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Combined coatings on aluminium — General specifications for combined coatings of electrophoretic organic coatings and anodic oxidation coatings on aluminium

Revêtements combinés sur aluminium — Spécifications générales pour les revêtements combinés appliqués sur l'aluminium composés d'un revêtement organique obtenu par électrophorèse appliqué sur un revêtement obtenu par anodisation

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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 28340 was prepared by Technical Committee ISO/TC 79, *Light metals and their alloys*, Subcommittee SC 2, *Organic and anodic oxidation coatings on aluminium*.

Combined coatings on aluminium — General specifications for combined coatings of electrophoretic organic coatings and anodic oxidation coatings on aluminium

1 Scope

This International Standard gives specifications for the combined coatings of electrophoretic organic coatings and anodic oxidation coatings on aluminium used for architecture.

It specifies the characteristic properties of combined coatings on aluminium, outlines the test methods for checking these characteristic properties and specifies their required performance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 2360, *Non-conductive coatings on non-magnetic electrically conductive basis materials — Measurement of coating thickness — Amplitude-sensitive eddy-current method*

ISO 2409, *Paints and varnishes — Cross-cut test*

ISO 2810, *Paints and varnishes — Natural weathering of coatings — Exposure and assessment*

ISO 2813, *Paints and varnishes — Determination of specular gloss of non-metallic paint films at 20 degrees, 60 degrees and 85 degrees*

ISO 2859-10, *Sampling procedures for inspection by attributes — Part 10: Introduction to the ISO 2859 series of standards for sampling for inspection by attributes*

ISO 4628-1, *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance — Part 1: General introduction and designation system*

ISO 4892-4, *Plastics — Methods of exposure to laboratory light sources — Part 4: Open-flame carbon-arc lamps*

ISO 7599, *Anodizing of aluminium and its alloys — General specifications for anodic oxidation coatings on aluminium*

ISO 7668, *Anodizing of aluminium and its alloys — Measurement of specular reflectance and specular gloss of anodic oxidation coatings at angles of 20 degrees, 45 degrees, 60 degrees or 85 degrees*

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

ISO 11341, *Paints and varnishes — Artificial weathering and exposure to artificial radiation — Exposure to filtered xenon-arc radiation*

ISO 11507, *Paints and varnishes — Exposure of coatings to artificial weathering — Exposure to fluorescent UV lamps and water*

ISO 15184, *Paints and varnishes — Determination of film hardness by pencil test*

AAMA 612-02, *Voluntary specification, performance requirements, and test procedures for combined coatings of anodic oxide and transparent organic coatings on architectural aluminum*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
combined coatings
superimposed electrophoretic organic coating and anodic oxidation coating on aluminium

3.2
significant surface
part of the article covered or to be covered by the coatings, and for which the coatings are essential for service and/or appearance

3.3
standard sample
limit sample
sample which defines the criteria for acceptable appearance

Note 1 to entry: This may be agreed between the surface processor and the customer.

4 Classes

The combined coatings are classified by corrosion resistance, which is specified in 5.6, resistance to accelerated weathering specified in 5.7, and resistance to cyclic corrosion/UV light specified in 5.8.

Performance requirements are given in Table 1.

To test the corrosion resistance, the acetic acid salt spray (AASS) test (method A) or copper-accelerated acetic acid salt spray (CASS) test (method B) shall be carried out.

To test the resistance to accelerated weathering, the xenon-arc lamp exposure test (method A) or the open-flame carbon-arc lamp exposure test (method B) shall be carried out.

To test the resistance to cyclic corrosion/UV light, the AASS test (method A) shall be carried out or the CASS test (method B) after the ultraviolet (UV) lamp exposure test specified in 5.8. The selection of the test method should be agreed between the surface processor and the customer.

NOTE Classes and applied environments are given in Table A.1.

Table 1 — Classes of combined coatings on aluminium

Characteristic property		Corrosion resistance		Resistance to accelerated weathering		Resistance to cyclic corrosion/ UV light			
Test method		**A**	**B**	**A**	**B**	**A**		**B**	
		AASS	**CASS**	**Xenon-arc lamp**	**Carbon-arc lamp**	**UV**	**AASS**	**UV**	**CASS**
Testing time h	**Class 4**	1 500	120	4 000	3 000	240	1 500	240	120
	Class 3	1 500	120	2 000	1 500	240	1 500	240	120
	Class 2	1 000	72	1 000	750	240	1 000	240	72
	Class 1	—	24	350	250	—	—	—	—
Criteria		Corrosion: RN 9,5 or more		No remarkable colour change and chalking Gloss retention: 75 % or more		Corrosion: RN 9,0 or more			

5 Quality

5.1 General

The required quality for the applied products shall be chosen from the performances specified in 5.2 to 5.14 which should be agreed between the surface processor and the customer.

5.2 Appearance

The appearance shall be examined by the method specified in 7.2.1, and any visual surface defects, such as scratches, unevenness, peeling, which are unacceptable for the application, shall not be permitted. The quality should be agreed between the surface processor and the customer.

