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Anodizing of aluminium and its alloys — Test method for chemical resistance of anodic oxidation coatings on aluminium and its alloys using electromotive force apparatus

Anodisation de l'aluminium et de ses alliages — Méthode d'essai pour la résistance chimique des couches d'oxydation anodique sur l'aluminium et ses alliages à l'aide d'un appareil à force électromotrice

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Foreword

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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*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Anodic oxidation coatings can be exposed to various chemicals and attacked by chemical means. The resistance of anodic oxidation coatings to chemicals can give important information about how the characteristics of the coatings are affected by anodizing conditions, especially sealing conditions.

The test given in this document evaluates resistance to alkali or acid by measuring the dissolving time of anodic oxidation coatings. This method can test the chemical resistance characteristics of the whole thickness of the coatings.

This test method for chemical resistance using electromotive force apparatus has positive characteristics, such as a simplified testing apparatus, the reduction of artificial errors and applicability to thick anodic oxidation coatings over 20 µm. This test method is characterized by its small test area, the small quantity of test liquid used and a short testing time. In addition, both the test solutions can be supported by the same apparatus.

This method specified in this document uses sodium hydroxide or phosphoric acid, but it is possible to use other chemicals in accordance with the use environment. Therefore, this method can be widely applicable to anodic oxidation coatings for industrial products, electrical appliances or kitchenware.

Anodizing of aluminium and its alloys — Test method for chemical resistance of anodic oxidation coatings on aluminium and its alloys using electromotive force apparatus

1 Scope

This document specifies a test method using electromotive force test apparatus for assessing the chemical resistance of anodic oxidation coatings on aluminium and its alloys.

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7583 and the following 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/

3.1
chemical resistance
capability of a coating to resist chemical agents of alkali and acid

4 Principle

This test is a method assessing chemical resistance by measuring the dissolving time of an anodic oxidation coating by a test solution. The dissolving time is determined by measuring the time from the injection of a test solution into an electric potential cell to detection of an electromotive force, which occurs when the coating is dissolved and there is electrical continuity between the test specimen and the cell. This test is capable of assessing the total characteristics of anodic oxidation coatings on aluminium and its alloys. Therefore, among products of the same coating thickness, this test can be applied to assess the protective capacity of the whole coating against chemical attack and its relationship with certain sealing methods, see Annex C.

5 Reagents

Use only reagents of a recognized analytical grade and distilled water or deionized water of preferably less than 2 µS/cm in conductivity, unless otherwise agreed by the anodizer and the customer.

The test solution should be prepared each time prior to use.

NOTE Where solution concentrations other than those specified in 5.1 and 5.2 are used, see Annex A.

5.1 Alkali solution, prepared by dissolving sodium hydroxide into water and adjusting the concentration given in Table 1. The concentration of alkali solution shall be chosen by agreement between the anodizer and the customer considering the application of the products.

Table 1 — Concentration of the alkali solution

Type of alkali solution	Concentration of sodium hydroxide (g/l)
A	100
B	40

NOTE Depending on the anodic oxidation coating specification, the dissolving time can be very short when using the type A solution. This can make it difficult to differentiate between test specimens. Therefore, type B solution is preferable for normal anodic oxidation coatings.

5.2 Acid solution, prepared by dissolving phosphoric acid into water and adjusting the concentration close to 570 g/l.

To prepare the test solution, dissolve 40 ml phosphoric acid (ρ_{20} = 1,685 g/ml) in water to obtain a total volume of 100 ml.

6 Apparatus

Use the following apparatus. An example of the test apparatus is given in Figure 1.

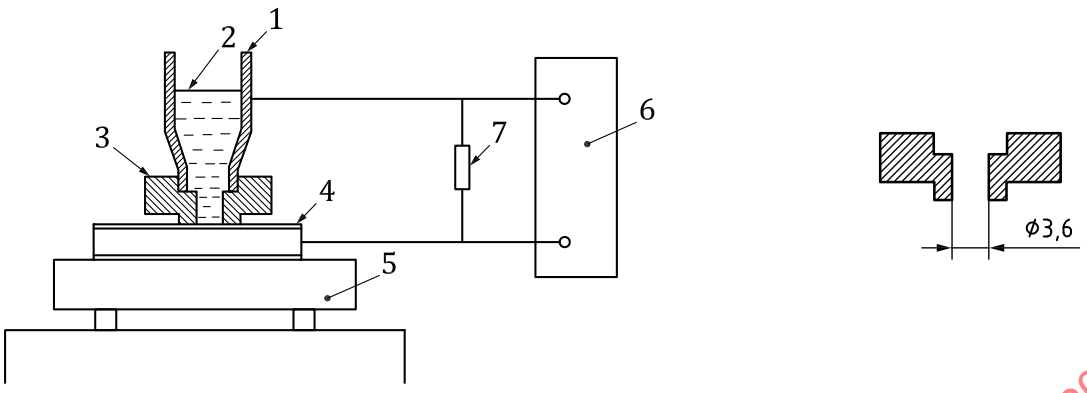
6.1 Hot plate, with a metal plate on which a test specimen can be kept at specified temperature.

