INTERNATIONAL STANDARD

ISO 26945

Second edition
2011-02-15

Metallic and other inorganic coatings — Electrodeposited coatings of tin-cobalt alloy

Revêtements métalliques et autres revêtements inorganiques — Dépôts électrolytiques d'alliage étain-cobalt

Reference number
ISO 26945:2011(E)

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

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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 26945 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*.

This second edition cancels and replaces the first edition (ISO 26945:2008), of which it constitutes a minor revision.

Introduction

Electrodeposited coating of tin-cobalt alloy is characterized by its bright surface which is similar to decorative chromium coating. Hardness and wear-resistance properties of tin-cobalt alloy coatings are not equivalent to those of chromium coatings, but are similar to those of tin-nickel alloy coatings (see ISO 2179). Thus, tin-cobalt coatings may be regarded, as far as surface lustre is concerned, as one of the possible alternatives to chromium coating. Due to its higher current efficiency (more than 70 %), tin-cobalt alloy coatings can be applied by rack-and-barrel plating processes to a wide range of complicated shapes and sizes, e.g. nuts, bolts, rivets, etc.

Metallic and other inorganic coatings — Electrodeposited coatings of tin-cobalt alloy

WARNING — This International Standard may not be compliant with some countries' health and safety legislations and calls for the use of substances and/or procedures that may be injurious to health if adequate safety measures are not taken. This International Standard does not address any health hazards, safety or environmental matters and legislations associated with its use. It is the responsibility of the user of this International Standard to establish appropriate health, safety and environmentally acceptable practices and take suitable actions to comply with any national and international regulations. Compliance with this International Standard does not in itself confer immunity from legal obligations.

1 Scope

This International Standard specifies electrodeposited coatings of tin-cobalt alloy of approximate composition 75 % (mass fraction) to 80 % (mass fraction) tin, remainder cobalt, as a substitute for decorative chromium coatings of 0,1 µm to 0,3 µm thickness. Hardness and wear resistance properties of the coatings obtained are not equivalent to those of chromium coatings, but similar to those of tin-nickel alloy coatings.

Tin-cobalt alloy coatings can be applied by rack or barrel plating processes.

This International Standard does not specify requirements for the surface condition of the basis metal prior to electroplating.

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 2064, *Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness*

ISO 2080, *Metallic and other inorganic coatings — Surface treatment, metallic and other inorganic coatings — Vocabulary*

ISO 2819, *Metallic coatings on metallic substrates — Electrodeposited and chemically deposited coatings — Review of methods available for testing adhesion*

ISO 3497, *Metallic coatings — Measurement of coating thickness — X-ray spectrometric methods*

ISO 4519, *Electrodeposited metallic coatings and related finishes — Sampling procedures for inspection by attributes*

ISO 4541, *Metallic and other non-organic coatings — Corrodkote corrosion test (CORR test)*

ISO 9220, *Metallic coatings — Measurement of coating thickness — Scanning electron microscope method*

ISO 9587, *Metallic and other inorganic coatings — Pretreatment of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 9588, *Metallic and other inorganic coatings — Post-coating treatments of iron or steel to reduce the risk of hydrogen embrittlement*

ISO 10289, *Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates — Rating of test specimens and manufactured articles subjected to corrosion tests*

ISO 10587, *Metallic and other inorganic coatings — Test for residual embrittlement in both metallic-coated and uncoated externally-threaded articles and rods — Inclined wedge method*

ISO 15724, *Metallic and other inorganic coatings — Electrochemical measurement of diffusible hydrogen in steels — Barnacle electrode method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2064, ISO 2080, ISO 9587 and ISO 9588 apply.

