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Anodizing of aluminium and its alloys — Determination of breakdown voltage and withstand voltage

Anodisation de l'aluminium et de ses alliages — Détermination de la tension de claquage et de la tension de tenue

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

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 2376:2010), which has been technically revised. The main changes compared with the previous edition are as follows:

— the information of the test specimen has been added;

— a withstand voltage test has been added.

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.

Anodizing of aluminium and its alloys — Determination of breakdown voltage and withstand voltage

1 Scope

This document specifies test methods for the determination of the breakdown voltage and withstand voltage of anodic oxidation coatings on aluminium and its alloys, on flat or near-flat surfaces and on round wire. The methods are applicable to anodic oxidation coatings used primarily as electrical insulators.

The methods are not applicable to coatings in the vicinity of cut edges, the edges of holes, or sharp changes of angle on, for example, extruded shapes.

NOTE 1 Breakdown voltage and withstand voltage are affected by relative humidity.

NOTE 2 The methods described do not give satisfactory results for unsealed coatings because they are affected by the humidity in particular.

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 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/

4 Principle

The electric voltage at which current first passes through an anodic oxidation coating is measured. These breakdown voltage and withstand voltage are a function of the dielectric characteristics and the insulation properties of the anodic oxidation coatings. The breakdown voltage and withstand voltage depend upon the thickness of the coating, as well as on many other factors, particularly the composition of the basis metal, its surface condition, the effectiveness of sealing, the dryness of the test specimen and the degree of ageing.

5 Apparatus

5.1 Power supply, from a suitable 50 Hz or 60 Hz source.

5.2 Transformer (AC), having an output with a waveform as nearly sinusoidal as possible, capable of producing the voltage required.

5.3 Voltage regulator, enabling the test voltage to be increased gradually from any point without interruption, and providing an essentially undistorted waveform so that the peak voltage is within the limit $\sqrt{2}$ ± 5 % (i.e. 1,34 to 1,48) of the root-mean-square (r.m.s.) voltage.

5.4 Current limiting resistor, 0,5 MΩ, in series with secondary winding of the transformer and the test electrode probe (5.6).

5.5 Voltage-measuring device, which gives r.m.s. values, expressed in volts.

5.6 Electrode probe, made from conducting material, suitably insulated for handling purposes, free to move as required and adequately supported. The contact surface shall be spherical with a diameter of 3 mm to 8 mm and shall be maintained in a smooth, untarnished condition. The design of the probe shall be such that, when the spherical surface is placed on the surface of the anodized test specimen, the total force exerted on the coating is 0,5 N to 1,0 N (a probe of mass 50 g to 100 g is suitable).

5.7 Contact plate, for testing flat test specimens, having a smooth, bright, metallic surface, or a contact probe or clip which is capable of breaking through to the basis metal (7.1).

5.8 Twisting machine, for testing round wire, having two sets of jaws 400 mm apart, with one set of jaws fixed, while the other set is free to rotate. The jaws shall be mounted so as to prevent lateral movement of the jaws when the twisting operation is carried out (7.2).

6 Test specimen

6.1 Sampling

The test specimen shall be taken from a significant surface of the product, where the anodic oxidation coating formed thereon needs to satisfy the quality adapted to the application of the product. The test specimen shall not be taken from the edges for possible distortion and/or non-uniformity.

Where it is impossible to test the product itself, a test specimen which is representative of the product may be used. In this case, the test specimen used 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 and anodizing shall be performed in the same bath and under the same conditions as the treatment of the product.

6.2 Treatment before testing

The test specimen shall be clean, free from dirt, stains and other foreign matters. Any deposits or stains shall be removed with a clean, soft cloth or similar material which is wetted by an appropriate organic solvent such as ethanol. Organic solvents which can corrode the test specimen or generate a protective film on the test specimen shall not be used.

6.3 Size

The standard size of the test specimen should be 100 mm in length by 100 mm in width. The test specimen of a different size may be used as agreed between the customer and the anodizer.

