INTERNATIONAL STANDARD ISO 2931

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Anodizing of aluminium and its alloys — Assessment of quality of sealed anodic oxide coatings by measurement of admittance or impedance

Anodisation de l'aluminium et de ses alliages — Détermination de la qualité des couches anodiques colmatées par mesurage de l'admittance ou de l'impédance

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 2931 was drawn up by Technical Committee ISO/TC 79, *Light metals and their alloys*, and circulated to the Member Bodies in March 1974.

It has been approved by the Member Bodies of the following countries :

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INTERNATIONAL STANDARD ISO 2931-1975 (E)

Anodizing of aluminium and its alloys — Assessment of quality of sealed anodic oxide coatings by measurement of admittance or impedance

1 SCOPE

This International Standard specifies a method for assessing the quality of sealed anodic oxide coatings on aluminium and its alloys, by measurement of the admittance or the impedance.

The method is suitable for use as a production control test. It is also suitable for use as an acceptance test when there is agreement between the manufacture and the purchaser.

2 FIELD OF APPLICATION

This test is intended to give a quick, non-destructive assessment of the quality of sealed anodic oxide coatings and is therefore very suitable for routine control. It shall be carried out following sealing before any other supplementary process is undertaken (for example oiling, waxing or lacquering).

The method is applicable to anodic oxide coatings sealed in an aqueous medium. The correlation of the results with those of other sealing tests may be affected by the presence of sealing additives, or contaminants such as silicate. For this reason sealing quality shall be checked from time to time by one of the acid-dissolution methods given in ISO 2932 and ISO 3210.

The pretreatment, the anodizing process, the colouring used and the alloy, may all have an effect on admittance or impedance readings.

Any type of anodized component may be tested provided that there is sufficient area (a circle of about 20 mm diameter) and that the film thickness is greater than 3 μm.

3 REFERENCES

ISO 2932, *Anodizing of aluminium and its alloys — Assessment of sealing quality by measurement of the loss of mass after immersion in acid solution.*

ISO 3210, *Anodizing of aluminium and its alloys — Assessment of sealing quality by measurement of the loss of mass after immersion in phosphoric-chromic acid solution.*

4 DEFINITIONS

The admittance Y is the inverse of the complex apparent resistance Z (impedance) which, in an alternating current circuit, is represented by the vectorial sum of the actual resistance R and the reactance X_c.

$$Y = \frac{1}{Z} \qquad \ldots (1)$$

$$|Z| = \sqrt{X_c^2 + R^2} \qquad \ldots (2)$$

In equation (2) :

R is the resistance, in ohms;

$X_c = \frac{1}{2\pi f C}$ is the reactance;

f being the frequency of the alternating current;

C being the capacitance.

5 PRINCIPLE

An anodic oxide coating on aluminium may be represented as an electrical diagram made up of a certain number of ohmic and capacity resistances mounted in series and/or parallel in an alternating current circuit. The numerical value of these resistances depends on the following variables :

a) basis metal (for example, composition, size and distribution of intermetallic compounds, and surface condition);

b) type of sealing process (for example steam, hot water, nickel or cobalt salts);

c) thickness and density of anodic oxide layer (depending upon electrolyte, type of current, current density, electrolyte temperature, etc.);

d) dyeing or pigmentation processes used to colour the anodic oxide coating;

e) time and conditions of storage between sealing and measurement.

6 APPARATUS

6.1 Device for measuring admittance over a range of 3 to 300 μS or impedance in the range of 3 to 3 000 kΩ with sufficient precision.

Both instruments should measure at a frequency of 1 kHz and be equipped with two electrodes, one of which makes contact with the basis metal of the sample, and the other being a pencil-like probe in the electrolyte.

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6.2 Cell containing the electrolyte.

6.2.1 For admittance test : it is suitably formed by a rubber ring of 13 mm internal diameter and about 5 mm thickness, the surface of which is self-adhesive. This type of cell has an internal area of 133 mm².

6.2.2 For impedance test : it is suitably formed by a glass tube 9 mm in outside diameter by 9 cm, with rubber gasket for ensuring sealing on test sample. This type of cell has an internal area of 12,9 mm².

6.3 Electrolyte, in the form of an aqueous 35 g/l solution of potassium sulphate or sodium chloride.

7 TEST SAMPLES

All anodized products, whatever their shape and dimensions, may be tested provided that it is possible at the point of measurement to determine the thickness of the oxide layer, to apply the electrolyte-filled cell to it and, if necessary, to determine the surface area of the measurement.

8 PROCEDURE

The test should be carried out preferably within 1 to 4 h after sealing and cooling to room temperature, and in any case within 48 h.

Degrease the test area of the test sample using a suitable organic solvent. If a silicone, wax preservative or lacquer has been applied after sealing, such degreasing may not be adequate. Satisfactory cleaning may be achieved by first using an organic solvent followed by rubbing with a paste of magnesium oxide or pumice powder and water until no water break occurs.

Screw one electrode into the sample so that it makes good electrical contact with the basis metal. Carefully fix the cell on the test area. If the area of the cell is modified by the geometric shape of the test sample, it is necessary to determine the new dimensions. Fill the cell with the electrolyte (6.3). At each point of measurement, use a new sealing ring and fresh solution. If the test is to be carried out on an oblique or vertical surface, it is necessary to introduce into the cell a cotton wool plug soaked in the electrolyte; alternatively, a cell of special design may be used.

