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Anodizing of aluminium and its alloys — Determination of electric breakdown potential

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

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Foreword

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ISO 2376 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 2376:1972), which has been technically revised.

Anodizing of aluminium and its alloys — Determination of electric breakdown potential

1 Scope

This International Standard specifies test methods for the determination of the electric breakdown potential 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 The methods described do not give satisfactory results for unsealed coatings.

NOTE 2 Electric breakdown potential is affected by relative humidity.

2 Principle

The electric voltage at which current first passes through an anodic oxidation coating is measured; this breakdown potential is a function of the dielectric characteristics and the insulation properties of the oxidation coatings. The breakdown potential depends 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 sample and the degree of ageing.

3 Apparatus

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

3.2 Transformer (a.c.), having an output with a waveform as nearly sinusoidal as possible, capable of producing the potential required.

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

3.4 Current limiting resistor, 0,5 MΩ, in series with secondary winding of the transformer and the test electrode probe (3.6).

3.5 Potential-measuring device, which gives r.m.s. values, expressed in volts.

3.6 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).

3.7 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 (see 4.2.1).

3.8 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 (see 4.2.2).

4 Procedure

4.1 Test specimen

The test specimen shall normally consist of a production component (or a part thereof). It shall be sealed, dry and clean and, if required, shaped to correspond to its ultimate use in service.

Unsealed items may be tested but only under conditions of known, recorded and controlled relative humidity.

NOTE The use of specially prepared test specimens, processed at the same time and in the same manner as production articles, can lead to erroneous results.

4.2 Determination

4.2.1 Flat or near-flat surfaces

Unless otherwise specified, carry out the determination at room temperature. Measure and record the relative humidity of the environment in which the test is taking place. Place the test specimen on the contact plate (3.7) 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 (3.7) and the electrode probe (3.6) to opposite poles of the secondary winding of the transformer (3.2), and place the probe on the test specimen so that the force exerted on the coating is 0,5 N to 1,0 N (see 3.6).

Starting at zero, increase the potential uniformly at a rate not exceeding 25 V/s until the specified potential is reached or the potential drops suddenly (indicating electric breakdown 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 potential 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 electric breakdown potential.

4.2.2 Round wire

Unless otherwise specified, carry out the determination at room temperature. Measure and record the relative humidity of the environment in which the test is taking place.

Twist together two suitable lengths of wire using the twisting machine (3.8) 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 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
$0{,}2 \leqslant d \leqslant 0{,}3$	5
$0{,}3 < d \leqslant 0{,}5$	4
$0{,}5 < d \leqslant 0{,}75$	3
$0{,}75 < d \leqslant 1{,}25$	2
$1{,}25 < d \leqslant 3{,}25$	1
$3{,}25 < d \leqslant 6{,}5$	0,5

Starting at zero, increase the potential uniformly at a rate not exceeding 25 V/s until the specified potential is reached or the potential drops suddenly (indicating electric breakdown of the coating). It is essential to return the potential 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 electric breakdown potential.

5 Expression of results

Express the electric breakdown potential, in volts, as the lowest value recorded and the mean value.

6 Test report

The test report shall include at least the following information:

a) a reference to this International Standard;

b) the type and identification of the product tested;

c) the anodizing specification, when applicable;

d) the electric breakdown potential (see Clause 5) and, where appropriate, a statement as to whether the electric breakdown potential conformed to that specified for the product;

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

e) the relative humidity of the environment at the time of the test;

f) any other relevant information on the tests or the results, including the test temperature, if it is different from room temperature;

g) the date of the test.

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