7 Procedure

7.1 Flat or near-flat surfaces

7.1.1 Preparation of test

Before the test, the test specimen shall be kept in the test environment over 1 h. Measure and record the temperature and relative humidity of the environment in which the test is taking place. Unless otherwise specified, carry out the determination at room temperature and less than 65 % of relative humidity. Place the test specimen on the contact plate (5.7) in good electrical contact with it, for example by using an earthing clip. Alternatively, make contact to the basis metal using the contact probe or clip.

Connect the contact plate or contact probe or clip (5.7) and the electrode probe (5.6) to opposite poles of the secondary winding of the transformer (5.2), and place the probe on the test specimen so that the force exerted on the coating is 0,5 N to 1,0 N (5.6).

7.1.2 Breakdown test

Starting at zero, increase the voltage uniformly at a rate not exceeding 25 V/s until the voltage drops suddenly (indicating breakdown voltage of the coating). It is necessary to clean the contact surface of the probe after any breakdown has occurred, and it is essential to return the voltage to zero after each determination and particularly before cleaning the probe.

Carry out a minimum of five tests and record the lowest value and the mean value obtained. Alternatively, ascertain whether or not any value falls below a predetermined breakdown voltage.

7.1.3 Withstand voltage test

Starting at zero, increase the voltage uniformly to the specified voltage and maintain that voltage for the specified period of time. If electric breakdown does not occur within the specified time period, then the voltage indicates the withstand voltage. If the voltage drops within the specified period of time, then that is due to electric breakdown.

It is necessary to clean the contact surface of the probe after each determination, and it is essential to return the voltage to zero after each determination and particularly before cleaning the probe.

The voltage and the period of time should be specified by the customer and the anodizer.

7.2 Round wire

Before the test, the test specimen shall be kept in the test environment over 1 h. Measure and record the temperature and relative humidity of the environment in which the test is taking place. Unless otherwise specified, carry out the determination at room temperature and less than 65 % of relative humidity. Twist together two suitable lengths of wire using the twisting machine (5.8) so that the number of twists per 50 mm specified in Table 1 is achieved.

Ensure that the two lengths of wire are of equal length between the jaws, are under equal tension and are touching in the jaws.

Remove the wires from the twisting machine, separate the wires for about 50 mm at each end, and remove the anodic oxidation coating from one pair of ends. Join the opposite poles of the secondary winding of the transformer to these exposed ends.

Table 1 — Number of twists for round wire test specimens

Diameter of wire, d mm	Number of twists per 50 mm
$0,2 \leq d \leq 0,3$	5
$0,3 < d \leq 0,5$	4
$0,5 < d \leq 0,75$	3
$0,75 < d \leq 1,25$	2
$1,25 < d \leq 3,25$	1
$3,25 < d \leq 6,5$	0,5

Starting at zero, increase the voltage uniformly at a rate not exceeding 25 V/s until the specified voltage is reached or the voltage drops suddenly (indicating electric breakdown of the coating). It is essential to return the voltage to zero after each determination, and to maintain the contacts between the transformer and test specimen.

Carry out a minimum of five tests and record the lowest value and the mean value obtained. Alternatively, ascertain whether or not any value falls below a predetermined breakdown voltage.

8 Expression of results

Express the breakdown voltage, in volts, as the lowest value recorded and the mean value and/or the withstand voltage.

9 Test report

The test report shall include at least the following information:

a) a reference to this document, i.e. ISO 2376:2019;

b) the type and identification of the product tested;

c) the anodizing specification, when applicable;

d) the breakdown voltage (see Clause 7) and, where appropriate, a statement as to whether the breakdown voltage conformed to that specified for the product;

and/or

the withstand voltage; the specified voltage, period of time;

NOTE The minimum acceptable breakdown voltage will normally be specified in the relevant product specification.

e) the room temperature and relative humidity of the environment at the time of the test;

f) any other relevant information on the tests or the results;

g) any unusual features observed;

h) the date of the test.