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Anodizing of aluminium and its alloys — General specifications for anodic oxidation coatings on aluminium

Anodisation de l'aluminium et de ses alliages — Spécifications générales pour couches anodiques sur aluminium

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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

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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 7599 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 2, *Organic and anodic oxidation coatings on aluminium*.

This second edition cancels and replaces the first edition (ISO 7599:1983), which has been technically revised.

Anodizing of aluminium and its alloys — General specifications for anodic oxidation coatings on aluminium

1 Scope

This International Standard lays down 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 oxidation coatings of the barrier layer type,

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

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

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

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 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 basis materials — 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 phosphoric acid/chromic acid solution*

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 — Vocabulary*

ISO 8251:—[1)], *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, *Aluminium and aluminium alloys — Rating system for the evaluation of pitting corrosion — Grid 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 and the following apply.

3.1
anodized aluminium
aluminium with an anodic oxidation coating, produced by an electrolytic oxidation process in which the surface of the aluminium is converted to a mainly oxidation coating having protective, decorative or functional properties

3.2
clear anodized aluminium
anodized aluminium with a substantially colourless, translucent anodic oxidation coating

3.3
colour anodized aluminium
anodized aluminium coloured either during anodizing or by subsequent colouring processes

3.4
integral colour anodized aluminium
anodized aluminium that has been anodized using an appropriate (usually organic acid-based) electrolyte which produces a coloured oxidation coating during the anodizing process itself

3.5
electrolytically coloured anodized aluminium
anodized aluminium with an anodic oxidation coating that has been coloured by the electrolytic deposition of a metal or metal oxide into the pore structure

3.6
dyed anodized aluminium
anodized aluminium with an anodic oxidation coating, coloured by absorption of dye-stuff or pigments into the pore structure

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1) To be published. (Revision of ISO 8251:1987 and ISO 8252:1987)

3.7
combination colour anodized aluminium
anodized aluminium with an anodic oxidation coating, coloured by electrolytic colouring or produced by integral colour anodizing followed by absorption dyeing

3.8
interference colour anodized aluminium
electrolytically coloured anodized aluminium, coloured by means of optical interference effects

3.9
bright anodized aluminium
anodized aluminium with a high specular reflectance as its primary characteristic

3.10
protective anodizing
anodizing where protection against corrosion or wear is the primary characteristic and appearance is secondary or of no importance

3.11
decorative anodizing
anodizing where a decorative finish with a uniform or aesthetically pleasing appearance is the primary characteristic

3.12
sealing
treatment of anodic oxidation coatings on aluminium, applied after anodizing to reduce the porosity and absorption capacity of the coating, including but not limited to hydrothermal sealing and cold sealing (cold impregnation)

3.13
significant surface
part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance

[ISO 2064:1996, definition 3.1]

3.14
measuring area
area of the significant surface over which a single measurement is made

[ISO 2064:1996, definition 3.2]

NOTE The measuring area is the point at which a single measurement is made for the microscopical method, and is the probe area, or area influencing the reading, for non-destructive methods.

3.15
reference area
area within which a specified number of single measurements is required to be made

[ISO 2064:1996, definition 3.3]

3.16
local thickness
mean of the thickness measurements, of which a specified number is made within a reference area

[ISO 2064:1996, definition 3.4]

3.17
minimum local thickness
lowest value of the local thickness found on the significant surface of a single article

[ISO 2064:1996, definition 3.5]

3.18
maximum local thickness
highest value of the local thickness found on the significant surface of a single article

[ISO 2064:1996, definition 3.6]

3.19
average thickness
mean value of a specified number of local thickness measurements that are evenly distributed over the significant surface of a single anodized piece

[ISO 2064:1996, definition 3.7]

4 Information supplied by customer to anodizer

4.1 General

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.

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 International Standard;

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 required;

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

h) whether the product is to be hydrothermally sealed, cold sealed or left unsealed.

Significant surfaces as per d) above are indicated preferably by drawings or by suitably marked samples; 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;

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.

5.2 Test pieces

Wherever practicable, test pieces shall be production components. However, if by agreement special test pieces are prepared for convenience in referee or acceptance tests, they shall be produced in the same way 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 International Standard 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.

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.

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 µm	Minimum local thickness 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
The interpretation of average and local thickness requirements on a piece being tested 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 20 or higher to obtain adequate dye absorption and light fastness.

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;

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 should be calibrated using the standard test panels described in Annex D before any measuring is performed.

In cases of dispute, method a) shall be the referee method for coatings of thickness 5 µm and thicker. For coatings of thickness less than 5 µm, the microscopical method cannot normally be used and a minimum mass of coating per unit area, measured by the gravimetric method (see Clause 16), shall be agreed between the interested parties.

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

7.1 General

The quality of hydrothermal sealing is of great importance and sealing is always essential, whether specified or not, except where an unsealed or cold sealed coating is expressly requested.

NOTE Anodic oxidation coatings sealed in dichromate solutions cannot be evaluated by the methods described in 7.2.2.1 and 7.2.2.2.

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 the test method specified in ISO 3210, which is the referee test. 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 coating.

For most applications, especially architectural, the maximum accepted loss of mass of anodic oxidation coatings should not exceed 30 mg/dm^2.

7.2.2 Production control tests

7.2.2.1 Admittance measurement

Where required, admittance shall be determined in accordance with ISO 2931.

For anodic oxidation coatings sealed in steam or hot water, sealing should normally be considered to be satisfactory if the corrected admittance value is less than 20 µS relative to a 20 µm coating.