4 Essential information to be supplied by the purchaser to the processor

When ordering articles to be processed in accordance with this International Standard, the purchaser shall provide the following information in writing, in, for example, the contract, purchase order, or on the engineering drawing:

a) the number of this International Standard, ISO 26945, and article designation;

b) the nature, condition and finish of the basis metal if they are likely to affect the serviceability and/or appearance of the coating (see 6.1);

c) the significant surface of the article to be electroplated, indicated, for example, by drawings or by the provision of suitably marked samples;

d) additional part of surfaces where the minimum thickness requirements apply;

e) positions where unavoidable contact marks and other defects are acceptable (see 6.2);

f) any requirements for special pretreatment (see 6.1);

g) tensile strength of parts and requirements for heat treatment before and/or after electrodeposition (see 6.7 and 6.8);

h) requirements, nature and thickness of undercoats (see 6.1 and 6.3);

i) requirements for thickness, quality-evaluation test for controlling the quality and continuity of the coating and test method(s) to be used, and adhesion testing (see 6.4, 6.5 and 6.6);

j) finish required, e.g. bright, dull or another type, accompanied by approved samples of the finish (see 6.2);

k) the sampling plan to be adopted, and the acceptance levels (see Clause 7);

l) any additional essential information.

5 Designation

5.1 General

The designation shall appear on engineering drawings, in the purchase order, the contract or in the detailed product specification.

The designation specifies, in the following order, the basis metal, the specific alloy (optional), stress-relief requirements, the type and thickness of undercoats (when present), the thickness and composition of alloy coating or coatings (when double or multilayer coatings are specified), and supplementary treatments, such as heat treatment to reduce susceptibility to hydrogen embrittlement.

5.2 Designation specification

The designation shall comprise the following:

a) the term “Electrodeposited coating”;

b) the number of this International Standard, ISO 26945;

c) a hyphen;

d) the chemical symbol of the basis metal (see 5.3), e.g. Fe (iron or steel), followed by a solidus (/);

e) the chemical symbol of the undercoat, e.g. Cu (copper) or Ni (nickel);

f) stress-relief (SR) designation (see 5.4);

g) a solidus (/);

h) the chemical symbol(s) for the metal or alloy or coating(s);

i) a number indicating the minimum local thickness, in micrometres, of the coating(s) followed by a solidus (/);

j) hydrogen-embrittlement-relief (ER) designation (see 5.4);

k) if appropriate, codes indicating the type of any supplementary coating, followed by a solidus (/);

l) if appropriate, codes designating any supplementary treatments.

See 5.5 for examples of designations.

5.3 Basis metal

The basis metal shall be designated by its chemical symbol, or its principal constituent, if it is an alloy. For example, Fe for iron and steel; Zn for zinc alloys; Cu for copper and copper alloys; Al for aluminium and aluminium alloys; Sn for tin and tin alloys; and Co for cobalt. In the case of non-metallic materials, the letters, NM, shall be used.

It is recommended that the specific alloy be identified by its standard designation; for example, its UNS number or the local, national equivalent placed between the symbols <>. For example, Fe<G43400> is the UNS designation for one high-strength steel (see Bibliography, Reference [1]).

5.4 Designation of heat treatment requirements

The heat treatment requirements shall be in brackets and designated as follows:

a) the letters SR, for stress-relief heat treatment prior to electroplating, the letters ER, for hydrogen-embrittlement-relief heat treatment after electroplating, and the letters HT, for heat treatment for other purposes;

b) in parentheses, the minimum temperature, in degrees Celsius (°C);

c) the duration of heat treatment in hours. For example, [SR(210)1] designates stress-relief heat treatment at 210 °C for 1 h;

d) when heat treatment prior to or after electrodeposition is specified, the requirements shall be included in the designation as shown in the examples in 5.5.

5.5 Examples

The example designations below describe the heat treatment and electroplating steps in the order that they are performed. The standard designation of the basis material is placed immediately after the chemical symbol for steel, Fe, in Examples 2 and 3. It is especially important to know the standard designation of a metal or alloy that is difficult to prepare for electroplating and that is susceptible to hydrogen embrittlement.

