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

*Anodisation de l'aluminium et de ses alliages — Termes et définitions*

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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. [www.iso.org/directives](http://www.iso.org/directives)

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

The committee responsible for this document is 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 7583:1986), which has been technically revised. The title has been changed and the English and French language versions are now presented as separate documents.

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# Anodizing of aluminium and its alloys — Terms and definitions

## 1 Scope

This International Standard defines terms concerning anodized aluminium.

## 2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 2.1 Anodized aluminium products

#### 2.1.1

##### **anodized aluminium**

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

#### 2.1.2

##### **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

#### 2.1.3

##### **batch anodizing**

anodizing aluminium parts by racking them together, passing them through a succession of processes including anodizing, and unranking

#### 2.1.4

##### **bright anodized aluminium**

anodized aluminium with high specular reflectance as its primary characteristic

#### 2.1.5

##### **clear anodized aluminium**

anodized aluminium with a substantially colourless, translucent anodic oxidation coating

#### 2.1.6

##### **coil anodizing**

strip anodizing

continuous anodizing (deprecated)

anodizing aluminium coils in a continuous process comprising unwinding, passing through a succession of processes including anodizing, and rewinding

Note 1 to entry: The term “continuous anodizing” is deprecated in this usage because it can also be applied to a method of anodizing extrusions.

#### 2.1.7

##### **colour-anodized aluminium**

anodized aluminium coloured either during anodizing or by a subsequent colouring process or processes

#### 2.1.8

##### **combination-coloured anodized aluminium**

anodized aluminium coloured by electrolytic colouring or produced by integral colour anodizing either followed by absorption dyeing

**2.1.9**

**combined coating**

combined coating of an electrophoretic organic coating and an anodic oxidation coating on aluminium

Note 1 to entry: The electrophoretic organic coating is deposited onto anodized aluminium.

**2.1.10**

**decorative anodizing**

anodizing to produce a decorative finish with a uniform or aesthetically pleasing appearance as the primary characteristic

**2.1.11**

**dyed anodized aluminium**

anodized aluminium coloured by absorption of dyestuffs or pigments into the pores

**2.1.12**

**electrolytically coloured anodized aluminium**

anodized aluminium coloured by the electrolytic deposition of metal or metal oxide into the pores

**2.1.13**

**hard anodized aluminium**

anodized aluminium where the anodic oxidation coating has been produced with high wear resistance or microhardness as its primary characteristic

Note 1 to entry: Wear includes abrasive wear and erosive wear.

**2.1.14**

**integral-colour anodized aluminium**

self-colour anodized aluminium

aluminium anodized using an appropriate (usually organic acid based) electrolyte which produces a coloured finish during the anodizing process itself

**2.1.15**

**interference-coloured anodized aluminium**

multi-coloured anodized aluminium

electrolytically coloured anodized aluminium exhibiting colours attributed to optical interference effects

Note 1 to entry: The optical mechanisms are not fully understood

**2.1.16**

**preanodized aluminium**

aluminium anodized before a forming process is applied

**2.1.17**

**protective anodizing**

anodizing to produce a finish where protection against corrosion or wear is the primary characteristic and appearance is secondary or of no importance

**2.1.18**

**two-step process**

process that produces electrolytically coloured anodized aluminium

**2.1.19**

**type I anodized aluminium**

anodized aluminium produced by chromic acid anodizing

**2.1.20**

**type II anodized aluminium**

anodized aluminium produced by sulfuric acid anodizing

**2.1.21****type III anodized aluminium**

anodized aluminium produced by any process that forms a heavy, dense coating of specified thickness

**2.2 Finishes****2.2.1****finish**

characteristic of the surface of a product

**2.2.2****matt finish**

diffuse finish typically produced by etching, blasting, rolling or brushing the aluminium before anodizing

**2.2.3****satin finish**

fine-textured matt finish generally produced by etching or by rolling with specially ground rolls

**2.2.4****scratch-brushed finish**

matt or satin finish produced by abrasion with rotating wire brushes

**2.2.5****texture**

<finish> characteristic of the appearance of the surface of a product

**2.3 Pretreatments****2.3.1****bright dipping**

brief immersion in a solution used to produce a bright surface

**2.3.2****brightening**

production of a bright surface by chemical or electrochemical polishing

**2.3.3****chemical brightening**

chemical treatment to improve the specular reflectivity of a surface

**2.3.4****chemical polishing**

polishing of an aluminium surface by immersion in a solution of chemical reagents

**2.3.5****cleaning**

removal of substances including oxide, pick-up, oil and grease from the surface of aluminium, which can negatively affect a subsequent surface treatment

EXAMPLE The cleaning of aluminium coils is often carried out in an acid solution.

