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IS 1868 (1996): Anodic Coatings on Aluminium and its Alloys
[MTD 24: Corrosion Protection]



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(तीसरा पुनरीक्षण)

Indian Standard

ANODIC COATINGS ON ALUMINIUM AND
ITS ALLOYS — SPECIFICATION

(Third Revision)

ICS 25.220.30;77.120.10

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Metallic and Non-metallic Finishes Sectional Committee had been approved by the Metallurgical Engineering Division Council.

This Standard was first published in 1961 and subsequently revised in 1968 and 1982. While reviewing this standard, the committee desired to revise this standard and various clauses have been aligned with International Standards.

In this revision following changes have been made:

- a) Scope of the standard has been widened.
- b) The existing clause on terminology has been revised incorporating definition of additional fifteen terms.
- c) A new clause providing general guidelines on grades of Aluminium suitable for anodizing has been added.
- d) A new clause on 'Surface Texture' of aluminium surface prior to anodizing has also been incorporated.

No one coating can satisfy all the requirements of this standard since individually the requirements may be incompatible with each other. A list of information which should be provided along with the inquiry and order is given in 7. It is in particular, essential that the purchaser states the clauses which are relevant, and specifying in each case the grade number of the agreed standard of performance desired. Merely asking for anodizing to IS 1868 without this information is insufficient.

In the formulation of this standard, assistance has been derived from ISO 7599:1983, 'Anodizing of aluminium and its alloy-General specification for anodic oxide coatings on aluminium', issued by the International Organization for Standardization.

For the purpose of deciding whether a particular requirements of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

ANODIC COATINGS ON ALUMINIUM AND ITS ALLOYS — SPECIFICATION

(Third Revision)

1 SCOPE

1.1 This standard lays down general specification for anodic oxide coatings on aluminium. It defines the characteristic properties of anodic oxide coatings on aluminium, lists methods of test for checking the characteristic properties, specifies minimum performance requirements, gives information on the grades of aluminium suitable for anodizing and describes the importance of pretreatment to ensure the required appearance or texture of the finished work.

1.2 This standard does not cover 'hard anodized' coatings for engineering purpose, for which abrasion and wear resistance are the primary characteristics.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 SUPPLY OF MATERIAL

The general requirements relating to the supply of material shall be as laid down in IS 1387:1993.

4 TERMINOLOGY

For the purpose of this standard, definitions given in IS 3554:1966 as well as the following shall apply.

4.1 Anodized Aluminium

Aluminium with an anodic coating, produced by an electrolytic oxidation process in which the surface of aluminium is converted to a coating, generally an oxide, having protective, decorative or functional properties.

4.2 Clear Anodized Aluminium

Aluminium with a substantially colourless, translucent anodic oxide coating.

4.3 Colour Anodized Aluminium

Aluminium with an anodic oxide coating that is coloured by absorptive dyes.

4.4 Integral Colour Anodizing

Anodizing of aluminium using an appropriate (usually organic acid-based) electrolyte which produces

coloured oxide coating during the anodizing process itself on specific aluminium alloys.

4.5 Electrolytic Colouring

The colouring of an anodic oxide coating by the electrolytic deposition of metals or metal oxide in the porous structure.

4.6 Bright Anodized Aluminium

Anodized aluminium with a high specular reflectance as the primary characteristic.

4.7 Protective Anodizing

Anodizing where protection against corrosion or wear is the primary characteristics and appearance is secondary or of no importance.

4.8 Decorative Anodizing

Anodizing where a decorative finish with a uniform or aesthetically pleasing appearance is the primary characteristic.

4.9 Architectural Anodizing

Anodizing to produce an architectural finish to be used in permanent, exterior and static situations where both appearance and long life are important.

4.10 Sealing

A hydration treatment of anodic oxide coatings on aluminium applied after anodizing to reduce porosity and/or the absorption capacity of the coating.

4.11 Significant Surface

The part of the article covered or to be covered by the coating and for which the coating is essential for serviceability and/or appearance.

NOTE — When necessary the significant surface is to be agreed upon between the manufacturer and the purchaser and is to be indicated on the drawings or by providing suitably marked sample.

4.12 Measuring Area

The area of the significant surface over which a single measurement is made.

Measuring area for the various methods is defined as following:

- a) For analytical method — the area over which the coating is removed;
- b) For the anodic dissolution method — the area enclosed by the sealing ring of the cell;
- c) For the microsectional method — the place at which a single measurement is made; and
- d) For non-destructive methods — the probe area or the area included in the reading.

4.13 Reference Area

The area within which a specified number of single measurements are required to be made.

4.14 Local Thickness

The mean of the thickness measurements, of which a specified number is made within a reference area.

4.15 Minimum Local Thickness

The lowest value of the coating thickness at any point on the significant surface.