5.3 Colour

The colour and its tolerance level shall be examined by the method specified in 7.2.2, and the quality should be agreed between the surface processor and the customer.

5.4 Gloss

The specular gloss of the electrophoretic organic coating shall be examined by the method specified in 7.2.3, and the quality should be agreed between the surface processor and the customer.

5.5 Thickness of anodic oxidation coating

The thickness of anodic oxidation coating shall be measured by the method specified in 7.2.4, and the quality should be agreed between the surface processor and the customer. The average thickness of anodic oxidation coating, as specified in ISO 7599, shall be more than 5 µm. Furthermore, the minimum local thickness shall not be less than 80 % (4 µm) of the average thicknesses at three or more measurement points.

The total thickness of the combined coatings is not specified because specification is based on performance.

5.6 Corrosion resistance

The corrosion resistance of the combined coatings shall be tested by the AASS test specified in 7.2.5.2 or the CASS test specified in 7.2.5.3 and shall be evaluated by the degradation in appearance and the corrosion rate [rating number(RN)] for the test specimens. The selection of the test method should be agreed between the surface processor and the customer. The testing time and the quality of the combined coatings shall conform to Table 1.

5.7 Resistance to accelerated weathering

The accelerated weathering resistance shall be tested by the xenon-arc lamp exposure test specified in 7.2.6.2 or the open-flame carbon-arc lamp exposure test specified in 7.2.6.3. The performance shall be evaluated by the visual degradation, such as colour change, chalking, and gloss-retention of the organic coating. The testing time and the quality of the combined coatings shall conform to Table 1.

5.8 Resistance to cyclic corrosion/UV light

The resistance to cyclic corrosion/UV light shall be tested by the AASS test specified in 7.2.5.2 or the CASS test specified in 7.2.5.3, after having been tested by UV lamp exposure, as specified in 7.2.7. The performance shall conform to Table 1.

5.9 Outdoor exposure

If required by the customer, the resistance to outdoor exposure shall be tested, and the exposure site, the testing time and the required performance should be agreed between the surface processor and the customer. This test shall be carried out by the method specified in 7.2.8, and the deterioration of the test specimens shall be evaluated by the change in appearance, gloss-retention and corrosion rate (RN). A recommended example of the outdoor exposure test and fastness are given in Table A.2.

5.10 Hardness of the organic coating

The surface hardness of the electrophoretic organic coating shall be tested by the method specified in 7.2.9, and shall be evaluated by the degree of pencil hardness to be scratched. The hardness of the electrophoretic organic coating shall be more than 3 H in all classes.

5.11 Adhesion of the organic coating

The adhesion between the anodic oxidation coating and the electrophoretic organic coating shall be tested by the cross-cut test specified in 7.2.10.2 and the cross-cut test after immersion in boiling water specified in 7.2.10.3, and the performance shall be evaluated by the degree of exfoliation of the electrophoretic organic coating. The required adhesion of the organic coatings of all classes shall conform to Table 2.

Table 2 — Required adhesion of the organic coating

Cross-cut test	Cross-cut test after immersion in boiling water	
Adhesion	Appearance	Adhesion
25/25	Without wrinkles, cracks and remarkable colour change on the significant surface	25/25

5.12 Solvent resistance of the organic coating

The solvent resistance of the electrophoretic organic coating shall be evaluated by using the method specified in 7.2.11. The change in hardness of the electrophoretic organic coating of all classes after the solvent resistance test shall be within Δ1H without swellings, cracks and peeling on the significant surface.

5.13 Chemical resistance

If required by the customer, the chemical resistance of the combined coatings shall be tested.

This test shall be carried out with the alkali resistance test specified in 7.2.12.2 and/or the acid resistance test specified in 7.2.12.3, and evaluated by the appearance and corrosion rate (RN) of the test specimens. Recommended testing time and qualities of the combined coatings are given in A3.1 and/or A3.2.

In case of the combined coatings contact with mortar, the alkali resistance test should be implemented.

5.14 Abrasion resistance

If required by the customer, the abrasion resistance of the combined coatings shall be tested. The performance requirements should be agreed between the surface processor and the customer.

This test shall be carried out by the abrasive jet test specified in 7.2.13.2 or the falling sand abrasion test specified in 7.2.13.3, and the performance should be evaluated by the degree of abrasion as given in A.4.

The substitute test specimens shall be produced in the same way as the products, using the same semiproduct (i.e. sheet, profile), alloy and temper.

6 Test specimen

6.1 Sampling procedure

The test specimens shall be cut from the significant surfaces of the products. However, if they cannot be taken from production, substitute test specimens produced together with the real products may be used for testing. The sampling lot size should be agreed between the surface processer and the customer in accordance with ISO 2859-10, taking into consideration the kind of products, size and quantity.

6.2 Size of the test specimen

The size of test specimens should be chosen from the following sizes if there is no consensus:

150 mm x 70 mm, or 150 mm x 75 mm

6.3 Cleanliness of the test specimen

The surface of test specimens shall be wiped clean using soft wet cloths with deionized water or ethanol. Use deionized water if the coating can be attacked by ethanol.