**2.3.6****degreasing**

cleaning (deprecated)

removal of substances including oil and grease from the surface of aluminium, which can negatively affect a subsequent surface treatment

EXAMPLE Degreasing is often carried out by the use of an aqueous detergent.

**2.3.7**

**desmutting**

removal of loosely adhering “smut” from an aluminium surface

EXAMPLE Smut consisting of intermetallic compounds insoluble in alkaline etch solutions can be removed by immersion in suitable acidic solutions such as nitric acid.

**2.3.8**

**electrobrightening**

electrochemical treatment to improve the specular reflectivity of a surface

**2.3.9**

**electrograining**

electrochemical treatment of aluminium normally in a hydrochloric or nitric acid solution using an alternating current to etch the surface

EXAMPLE This process is used before anodizing in the production of lithographic plates.

**2.3.10**

**electrolytic etching**

roughening of an aluminium surface by overall or selective dissolution in an acid or alkaline media with the aid of an electric current

**2.3.11**

**electropolishing**

polishing of an aluminium surface by making it anodic in an appropriate electrolyte

**2.3.12**

**etching**

selective dissolution of the surface of aluminium in an aqueous solution to produce the required finish, improve the surface appearance or prepare the surface for further treatment or for inspection

**2.3.13**

**pickling**

removal of oxides or other compounds from the surface by chemical action

Note 1 to entry: The term is not normally used in the aluminium surface treatment industry except in the aerospace industry

**2.3.14**

**pretreatment**

surface treatment process or processes carried out before the anodic oxidation process

**2.3.15**

**tunnel etching**

electrochemical treatment of aluminium normally in a hydrochloric acid solution using an alternating current to etch the surface and produce an array of crystallographic tunnels

EXAMPLE This process is used before anodizing in the production of electrolytic capacitors.

**2.4 Anodic oxidation processes**

**2.4.1**

**a.c. anodizing**

process to produce anodized aluminium using an alternating current

**2.4.2**

**anodizing**

anodic oxidation of aluminium by applying an electric current

**2.4.3****barrier film anodizing**

barrier layer anodizing (deprecated)

anodizing process that produces a thin, non-porous anodic oxidation coating on aluminium

EXAMPLE This process is generally used in the production of electrolytic capacitors.

**2.4.4****basket anodizing**

barrel anodizing

anodizing of small parts (eg rivets) in a perforated basket

Note 1 to entry: The aluminium parts are pressed into the basket to form the anode and the acid electrolyte circulates between the parts.

**2.4.5****chromic acid anodizing**

anodizing in a chromic acid electrolyte

EXAMPLE This process is mainly used for aerospace applications.

**2.4.6****constant voltage anodizing**

anodizing at a constant electrical potential

**2.4.7****d.c. anodizing**

process to produce anodized aluminium using a direct current

**2.4.8****phosphoric acid anodizing**

anodizing in a phosphoric acid electrolyte

EXAMPLE This process is sometimes used as a pretreatment before the application of an organic coating.

**2.4.9****plasma anodizing**

plasma electrolytic oxidation

PEO

micro-arc oxidation

MAO

spark anodizing

anodizing where dielectric breakdown constitutes an essential part of the mechanism of coating formation

**2.4.10****sulfuric acid anodizing**

anodizing in an electrolyte based on sulfuric acid

**2.5 Anodic aluminium oxide****2.5.1****anodic aluminium oxide**

AAO

anodic oxidation coating either attached to or separated from its aluminium substrate

Note 1 to entry: This term is often used in nanotechnology applications.

### 2.5.2

#### **anodic oxidation coating**

anodic oxide film

anodic oxide coating

anodic film

coating composed mainly of aluminium oxide formed on the surface of aluminium by anodically polarizing the metal in a suitable electrolyte

### 2.5.3

#### **barrier layer**

non-porous part of the morphology of a porous anodic oxidation coating that separates the pores from the aluminium metal and has a thickness proportional to the bath voltage

### 2.5.4

#### **morphology**

structure (deprecated)

<anodic oxidation coating> cells, pores and barrier layer of a porous anodic oxidation coating

Note 1 to entry: The term "structure" generally refers to the crystalline structure of a material and is therefore deprecated in the usage of this subclause.