4.16 Maximum Local Thickness

The highest value of the coating thickness at any point on the significant surface.

4.17 Average Thickness

Either the value obtained by analytical methods, or the mean value of a specified number of local thickness measurements that are evenly distributed over the significant surface.

4.18 Impregnation

A treatment carried out after anodizing in order to plug the pores of the anodic oxidation coating, but not involving hydrothermal sealing.

5 GRADES OF ALUMINIUM FOR ANODIZING

General guidance on anodising of different categories of aluminium is given in Annex B.

6 SURFACE TEXTURE

General guidance on details of surface texture is given in Annex C.

7 INFORMATION TO BE GIVEN WITH THE INQUIRY AND ORDER

7.1 The following is a list of the characteristic properties of anodic oxide coatings that may be required to be specified and measured, or otherwise agreed upon.

Only some of the properties will be significant in any particular application. The anodizer shall be notified of either the end use or of the specific properties required.

Some properties (for example specular reflectance) are only obtainable by the use of special alloys, and some properties may be mutually incompatible with others.

The following information, where appropriate, should be provided with the inquiry and order:

- a) Thickness (*see 9*)
- b) Quality of sealing (*see 10*)
- c) Colour and appearance (*see 11*)
- d) Corrosion resistance (*see 12*)
- e) Abrasion resistance (*see 13*)
- f) Resistance to crazing deformation (*see 14*)
- g) Fastness to light (*see 15*)
- h) Light reflection properties (*see 16*)
- j) Electrical breakdown potential (*see 17*), and
- k) Continuity of the coating (*see 18*)

7.2 Sampling Procedure

Sampling procedure shall be as agreed to between the anodiser and the purchaser. For sampling plan IS 2500 (Part 1) :1992 may be referred.

8 TEST PIECES

8.1 Wherever practicable, test pieces shall be the production component. However, if by agreement, special pieces are prepared for convenience as referee or acceptance test, they shall be made of the same material as the production batch they represent, and shall be anodized by the same process and at the same time.

8.2 Acceptance Tests

Acceptance tests shall be as agreed between the anodizer and the customer. However following acceptance tests can be adopted by the users:

- a) Colour and appearance;
- b) Thickness (*see 9*);
- c) Quality of sealing by marking test (*see IS 5523 : 1983*); and
- d) Continuity of anodising coating, if required (*see IS 5523 : 1983*).

In case of any change in raw material, manufacturing method and operational conditions, all the tests as given in this standard shall be carried out.

9 THICKNESS

9.1 Anodic oxide coatings are graded by their thickness and are denoted by the grade numbers shown in Table 1. The thickness of anodic coatings shall not be less than specified in Table 1 for the appropriate grade.

9.2 Measurement of Thickness

Thickness measurements shall be carried out by one or more of the following methods:

- Microsection method,
- Stripping method, and
- Eddy current method (*see* IS 6012:1992).

9.2.1 In case of dispute, the Microsection method shall be the referee method for coatings Grade AC 15 and higher thicknesses and stripping method shall be used for thinner coatings (Grade AC 10, AC 5, AC 2.5) and for coatings on wire.

9.2.2 Thickness measurements shall be made on the significant surfaces and sharp edges should be avoided, but no measurements shall be made within 5 mm of the areas of anodic contact, nor in the immediate neighbourhood of an edge.

10 QUALITY OF SEALING

10.1 General

The quality of sealing is of great importance and sealing is always essential, whether stated or not, except where an unsealed coating is expressly requested.

10.2 Assessment of Quality of Sealing

10.2.1 If test pieces are submitted, these shall measure not less than 75 × 50 mm (*see* 8.1).

10.2.2 For mild environments (for example indoors), sealing shall be tested by the marking test as given

in IS 5523 : 1983.

10.2.3 For severe service (for example outdoors), adequacy of sealing shall be tested by the sulphur dioxide humidity test as specified in IS 5523 : 1983.

11 APPEARANCE AND COLOUR

11.1 Anodized articles shall be free from visible defects on the significant surface(s) when viewed from an agreed distance. If important to be customer, the position and maximum size(s) of the contact mark(s) shall be agreed between the anodizer and the customer.

11.2 The colour, surface texture, and their tolerances, shall be agreed between the anodizer and the customer. If required for matching purposes, the acceptable limits of variation shall be defined by agreed samples.

The surface of anodized aluminium has the property of double reflection from the surface of the base metal. Therefore, when matching colour samples, they shall be held in the same plane and viewed as near to normal as is practicable, the direction of working being always the same. A diffuse source of illumination shall be placed behind the viewer.

11.3 Unless otherwise agreed, the colours shall be compared in diffuse daylight from a northern aspect north of the equator and from a southern aspect south of equator.

