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Anodizing of aluminium and its alloys — Method for specifying decorative and protective anodic oxidation coatings on aluminium

Anodisation de l'aluminium et de ses alliages — Méthode de spécification des caractéristiques des revêtements décoratifs et protecteurs obtenus par oxydation anodique sur aluminium

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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This document was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 2, *Organic and anodic oxidation coatings on aluminium*.

This third edition cancels and replaces the second edition (ISO 7599:2010), which has been technically revised.

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The main changes compared to the previous edition are as follows:

— certain terms and definitions have been deleted;

— Annex D has been revised.

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Anodizing of aluminium and its alloys — Method for specifying decorative and protective anodic oxidation coatings on aluminium

1 Scope

This document specifies a method for specifying decorative and protective anodic oxidation coatings on aluminium (including aluminium-based alloys). It defines the characteristic properties of anodic oxidation coatings, lists methods of test for checking the characteristic properties, provides minimum performance requirements, and gives information on the grades of aluminium suitable for anodizing and the importance of pretreatment to ensure the required appearance or texture of the finished work.

It is not applicable to

a) non-porous anodic oxidation coatings of the barrier layer type,

b) anodic oxidation coatings produced by chromic acid or phosphoric acid anodizing,

c) anodic oxidation coatings intended merely to prepare the substrate for subsequent application of organic coatings or for the electrodeposition of metals, and

d) hard anodic oxidation coatings used mainly for engineering purposes, for which abrasion and wear resistance are the primary characteristics (see ISO 10074).

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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 7599:2018

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

ISO 2085, *Anodizing of aluminium and its alloys — Check for continuity of thin anodic oxidation coatings — Copper sulfate test*

ISO 2106, *Anodizing of aluminium and its alloys — Determination of mass per unit area (surface density) of anodic oxidation coatings — Gravimetric method*

ISO 2128, *Anodizing of aluminium and its alloys — Determination of thickness of anodic oxidation coatings — Non-destructive measurement by split-beam microscope*

ISO 2143, *Anodizing of aluminium and its alloys — Estimation of loss of absorptive power of anodic oxidation coatings after sealing — Dye-spot test with prior acid treatment*

ISO 2360, *Non-conductive coatings on non-magnetic electrically conductive base metals — Measurement of coating thickness — Amplitude-sensitive eddy-current method*

ISO 2376, *Anodizing of aluminium and its alloys — Determination of electric breakdown potential*

ISO 2931, *Anodizing of aluminium and its alloys — Assessment of quality of sealed anodic oxidation coatings by measurement of admittance*

ISO 3210, *Anodizing of aluminium and its alloys — Assessment of quality of sealed anodic oxidation coatings by measurement of the loss of mass after immersion in acid solution(s)*

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ISO 3211, *Anodizing of aluminium and its alloys — Assessment of resistance of anodic oxidation coatings to cracking by deformation*

ISO 7583, *Anodizing of aluminium and its alloys — Terms and definitions*

ISO 8251, *Anodizing of aluminium and its alloys — Measurement of abrasion resistance of anodic oxidation coatings*

ISO 8993, *Anodizing of aluminium and its alloys — Rating system for the evaluation of pitting corrosion — Chart method*

ISO 8994, *Anodizing of aluminium and its alloys — Rating system for the evaluation of pitting corrosion — Grid method*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7583 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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4 Information supplied by the customer to the anodizer

4.1 General

ISO 7599:2018

The information required from the customer by the anodizer in order to anodize the product correctly is given in 4.2 and 4.3: 4.2 specifies information that is essential whenever a product is to be anodized; 4.3 identifies additional information required for particular product applications. A summary of the subclause references relating to this information is given in Annex F.

NOTE Certain properties (for example, high specular reflectance) are only obtainable by the use of special alloys, and some properties can be incompatible with others.

The customer and the anodizer can share the information about cleaning in case of external architectural application (see Annex E).

4.2 Essential information

The following information shall be supplied by the customer to the anodizer, if necessary in consultation with the aluminium supplier and/or anodizer:

a) a reference to this document, i.e. ISO 7599;

b) the intended service use of the article to be anodized;

c) the specification of the aluminium to be anodized;

d) an indication of the significant surface(s) of the article to be anodized;

e) the surface preparation to be used on the aluminium before anodizing;

f) the anodic oxidation coating thickness class required (see 6.2);

g) whether a clear or coloured anodized finish is required;

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h) whether the product is to be sealed or left unsealed, and if it is to be sealed, what sealing method is to be used.

Significant surfaces as per d) above are indicated preferably by drawings or by suitably marked test specimens; in some cases, there can be different requirements for the finish on different parts of the significant surface(s).

The surface preparation as per e) above is indicated preferably by agreed samples; guidance on surface preparation is given in Annex B.

NOTE Guidance on the choice of aluminium is given in Annex A.