6.2 Electric potential generating cell, of stainless steel of 316 grade (ISO number 4401-316-00-1 or 4436-316-00-1) and where it is possible to attach and detach the gasket and hold the test solution. The volume inside the cell shall be over 1 ml.

6.3 Gasket, made of non-conductive materials, such as rubber or synthetic resins. The internal diameter of the gasket contacting with the test specimen shall be approximately 3,6 mm. In cases using a different internal diameter size of the gasket, see Annex A.

6.4 Electric potential detector, able to correctly detect the point of time when the voltage exceeds 1,0 mV between the basis metal and the cell, which is connected with a resistor of 1,0 Ω.

Dimension in millimetres



a) Configuration of the test apparatus **b) Detail of gasket**

Key

1 electric potential generating cell
2 test solution
3 gasket
4 test specimen
5 hot plate
6 electric potential detector
7 resistor of 1,0 Ω

Figure 1 — Example of the test apparatus

7 Test specimen

7.1 Sampling

The test specimen shall be taken from a flat significant surface of the product and shall not be taken from the edge because of possible distortion and/or non-uniformity.

Where it is impossible to test the product itself, a test specimen may be used. However, in this case, the test specimen used shall be one that is representative of the product. It shall be made from the same material and prepared under the same conditions of finishing as those used for the preparation of the product.

The aluminium alloy, the manufacturing conditions (kind and temper of the material) and the surface condition before treatment shall be the same as those of the product.

Pretreatment, anodizing, colouring and sealing shall be performed in the same baths and under the same conditions as the treatment of the product.

7.2 Size

The standard size of the test specimen should be about 50 mm × 50 mm.

7.3 Treatment before testing

The test specimen shall be previously cleaned by using soft cloth with an appropriate solvent, such as ethanol. Solvents that corrode the test specimen or protect the coating shall not be used.

WARNING — Where organic solvents are used, carry out the cleaning operation in a well-ventilated area to minimize exposure to solvent vapour.

8 Procedure

8.1 Test solution

Choose the type of test solution according to the agreement between the anodizer and the customer.

8.2 Test temperature

The temperature of the test specimen shall be kept as given in Table 2.

Table 2 — Test temperature

Kinds of test solution	Temperature
Alkali solution (5.1)	35 °C ± 1,0 °C
Acid solution (5.2)	80 °C ± 1,0 °C

It is preferable to check the temperature of the test specimen surface by the surface thermometer.

NOTE In cases of using other temperatures, see Annex A.

8.3 Measurement

8.3.1 Place the test specimen on the hot plate, which shall be adjusted to keep the test specimen within the specified temperature range, and keep for more than 1 min. If the test specimen is thick or is not flat, it is preferable to add a few drops of water between the hot plate and test specimen to ensure thermal conductivity, as demonstrated in Annex B.

8.3.2 Place the cell with gasket on the test specimen and inject approximately 1 ml of test solution into it using a dropping pipette. Avoid air bubbles and make sure that the coating of the test area is totally in contact with the test solution. The test solution may be at room temperature.

8.3.3 Measure the time (in seconds) from the injection of the test solution until the electric potential detector indicates 1,0 mV.

8.3.4 Extract the test solution from the cell using a different dropping pipette and remove the cell from the test specimen.

8.3.5 Remove the gasket from the cell after every test and wipe off the test solution on the gasket using dried gauze or similar.

8.3.6 Repeat other two or more times the procedures from 8.3.2 to 8.3.5 at the different positions in the test area.

WARNING — Take sufficient caution so as not to leak the solution. Wear gloves when using the acid solution because the hot plate is at a high temperature.

9 Expression of results

Chemical resistance is indicated by the time in seconds to dissolve the whole thickness of the coating (when the electric potential detector shows 1 mV).

The test result shall be determined by the average of all the tests, which are three or more times.

Sometimes extraordinary large or small values can be obtained. These data should be omitted from the test values because they are caused by coating defects, such as scratches or micro cracks or by remaining air bubbles or leakage of the solution.