If the coloured coatings are to be used in the service in artificial light, this lighting shall be used for colour comparison.

Table 1 Minimum Thickness of Anodic Coating
(Clause 9.1)

Grade	Minimum Average Thickness in Micrometer	Minimum Local Thickness in Micrometer	Application
(1)	(2)	(3)	(4)
AC25	25	20	For permanent installations, out doors and where little or no deterioration of surface appearance are tolerated, even with minimum maintenance.
AC15	15	12	For outdoor architectural use, for indoor applications in arduous conditions and for graphic application used for defence services and professional equipment.
AC10	10	8	May be used for outdoor in special applications where cleaning is very frequent (for example, decorative rim for vehicles) and also for certain other indoor applications like refrigerator parts.
AC5	5	4	Generally used for indoor applications.
AC2.5	2.5	2	For some reflectors and as a base for paint.

NOTES

1 All grades may be produced in electrolytes based primarily on sulphuric or oxalic acid. With most chromic acid electrolytes, only thinner coatings are obtainable. Barrier layer anodic coatings used in capacitors as dielectrics produced in boric acid electrolytes are not included in the table.

2 For control purposes, thickness may be determined by eddy current method or by breakdown voltage test.

3 Minimum Average thickness shall be the average of five measurements as specified in IS 5523 : 1993

11.4 The agreed colour samples shall be stored in a dry place in the dark.

11.5 Standard colour panels as supplied by the user may be used for acceptance of processed colour parts subject to agreement between the manufacturer and the purchaser. Colour matching shall be carried out by the day light in a room with northern aspect. The agreed sample colour panels are to be stored in a dark and dry place.

12 CORROSION RESISTANCE

If required by the customer, the anodic oxide coating shall be tested for resistance to corrosion by, for example, the AAS test as given in IS 6910 : 1985 or the CASS test as given in IS 5528 : 1985. The choice of method and period of exposure shall be as agreed to between the anodizer and the customer.

13 ABRASION RESISTANCE

If required by the customer, the abrasion resistance of the anodic oxide coating shall be tested using a method as agreed between the anodizer and the customer. The performance requirements shall be agreed between the anodizer and the customer in accordance with the relevant provisions of IS 5523 : 1983.

14 RESISTANCE TO CRAZING BY DEFORMATION

If required by the customer, the resistance to crazing by deformation of the anodic oxide coating shall be tested in accordance with the relevant provisions of IS 5523 : 1983 and/or the performance requirements shall be as agreed to between the anodizer and the customer.

15 FASTNESS TO LIGHT

15.1 General

For evaluating exterior colour fastness, only outdoor exposure under conditions comparable to actual service use is acceptable. Accelerated testing is suitable only as a quality control test of coloured anodic oxide coatings where the fastness of the colouring medium has already been established by outdoor exposure tests.

The light fastness of colour anodized aluminium depends upon the method of colouring and the colouring medium used, and only a limited range of coloured finishes may be suitable in any particular application. Advice in this regard should be sought from the anodizer.

15.2 Fastness to Light

An accelerated method of testing the fastness of coloured anodic oxide coatings to light is specified in IS 5523 : 1983. When tested, the performance of colour anodized aluminium in terms of Fastness rating number shall be:

- a) 5 *Min* for interior application.
- b) 9 *Min* for exterior application.

16 LIGHT REFLECTION PROPERTIES

16.1 General

The following characteristic properties may be measured:

- a) Total reflectance (or total reflectivity)
- b) Specular reflectance for surfaces with high gloss
 - at 45°
 - at 30°
 - at 20°
- c) Specular reflectance for surface with medium or low gloss
 - at 60°
 - at 85°
 - at 45°
- d) Diffused reflectance

These properties can be determined using a variety of optical instruments, which differ in degree of sophistication, cost and the type of surface for which they are designed. These differences relate to the illumination system, the angle of the incident light, the angle at which the reflected light is measured and the geometry of the light collecting system. The properties are not, therefore, completely independent of the instrument used for measurement.

Several of the properties require the provision of very flat surfaces and measurements can only be carried out on special test pieces.

The customer, wherever necessary, shall inform the anodizer of the properties to be measured. They shall also agree upon on the instrument as well as the method of testing.

Bright finishes with a high specular gloss can however be obtained only by the use of special grades of aluminium.

17 ELECTRICAL BREAKDOWN POTENTIAL

If required, the electrical breakdown potential of the anodic oxide coating shall be determined by the method specified in IS 6910 : 1985. The acceptable breakdown potential shall, however, be agreed between the anodizer and the customer.

18 CONTINUITY OF THE ANODIZED COATINGS

If required, the continuity of the anodic oxide coating shall be determined by the method specified in IS 8375 : 1977. This test shall, however, be applicable only to coatings of thickness less than 5 micrometer. The requirements for continuity shall, however, be as agreed to between the anodizer and the customer.