4.3 Additional information

Additional information can be required for certain applications and, if so, shall be specified by the customer, if necessary in consultation with the anodizer. It includes the following:

a) the type of anodizing and the colouring process to be used;

b) details of any formal sampling plans required;

c) the preferred position and maximum size of contact marks;

d) any limits of variation of final surface finish on the significant surface(s);

e) the colour of the anodized article(s) and maximum limits of colour variation (see 8.2);

f) any requirements for quality of sealing;

g) any requirements for corrosion resistance and the method of test to be used;

h) any requirements for abrasion resistance, the property to be tested and the measurements required (i.e. wear resistance, wear resistance coefficient, wear index, mass wear index, mean specific abrasion resistance) and the method of test to be used;

i) any requirements for resistance to cracking by deformation;

j) any requirements for fastness to light or ultraviolet radiation of coloured anodic oxidation coatings;

k) any requirements for light reflection properties, i.e. total reflectance, specular reflectance, specular gloss, diffuse reflectance and image clarity;

l) any requirements for electric breakdown potential;

m) any requirements for the continuity of the anodic oxidation coating;

n) any requirements for the mass per unit area (surface density) of the coating.

Acceptable limits of variation of final surface finish as per d) above are identified preferably by agreed limit samples.

Acceptable maximum limits of colour variation as per e) above are identified preferably by agreed limit samples.

5 Tests

5.1 Sampling procedures

Sampling procedures shall be specified by the customer. Guidance on the choice of suitable sampling procedures is given in ISO 2859-1.

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5.2 Test specimens

Wherever practicable, test specimens shall be production components. However, if by agreement special test specimens are prepared for convenience in referee or acceptance tests, they shall be of the same alloy as the production components and processed through the anodizing line at the same time as the production components.

5.3 Acceptance tests

Acceptance tests shall be as specified by the customer.

5.4 Referee tests

In cases of dispute, the appropriate referee tests specified in this document shall be used.

5.5 Production control tests

Tests for production control purposes shall be at the discretion of the anodizer.

6 Coating thickness

6.1 General

Anodic oxidation coatings are designated by their thickness class. The required thickness of a coating is of the utmost importance and shall always be specified.

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6.2 Classification

Anodic oxidation coatings are graded according to the minimum allowed value of the average thickness (minimum average thickness) in micrometres. The thickness classes are designated by the letters "AA", followed by the thickness grade; typical thickness classes are given in Table 1.

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For anodic oxidation coatings designed to impart particular surface properties, an average thickness higher than typical may be selected, and additional intermediate values of average thickness may be specified if necessary, but in no case shall the minimum local thickness be less than 80 % of the minimum average thickness. The choice of thickness class will depend on relevant national standards.

Table 1 — Typical coating thickness classes

Class	Minimum average thickness[a] µm	Minimum local thickness[a] µm
AA 5	5,0	4
AA 10	10,0	8
AA 15	15,0	12
AA 20	20,0	16
AA 25	25,0	20

[a] The interpretation of average and local thickness requirements on a test specimen shall be in accordance with Annex C.

For certain applications, such as those where resistance to corrosion is paramount, the anodizer and the customer may agree to specify a minimum local thickness, with no restriction as to the average thickness.

The use of some dyestuffs necessitates the specification of class AA 20 or higher to obtain adequate dye absorption and light fastness.

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For anodized aluminium, the degree of protection against pitting corrosion of the aluminium increases with an increase in coating thickness. Thus, product life time is very dependent on the coating thickness. Specifiers should consider the full life cycle impact of the product, including the energy expenditure associated with manufacture, in-service maintenance procedures and recycling.

6.3 Measurement of thickness

Thickness measurements shall be carried out by one or more of the following methods:

a) examination of cross-section using microscopy in accordance with ISO 1463 or ISO 9220;

b) eddy-current method in accordance with ISO 2360;

c) split-beam microscope method specified in ISO 2128.

When using method b), the measurement apparatus shall be calibrated in accordance with the manufacturer's instructions using calibration standards before any measuring is performed. Calibration standards are described in Annex D.

In cases of dispute, method a) shall be the referee method.

Thickness measurements shall be made on the significant surfaces in accordance with Annex C, but no measurements shall be made within 5 mm of the areas of anodic contact or in the immediate vicinity of a sharp edge.

7 Quality of sealing

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7.1 General

Sealing is a treatment applied to an anodic oxidation coating to reduce its porosity and absorption capacity (as defined in ISO 7583). In many applications, anodic oxidation coatings are expected to resist degradation by aqueous solutions. Sealing can provide that resistance. Where the retention of the initial appearance is important, for example, in outdoor architectural applications, sealing at the surface of the anodic oxidation coating is important. Where the anodized aluminium is expected to resist strongly acidic or alkaline conditions over a short time period, for example, car-wash fluids, sealing throughout the thickness of the coating can be important.

Hydrothermal sealing is very well established and quality control methods have been developed for anodic oxidation coatings sealed using such treatments. These test methods can be appropriate where other sealing treatments are used.

7.2 Assessment of quality of hydrothermal sealing

7.2.1 Referee test

In cases of dispute, the quality of hydrothermal sealing of anodic oxidation coatings shall be determined by one of the test methods specified in ISO 3210. The necessity of prior acid treatment and maximum accepted loss of mass shall be agreed between the anodizer and the customer.

The test should be carried out without prior acid treatment for internal architectural and decorative coatings and with prior acid treatment for external architectural coatings.

These methods are surface-specific. They test the resistance of the surface of a sealed anodic oxidation coating to attack by certain acid solutions. They are not intended to test the quality of the whole thickness of the coating.

NOTE The maximum accepted loss of mass of anodic oxidation coatings is variously set at 30 mg/dm^2 or 40 mg/dm^2.

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