10 Test report

The test report shall include at least the following information:

a) a reference to this document, i.e. ISO 23052;

b) the type and identification of the product tested;

c) the internal diameter of gasket, in cases using a larger internal diameter;

d) the kind of test solution: alkali (type A or B) or acid (see Clause 6);

e) the concentration of test solution, in cases tests using different concentrations;

f) the temperature, in cases tests being carried out at different temperatures;

g) any observations concerning the conduct of the test;

h) any deviation from the procedure;

i) the result of the test(s);

j) the date of the test.

Annex A
(informative)

Other conditions for the chemical resistance test

A.1 General

The chemical resistance test can be carried out using other test conditions, e.g. gasket size (A.2), concentration of sodium hydroxide solution or phosphoric acid solution (different alkali or acid solution, test temperature) (A.3), as agreed between the anodizer and the customer and considering the use environment.

A.2 Gasket size

Other gaskets having an internal diameter larger than 3,6 mm given in Table 1 may be used for this test. However, the test results in these cases cannot be compared with those of the 3,6 mm gasket.

A.3 Concentration of sodium hydroxide solution or phosphoric acid solution

A.3.1 Alkali solution

Other concentrations of sodium hydroxide different from those of the type A and type B solutions in Table 2 may be used for assessing alkali resistance. However, the test results in these cases cannot be compared with those of the type A and type B solutions.

A.3.2 Acid solution

Other concentrations of phosphoric acid different from 570 g/l given in 5.2 may be used for assessing acid resistance. However, the test results in these cases cannot be compared with those of the phosphoric acid concentration of 570 g/l.

A.3.3 Test temperature

The test may be carried out at a test temperature different from that specified in Table 2. However, the test results in these cases cannot be compared with that those according to Table 2.

Annex B
(informative)

Validation of the heating-up time

B.1 General

The test given in this annex was performed to consider the necessary heating-up time.

The result suggests that the thickness of the test specimen has only a small effect on the heating-up time and that water drops between the hot plate and the test specimen are effective to increase the thermal conductivity.

B.2 Test conditions and result

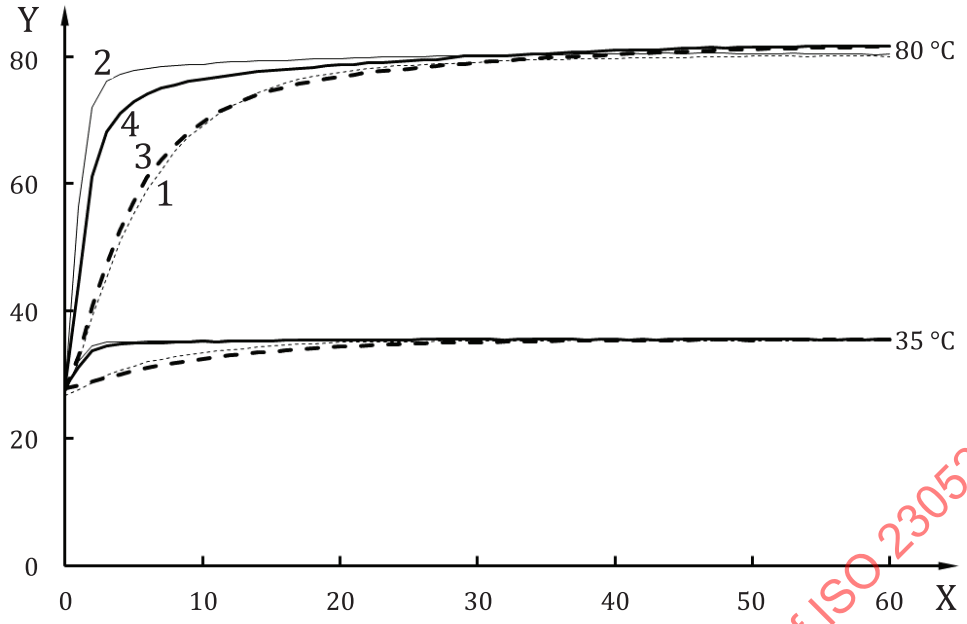
The test was performed under the following conditions. The result is shown in Figure B.1.

Common conditions:

Test specimen size:	50 mm × 40 mm
Surface finishing:	none (bare)
Measurement:	on the surface of the test specimen by the thermocouple

Changing conditions:

Plate thickness:	1 mm or 4 mm
Contact to the hot plate:	with or without a few drops of water between the hotplate and the test specimen
Temperature:	80 °C or 35 °C



Key

X time after setting specimen on hot plate, in s
Y temperature of specimen, in °C
1 the specimen thickness is 1 mm without water drops
2 the specimen thickness is 1 mm with water drops
3 the specimen thickness is 4 mm without water drops
4 the specimen thickness is 4 mm with water drops

Figure B.1 — Relationship between the specimen thickness and the heating-up time