### 2.5.5

#### **oxide cell**

unit of the morphology of a porous anodic oxidation coating that contains at its centre a single pore and has a diameter proportional to the bath voltage

### 2.5.6

#### **pore**

unit of the morphology of a porous anodic oxidation coating that extends through the thickness of the coating and opens at its outer surface

### 2.5.7

#### **porosity**

ratio of the volume of the pores in a given thickness of anodic oxidation coating to the total volume of the coating in that thickness

### 2.5.8

#### **porous layer**

part of the morphology of a porous anodic oxidation coating between the barrier layer and the outer surface of the coating

## 2.6 Colouring

### 2.6.1

#### **bleaching**

destruction of a dyestuff or colouring compound in an anodic oxidation coating by a chemical treatment

Note 1 to entry: A solution of nitric acid can be used for this purpose.

### 2.6.2

#### **bleeding**

loss of colour by dissolution from dyed anodic oxidation coatings

Note 1 to entry: This can occur during sealing.

### 2.6.3

#### **colour limit**

colour tolerance

permitted deviation of a colour from a given colour standard when compared using a suitable instrumental method or under specified conditions of illumination and viewing

**2.6.4****fixing**

exposing to an aqueous solution that minimizes the bleeding of dyestuffs from an anodic oxidation coating

Note 1 to entry: Solutions of nickel sulfate are often used for this purpose.

**2.6.5****limit samples**

samples demonstrating colour limits

**2.6.6****reactivation**

treatment of an anodic oxidation coating with acids to increase its absorption capacity for dyestuffs

**2.7 Sealing****2.7.1****ageing**

modification of the structure and properties of an anodic oxidation coating resulting from the slow continuation of a sealing process under ambient conditions

**2.7.2****antismut additive**

chemical additive to a sealing solution that prevents or inhibits the formation of sealing smut

**2.7.3****cold sealing**

cold impregnation

sealing process carried out using an aqueous solution at a temperature no higher than 35 °C

Note 1 to entry: Solutions with nickel fluoride as the main active constituent are often used for cold sealing.

**2.7.4****hydrothermal sealing**

either steam sealing not below the saturated steam temperature or sealing in an aqueous solution at a temperature no lower than 95 °C

**2.7.5****intermediate layer**

surface layer of fully hydrated anodic oxidation coating material, which is formed by some sealing processes

**2.7.6****medium temperature sealing**

sealing process carried out using an aqueous solution at an intermediate temperature generally no lower than 60 °C

**2.7.7****nickel sealing**

sealing process using an aqueous solution containing nickel salts at an elevated temperature

Note 1 to entry: Nickel acetate is typically used for this purpose.

**2.7.8****sealing**

treatment applied to an anodic oxidation coating on aluminium to reduce its porosity and absorption capacity

**2.7.9**

**sealing smut**

sealing bloom

friable, superficial layer deposited on the surface of anodized aluminium during certain sealing processes

Note 1 to entry: It can usually be removed readily by wiping, leaving a clean surface.

**2.7.10**

**steam sealing**

sealing of an anodic oxidation coating by the use of saturated or unsaturated steam

**2.8 Process operation and control**

**2.8.1**

**anodizing**

totality of the processes in a production line which includes the anodic oxidation of aluminium

**2.8.2**

**anodizing efficiency**

ratio of the number of coulombs used to anodize a load to the number of coulombs required to anodize under ideal conditions the same geometric surface area of aluminium to the coating thickness specified by the customer

Note 1 to entry: The coating thickness specified by the customer is likely to be a thickness class.

Note 2 to entry: Based on laboratory tests of sulfuric acid anodizing with conditions typically used for decorative and/or protective anodizing, 20 kC produces 1 m<sup>2</sup>.µm of anodic oxidation coating.

**2.8.3**

**auxiliary electrode**

supplementary anode or cathode used during electrolysis to achieve a more homogenous current distribution

**2.8.4**

**bath voltage**

tank voltage

anodizing voltage

voltage between the anode and the cathode in an electrolytic cell in an anodizing production line

**2.8.5**

**constant cycle-time anodizing**

anodizing where the time in the anodizing tank is  $x$  minutes or  $nx$  minutes where  $x$  is a time compatible with the times required by other processes in the anodizing production line and  $n$  is a whole number

Note 1 to entry: This is an operating practice that can give good productivity.

**2.8.6**

**jig**

rack

device for suspending and carrying the work pieces during chemical or electrochemical treatments

Note 1 to entry: The jig can be constructed of aluminium or titanium.

**2.8.7**

**over-anodizing**

formation of anodic oxidation coating in excess of that specified by the customer

Note 1 to entry: The coating thickness specified by the customer is likely to be a thickness class.

Note 2 to entry: Over-anodizing is quantified as the average thickness minus the specified thickness, divided by the specified thickness. The energy consumption associated with anodizing can be reduced by minimizing over-anodizing.