EXAMPLE 1 Tin-cobalt coating (SnCo) with a minimum thickness of 2 µm on brass (Cu) has the following designation:

Electrodeposited coating ISO 26945 - Cu/SnCo2

EXAMPLE 2 Tin-cobalt coating (SnCo) with a minimum thickness of 3 µm with a nickel undercoat (Ni) that is 5 µm thick has the following designation:

Electrodeposited coating ISO 26945 - Fe/Ni5/SnCo3

EXAMPLE 3 Tin-cobalt coating (SnCo) with a minimum thickness of 3 µm (SnCo) deposited over a copper undercoat that is 5 µm thick (Cu5) on steel that has an ultimate tensile strength of 1 200 MPa heat treated prior to electroplating for stress relief at 200 °C for 3 h [SR(200)3] and after electroplating, to reduce the risk of hydrogen embrittlement, at 190 °C for at least 12 h [ER(190)12] has the following designation:

Electrodeposited coating ISO 26945 - Fe/[SR(200)3]/Cu5/SnCo3/[ER(190)12]

6 Requirements

6.1 Basis material

This International Standard does not specify requirements for the surface condition of the basis metal prior to electroplating.

Because the appearance and serviceability of coatings depends on the surface condition of the basis metal, agreement shall be reached between the interested parties that the surface finish of the basis metal is satisfactory for electroplating (see Bibliography) [see 4 b)].

Some basis materials, for example phosphor-bronze, beryllium-copper and nickel-iron alloys, especially when rolled or drawn, are difficult to prepare chemically clean because of the nature of the surface oxide film. In such cases, an undercoat of copper shall be used, unless otherwise specified [see 4 h)].

Aluminium, magnesium and zinc alloys are readily attacked by dilute acids and/or alkalis, and therefore special pretreatments, including the deposition of relatively thick (10 µm to 25 µm) undercoats of copper, bronze or nickel, shall be used before the articles are electroplated with tin-cobalt alloy, unless otherwise specified [see 4 h)].

Tin-cobalt alloy coatings on aluminium and aluminium alloys, which could suffer deterioration at heating at or above 130 °C, shall not be heated at or above 130 °C.

6.2 Appearance

When examined by the unaided eye or corrected vision, the significant surfaces of the electroplated article shall be free from any visible defects, such as blisters, pits, roughness, cracks or uncoated areas and shall not be stained or discoloured. The acceptability and positions of unavoidable contact marks and defects on non-significant surfaces shall be specified by the purchaser [see 4 e)].

If necessary, a sample showing the required finish shall be supplied or approved by the purchaser [see 4 j)].

6.3 Undercoats

Undercoats may be necessary on certain basis materials for improvement of adhesion [see 4 h) and 6.1 and 6.5) and resistance to decomposition, observable by a quality-evaluation test, unless otherwise specified [see 4 i) and 6.6].

An initial copper coating, 5 µm to 10 µm thick, is to be applied to iron and steel from a copper cyanide solution before electroplating with ductile acid copper to prevent immersion deposition and poorly adherent deposits.

Zinc alloys are first electroplated with copper to ensure adhesion of the subsequent nickel coatings. The initial layer of copper is usually electrodeposited from a copper cyanide solution but cyanide-free alkaline copper solutions are also being used. Ductile, levelling copper electrodeposited from acid solutions is usually applied over the initial cyanide copper deposit when the specified copper thickness is greater than 10 µm (see Bibliography, Reference [8]).

For aluminium and aluminium alloys, immersion deposits of zinc or tin, and electrodeposited copper and other undercoats are used as part of the preparation for electroplating to ensure adhesion, prior to application of the designated nickel coatings (see Bibliography, Reference [8]).

When undercoats are specified, their nature and minimum local thickness shall be specified by the purchaser [see 4 h)]. The thickness of the undercoat or undercoats shall be measured by the method specified in Annex A.

Care should be taken for selection of undercoat(s) that will be detrimental to the basis material, for example, embrittlement of the basis material or finished article with an undercoat of highly stressed nickel.

6.4 Thickness

The thickness of the coating specified in the designation shall be the minimum local thickness. The minimum local thickness of the coating shall be measured at any point on the significant surface that can be touched by a ball 20 mm in diameter, unless otherwise specified by the purchaser [see 4 c)].

The minimum thickness of tin-cobalt alloy coatings is given in Table 1.

