with the base material can be achieved, for example with a self-fluxing alloy or vacuum sprayed coating, as soon as a fusing process or a diffusion heat treatment of the coating is carried out during or after the spraying process.

4.3.2 Description of features

The quality of sprayed coatings is mostly characterised by the structure of the coating, and the distribution and size of e.g. phases, pores, oxides, inclusions of the same or of different materials, segregations and cracks. These are assessed in etched or unetched cross-section micrographs. As these variables are difficult to quantify, assessment is made by comparison with a reference series for the coating.

4.3.3 External features

External features are surface unevenness, roughness or surface texture, with an even coloration and appearance in normal cases. The properties of the coating are significantly influenced by cracks, nodules, flaking, peeling and the coating thickness.

4.3.4 Internal features

Internal features are e.g. coating formation and structure (mechanical adherence or metallurgical bonding) and, depending on the manufacturing method, oxide inclusions, pores, and inclusions of the same or different materials. Spray materials depending on the process and spray parameters affect the coating structures. These are normally detected by metallographic methods.

iTeh STANDARD PREVIEW

(standards.iteh.ai)

ISO 14923:2003

[https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-](https://standards.iteh.ai/catalog/standards/sist/e2fd9f82-6e1d-41fa-bbfa-1ebffiso-14923-2003)

4.4 Technological and physical properties

4.4.1 Technological properties

4.4.1.1 Wear resistance

The wear resistance of a material is understood as the property of resisting progressive mechanical removal of material caused by relative movement at the boundary between a solid body and another solid, liquid or gaseous body.

Wear, terms and system analysis of wear processes are described in national standards.

4.4.1.2 Corrosion resistance

The corrosion resistance of a material is understood as the property of resisting a chemical and/or physical reaction with the surrounding medium. Corrosion resistance depends on the material, the attacking corrosive medium and the physical and chemical conditions pertaining. It is described e.g. in EN ISO 4541 or in national standards.

Oxidation resistance is a specific form of corrosion resistance.

4.4.1.3 Machinability

Machinability of a sprayed coating is understood as its behaviour during shaping to the contour of the finished component by means of mechanical machining. The coating structure determined by the process employed shall be taken into account when machining, which gives rise to production engineering differences compared to solid material. Depending on the coating material used, the machining process can be turning, grinding or honing, for example.