7 Test

7.1 General condition

The temperature of the testing environment shall be room temperature and the relative humidity should be under 65 %. It shall be free from direct sunlight, gas, steam dust and wind, which all can influence the test results.

7.2 Test methods

7.2.1 Visual test

The visual test of the significant surface shall be carried out under artificial light or diffuse daylight specified in ISO 4628-1. The light source C (or D65) or high colour fidelity light (colour fidelity AAA) on the test specimens shall be over 600 lx. The distance and observing angle should be agreed between the surface processer and the customer. The background of the test specimens should be monochrome grey or black. The distance between the inspector and the test specimens should be 5 m when the inspection is done outdoors, and 3 m when it is indoors.

7.2.2 Inspection of colour

The inspection of colour and colour tolerance of the significant surface shall be carried out as specified in 7.2.1. The test specimens and standard specimen shall be placed on the same plane stand. Unless otherwise agreed between the surface processer and the customer, in the case of artificial light, the light source shall be placed behind the inspector and the test specimens shall always be observed at the same angle.

For the instrumental colour measurement, the surface processor and the customer should agree on the measurement condition, for example, the colourimetric system, the illuminant, the observation angle, the geometric light system.

7.2.3 Measurement of specular gloss

The measurement of the specular gloss shall be carried out in accordance with ISO 7668 (in the case of pigmented organic coatings, ISO 2813 is applied) at a 60° angle and the gloss-retention, G, expressed as a percentage, shall be calculated from the change of gloss caused by the exposure test, using Formula (1):

$$G = \frac{G_2}{G_1} \times 100 \tag{1}$$

where

G is the gloss-retention;

G_1 is the gloss at a 60° angle before exposure test;

G_2 is the gloss at a 60° angle after exposure test.

In the case that the inspected surface has a certain texture and the direction of measurement can affect the test result, the surface processer and the customer should agree upon the direction of measurement.

7.2.4 Measurement of anodic oxidation coating thickness

7.2.4.1 General

The thickness measurements of the anodic oxidation coating shall be carried out by the microscopical method specified in 7.2.4.2 or the eddy current method specified in 7.2.4.3.

In the case of dispute, the microscopical method shall be used for the reference test.

7.2.4.2 Microscopical method

The microscopical method shall be carried out in accordance with ISO 1463. Measure the anodic oxidation coating thickness at three points or more on the test specimen and round the mean to one decimal place and do it with the mean anodic oxidation coating thickness.

7.2.4.3 Eddy current method

The eddy current method shall be carried out in accordance with ISO 2360. Measure the anodic oxidation coating thickness at three points or more on the test specimen, calculate the average thickness and quote the result to one decimal place.

The thickness of anodic oxidation coating under organic coating may be measured after removing the organic coating using a suitable method that does not damage the anodic oxidation coating.

7.2.5 Corrosion resistance test

7.2.5.1 General

The corrosion resistance test shall be carried out using the AASS test or the CASS test in accordance with ISO 9227. The selection of the test method should be agreed between the surface processor and the customer. The corrosion rate (RN) may be assessed by the method specified in ISO 8993.

7.2.5.2 AASS test

Each test specimen shall be evaluated by determining the ratio of the area of corrosion pits to the area of the test specimen or the chart rating in accordance with ISO 8993. The result shall be converted to a rating number (RN) as shown in Table B. 1.

When calculating the ratio of the corrosion pits area, it is recommended to use a magnifying glass (10x to 15x magnification with scale).

When the test specimens in standard size are tested, it is permissible to evaluate the area of the test specimen except 25 mm from the top and bottom edges, and 10 mm from the right and left edges.

7.2.5.3 CASS test

Each test specimen shall be evaluated by determining the ratio of the area of corrosion pits to the area of the test specimen or the chart rating in accordance with ISO 8993. The result shall be converted to a rating number (RN) as shown in Table B. 1.

When calculating the ratio of the corrosion pits area, it is recommended to use a magnifying glass (10x to 15x magnification with scale).

When the test specimens in standard size are tested, it is permissible to evaluate the area of each test specimen except 25 mm from the top and bottom edges, and 10 mm from the right and left edges.

If copper is deposited on the surface of the test specimens, dissolve with dilute hydrochloric acid solution and followed by usual rinsing and drying.

7.2.6 Accelerated weathering test

7.2.6.1 General

The accelerated weathering test shall be carried out by the xenon-arc lamp exposure test or the open-flame carbon-arc exposure test. In the case of dispute, the xenon-arc lamp exposure test shall be the reference test.

7.2.6.2 Xenon-arc lamp exposure test

The xenon-arc lamp exposure test shall be carried out as follows:

a) This test shall be carried out in accordance with ISO 11341 and testing time shall be adapted to Table1;

b) The condition of wetting cycles, irradiance, black standard temperature (BST) or black panel temperature (BPT), and relative humidity during dry period shall be adapted to Table 3;

c) Evaluate the appearance of the test specimens specified in 7.2.1 after the exposure test;

d) Then, the exposed test specimens shall be rinsed with deionized water and left for 1 h in the room for drying;

e) Measure specular gloss of the test specimens specified in 7.2.3.