Methods for the measurement of the thickness of tin-cobalt alloy coatings are specified in ISO 1463, ISO 3497 and ISO 9220. The thickness of the coating shall be measured by appropriate method(s) selected by the purchaser from those contained in Annex A.

In the case of articles having a significant surface area of 100 mm^2 or greater, the minimum thickness shall be regarded as the minimum value of local thickness. In the case of articles having a significant surface area of less than 100 mm^2, the minimum thickness shall be regarded as the minimum value of average thickness.

Table 1 — Tin-cobalt alloy coatings on basis metal and its alloys

Basis metal	Service condition number	Partial designation
Iron or steel	3	Fe/Ni40/SnCo3 Fe/Cu20/Ni3 5/SnCo3
	2	Fe/Ni20/SnCo3 Fe/Cu20/Ni 1 0/SnCo3
	1	Fe/Ni10/SnCo3 Fe/Cu 1 0/Ni5/SnCo3
Copper and copper alloys	3	Cu/Ni30/SnCo3
	2	Cu/Ni10/SnCo3
	1	Cu/Ni5/SnCo3
Zinc and zinc alloys	3	Zn/Ni3 5/SnCo3 Zn/Cu20/Ni30/SnCo3
	2	Zn/Ni15/SnCo3 Zn/Cu20/Ni10/SnCo3
	1	Zn/Ni8/SnCo3 Zn/Cu10/Ni 8/SnCo3
Aluminium and aluminium alloys	2	Al/Ni25/SnCo3
	1	Al/Ni10/SnCo3

6.5 Adhesion

When specified by the purchaser, adhesion shall be tested by the thermal shock test method described in ISO 2819 using a heating period of 1 h [see 4 i)]. The specimen shall be deemed to have failed if there is evidence of the coating showing signs of detachment.

This test may have an adverse effect on the mechanical properties of the article tested and is not to be reused for other tests.

6.6 Quality-evaluation test of tin-cobalt alloy coatings

When specified by the purchaser in support of the requirement for a quality-evaluation test for controlling the quality and continuity of the coatings [see 4 i)], use the test methods specified in Table 2. The test method(s) selected shall be specified by the purchaser and shall comply with the requirements of Table 2.

The method of rating of specimens and manufactured articles shall be in accordance with ISO 10289. The minimum rating after corrosion tests shall be 9.

NOTE The duration and results of artificial accelerated corrosion tests might bear little relationship to the service life of the coated article and, therefore, the results obtained are not regarded as a direct guide to the corrosion resistance of the tested coatings in all environments where these coatings can be used.

Table 2 — Quality-evaluation test of tin-cobalt alloy coatings

Basis metal	Service condition number	Duration of test (h)		
		CASS test (see Bibliography)	**Corrodkote test** (ISO 4541)	**Salt spray/(fog) test** (see Bibliography)
Steel, zinc or zinc alloys, copper or copper alloys, aluminium or aluminium alloys	3	16	16	96
	2	8	8	48
	1	—	—	8

NOTE The service condition number indicates the severity of the service conditions:

3: Severe – service outdoors in typical temperate conditions;
2: Moderate – service indoors with condensation;
1: Mild – service indoors in dry atmosphere.

6.7 Stress-relief heat treatment prior to electroplating

Steel parts that have an ultimate tensile strength equal to or greater than 1 000 MPa and that contain tensile stresses caused by machining, grinding, straightening or cold-forming operations shall be given a stress-relief heat treatment prior to cleaning and metal deposition, according to the procedures and classes of ISO 9587 [see 4 g)] unless otherwise specified by the purchaser.

Steels with oxide or scale shall be cleaned before application of the coatings. For high-strength steels (equal to or greater than 1 000 MPa), non-electrolytic alkaline and anodic alkaline cleaners, as well as mechanical cleaning procedures, are preferred, to avoid the risk of producing hydrogen embrittlement during cleaning procedures.

6.8 Hydrogen-embrittlement-relief heat treatment after electroplating

Steel parts having an ultimate tensile strength equal to or greater than 1 000 MPa (Rockwell hardness: 31 HRC), as well as surface-hardened parts, shall receive hydrogen-embrittlement-relief heat treatment according to the procedures and classes of ISO 9588, unless otherwise specified by the purchaser [see 4 g)].