Immerse the other electrode in the solution and measure the admittance or impedance. Choose the range of measurement, as far as possible, so that the pointer is situated in the upper one-third of the scale.

Carry out the measurement at a temperature between 10 and 35 °C. Take the reading at least 2 min after the introduction of the electrode into the cell. If at the end of these 2 min the reading continues to increase in the case of admittance, or decrease in the case of impedance, take a final reading after a further 3 min.

After the admittance or impedance has been measured, determine the thickness of the oxide layer at the point of measurement.

NOTE — Cells which are not perfectly attached and therefore not water-tight give an inaccurate reading.

9 EXPRESSION OF RESULTS

In order to allow comparison of measured values, the value to be retained must be the result of three conversions of the measured value :

1) Conversion required to relate the measured value to a measuring area of 133 mm² (in the case where it is not possible to use this area and if the actual measuring area is between 10 and 50 mm² for the measurement of impedance and between 100 and 200 for the measurement of admittance).

2) Conversion required according to the ambient temperature in °C.

3) Conversion required to relate the measured admittance or impedance to a conventional layer thickness of 20 μm.

These three conversions are carried out by means of the following formulae :

Admittance	**Impedance**
1) $Y_1 = Y_m \times \frac{133}{A}$	1) $Z_1 = Z_m \times \frac{A}{133}$
2) $Y_2 = Y_1 \times f_1$	2) $Z_2 = Z_1 \times f_2$
3) $Y_3 = Y_2 \times \frac{e-3}{17}$	3) $Z_3 = Z_2 \times \frac{17}{e-3}$

where

Y_m is the measured admittance value, in microsiemens;

Z_m is the measured impedance value, in kilohms;

A is the actual measuring area, in square millimetres;

Y_3 is the corrected admittance value;

Z_3 is the corrected impedance value;

e is the thickness of the layer, in micrometres;

f_1 and f_2 are coefficients depending upon the temperature (T °C) as shown in the figure.

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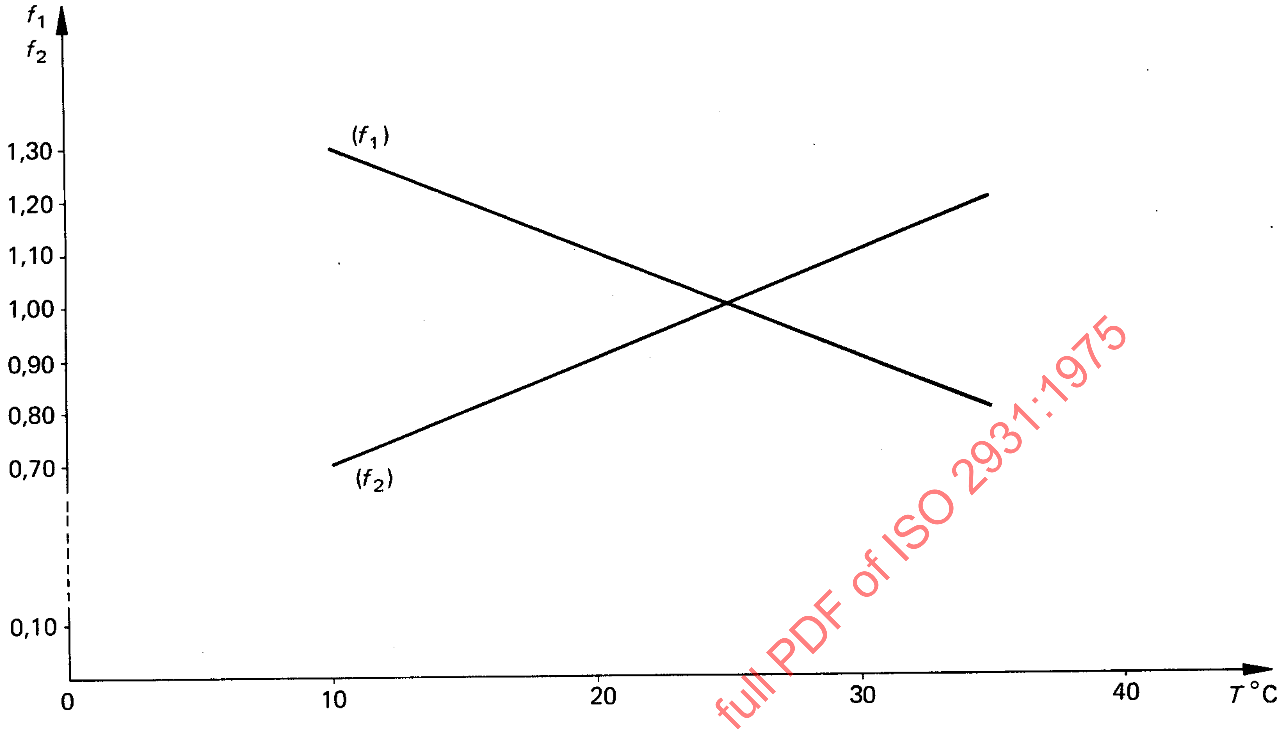

FIGURE – Variation of coefficients f_1 and f_2 as a function of temperature (in °C)

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