19 MARKING

The anodized articles shall be marked legibly and indelibly with grade of the coating and the name or trade-mark of the manufacturer.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
1387 : 1993	General requirements for the supply of metallurgical materials (<i>second revision</i>)		anodized aluminium coating by copper accelerated acetic acid salt spray (CASS) test (<i>first revision</i>)
2500 (Part 1) : 1992	Sampling inspection tables: Part 1 Attribute sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection (<i>second revision</i>)	6012:1992	Method for measurement of coating thickness by eddy current
3554 : 1966	Glossary of terms relating to electroplating	6651:1972	Anodized aluminium for automobile use
5523 : 1983	Method of testing anodic coating on aluminium and its alloys (<i>first revision</i>)	6910:1985	Method of testing corrosion resistance of electroplated and anodized aluminium coatings by acetic acid salt spray (AAS) test (<i>first revision</i>)
5528 : 1985	Method of testing corrosion resistance of electroplated and	8375:1977	Method for checking continuity of anodized coatings

ANNEX B

(Clause 5)

B-1 GENERAL

Aluminium, in most of its forms can be anodized (*see B-5*), but the results differ widely in appearance, colour, maximum possible coating thickness, reflectivity, abrasion resistance, corrosion resistance and electrical breakdown potential. The protective value of the coating is excellent on aluminium produced for general engineering purposes, but for uniformity of appearance or other special effects (for example bright finishes) special grades of aluminium have been produced where close control of chemical composition and metallurgical properties are combined with special production procedures to provide high standards of surface finish and a guaranteed response to anodizing. These grades cannot readily be classified because different companies have developed their own range of products to meet the requirements of a particular industry or a customer and there is no clear dividing line between the various categories.

The categories of coatings as listed below are given for general guidance and are based on the end-use. The anodizer must be therefore be aware of the end-use, and it is stressed that, for this reason, there must be close co-operation between the supplier of the aluminium, the customer and the anodizer.

B-2 ARCHITECTURAL QUALITY

Semi-finished products of this grade will give a substantially uniform appearance after anodizing when viewed from a distance of not less than 3 m.

Some variations in appearance and colour can be expected after anodizing, between different batches of the same material and between different forms of the same material. It is sometimes possible to observe on close inspection, or from certain viewing angles, variations in brightness, banding, streaking and other visual defects. These do not affect in any way the quality of the coating. The extent to which such defects can be accepted shall be specified by the customer.

Special alloys have been developed for use with integral colour anodizing processes and these may have to be specified for particular coloured finishes.

B-3 DECORATIVE QUALITY

Semi-finished products of this category have a particularly homogeneous appearance when viewed from a distance of 0.5 m. The finish may be matt, bright or semibright according to the material and anodizing treatment, but freedom from defects is assured (*see 11*).

B-4 BRIGHT ANODISING QUALITY

Materials in this category will normally be based on ingot metal aluminium of high (99.7 percent) or very high (99.99 percent) purity. Proper manufacturing control of the metal is essential.

B-5 GENERAL ENGINEERING QUALITY

Most aluminium will come within this category and will anodize to give a continuous coating of good

protective value but with no guarantee about appearance, although it may be good.

Alloys containing high proportions of copper, silicon or zinc are likely to create problem in anodizing and advice should be sought from the manufacturer and the anodizer, in particular, if the copper content is higher than 3 percent since anodising as it will offer only a limited protection.

NOTE — IS 6651:1972 may be referred for requirements of anodized aluminium for automobile use.

ANNEX C

(Clause 6)

C-1 The pretreatment given before anodizing largely determines the final appearance and texture of the anodized aluminium surface. Different surface texture may be obtained by a variety of treatment processes.

The work may be mechanically polished to obtain a smooth or bright surface. Chemical or electrochemical brightening can also be employed with special aluminium to obtain a very bright finish.

Usually, the work, either polished or unpolished, is subjected to a chemical etching procedure to provide a range of texture from light satin with varying degrees of gloss to full matt, depending upon the type of etch used.

Alternatively, the texture may be produced mechanically using brushes, abrasive belts or wheels to give matt finishes which are lined or directional in contrast to the essentially non-directional etched finishes. Mechanical finishes have good reproducibility and are less dependent on metal structure and composition than chemical pretreatment finishes. Surface irregularities, if not too deep, can also be removed by mechanical means.

C-2 The desired surface texture shall be agreed between the anodizer and the customer and, if necessary, on the basis of agreed samples. The provision of such samples is a useful guide in production, but it should be recognized that they are of limited value in assessing surface finish, since different forms and sizes of material may respond to pretreatments in slightly different ways.

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards Monthly Additions'.

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