The effectiveness of the hydrogen-embrittlement-relief treatment shall be determined in accordance with ISO 10587 for testing threaded articles for residual hydrogen-relief heat treatment and with ISO 15724 for measuring the relative, diffusible hydrogen concentration in steels, unless otherwise specified by the purchaser.

7 Sampling

A random sample of the size specified in ISO 4519 shall be selected from the inspection lot. The articles in the sample shall be inspected for conformance to the requirements of ISO 4519. The lot shall be considered conforming or non-conforming for each requirement, according to the criteria of the sampling plans in ISO 4519 [see 4 k)].

Annex A
(normative)

Methods of measuring the thickness of tin-cobalt alloy coatings

A.1 Uncertainty of thickness measurements

The methods cited below have adequate precision; that is, the uncertainty in the measurement is less than 10 %, when properly used with standard-thickness reference materials. If a referee method is required, it shall be specified by the purchaser and shall be selected from the test methods given in A.2. The most reliable method shall be selected taking into consideration the expected coating thickness, the shape and size of the components, the coating material, and the basis material.

A.2 Test methods

A.2.1 Microscopical method (see ISO 1463)

This method is considered to have a measurement uncertainty of less than 10 % or ±0,8 µm, whichever is the greater value. With high-resolution microscopes and careful specimen preparation, measurement uncertainties of less than 0,5 µm can be achieved.

For deposits in excess of 3 µm, the thickness of the over plated coating for microscopical examination should be similar to that of the original coating.

A.2.2 X-ray spectrometric method (see ISO 3497)

This method has a measurement uncertainty of less than 10 % over a thickness range of 0,5 µm to 7,5 µm. The uncertainty can be better than ±5% when measured by an experienced operator and could even be considerably better. A value of the density of the coating is required for precise measurements.

A.2.3 Scanning electron microscope method (see ISO 9220)

This method has a measurement uncertainty of 10 % or 0,1 µm, whichever is greater. It is particularly useful for the thickness determination of individual layers of multiple (i.e. multilayer) coatings and also for layers thinner than those normally measured with a light microscope (see ISO 1463).

The magnification should be such that the field of view is between 1,5 and 3 times the coating thickness.

A.3 Measurement of average thickness

Determine the average of a number of local thickness measurements to obtain the average thickness (see ISO 2064).

A.4 General thickness test report

The test report shall contain at least the following information:

a) a reference to this annex including identification of the specific test method used;

b) the result(s) of the test(s) carried out and the form in which these are expressed;

c) any unusual features noticed during the determinations;

d) any operation not included in this annex or in the International Standards to which reference has been made;

e) any other relevant information requested by the purchaser.

Bibliography

[1] ASTM E527, *Standard Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)*

[2] ISO 1456, *Metallic and other inorganic coatings — Electrodeposited coatings of nickel, nickel plus chromium, copper plus nickel and of copper plus nickel plus chromium*

[3] ISO 2179, *Electroplated coatings of tin-nickel alloy — Specification and test methods*

[4] ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

[5] ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

[6] ISO 27830, *Metallic and other inorganic coatings — Guidelines for specifying metallic and inorganic coatings*

[7] ISO 27831-1, *Metallic and other inorganic coatings — Cleaning and preparation of metal surfaces — Part 1: Ferrous metals and alloys*

[8] ISO 27831-2, *Metallic and other inorganic coatings — Cleaning and preparation of metal surfaces — Part 2: Non-ferrous metals and alloys*

[9] ASTM B117, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

[10] ASTM B368, *Standard Test Method for Copper-Accelerated Acetic Acid-Salt Spray (Fog) Testing (CASS Test)*

[11] RAY, G.P., *Thickness testing of electroplated and related coatings*, 2nd Ed, 1993, Electrochemical Publications Ltd, Isle of Man, UK, ISBN 0 901150 27 4

ICS 25.220.40

Price based on 10 pages