**2.8.8****stripping**

removal of an anodic oxidation coating from a surface by means of a solution of chemical reagents

**2.8.9****superimposed a.c**

form of current for an electrolytic process where an alternating current is superimposed on a direct current

**2.8.10****thief**

robber

auxiliary electrode so placed to divert to itself some current from portions of the work that would otherwise receive too high a current density

**2.9 Defects****2.9.1****barnacling**

array of small multifaceted crystals of aluminium phosphate on the surface of parts brightened in a solution containing phosphoric acid

**2.9.2****black pitting**

deep pitting of the aluminium occurring during anodic oxidation and caused by contamination of the bath by monovalent anions

Note 1 to entry: The contaminant is generally chloride ions introduced in water used to replenish the bath.

**2.9.3****burning**

region of thick, powdery anodic oxidation coating produced by current concentration due to local overheating during anodizing

**2.9.4****etch staining**

non-uniform film of aluminium hydroxide formed on the surface of aluminium when alkaline etch solution is allowed to dry

Note 1 to entry: Etch staining is difficult to remove.

**2.9.5****hot spot**

soft spot

black spot

defect occurring on AA 6000 series alloys appearing as a discoloured area and caused by excessive  $Mg_2Si$  precipitate at the metal surface

**2.9.6****spalling**

chipping

loss of cohesion within an anodic oxidation coating with the formation of flakes of the coating material

**2.9.7****spangle**

spangled appearance of aluminium after etching in a sodium hydroxide solution in the presence of zinc

**2.9.8****spotting out**

delayed appearance of spots and blemishes on finished surfaces

### 2.9.9

#### **white etch bloom**

patchy, non-uniform whiteness after etching in an alkaline solution due to incomplete removal of surface magnesium oxide before etching

## 2.10 Tests

### 2.10.1

#### **acetic acid salt spray test**

##### **AASS test**

accelerated test involving exposure of an anodized part to a mist of a solution containing acetic acid and sodium chloride

EXAMPLE See ISO 9227.[1]

### 2.10.2

#### **admittance test**

measurement of the apparent conductivity of an anodic oxidation coating in an alternating current circuit

EXAMPLE See ISO 2931.[2]

### 2.10.3

#### **average thickness**

mean value of a specified number of local thickness measurements that are evenly distributed over the significant surface of a single anodized piece

### 2.10.4

#### **bend test**

test for determining the minimum radius, expressed as a function of the sheet thickness, that an anodized sheet can sustain without visible crazing of the anodic oxidation coating

EXAMPLE See ISO 3211.[3]

### 2.10.5

#### **Clarke test**

method, based on Mohs's principle, of assessing surface abrasion resistance by manually rubbing abrasive paper across an anodic oxidation coating

Note 1 to entry: White powder is produced if the abrasive is harder than the anodic oxidation coating.

### 2.10.6

#### **continuity test**

method for checking the continuity of thin anodic oxidation coatings on aluminium by contacting the anodized surface with a solution of copper sulfate

Note 1 to entry: See ISO 2085.[4]

### 2.10.7

#### **copper-accelerated acetic acid salt spray test**

##### **CASS test**

accelerated test involving exposure of an anodized part to a mist of a solution containing acetic acid, copper(II) chloride and sodium chloride

EXAMPLE See ISO 9227.[1]

### 2.10.8

#### **double stroke**

##### **ds**

one complete reciprocal movement made by a wheel or similar device during a test

Note 1 to entry: Tests include the abrasive wheel test described in ISO 8251.[5]

**2.10.9****dye absorption test**

dye spot test

dye stain test

test of the ability of an anodic oxidation coating to absorb dyestuffs under specified conditions

EXAMPLE See ISO 2143.[\[6\]](#)**2.10.10****Ford anodized aluminium corrosion test****FACT test**

test carried out by applying a d.c. potential across an anodic oxidation coating using a special cell

**2.10.11****impedance test**

measurement of the apparent resistivity of an anodic oxidation coating in an alternating current circuit

**2.10.12****Kesternich test**

accelerated test in a humid atmosphere at an elevated temperature containing sulfur dioxide

**2.10.13****local thickness**

mean of the thickness measurements of which a specified number is made within a reference area on the significant surface of a single article

**2.10.14****mass loss test**

weight loss test

method of assessing the quality of an anodic oxidation coating by immersion in an aggressive solution or solutions and measuring the loss of mass

EXAMPLE See ISO 3210.[\[7\]](#)**2.10.15****measuring area**

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

**2.10.16****neutral salt spray test****NSS test**

salt spray test

accelerated test involving exposure of an anodized part to a mist of a solution containing sodium chloride

EXAMPLE See ISO 9227.[\[1\]](#)**2.10.17****reference area**

area within which a specified number of single measurements is required to be made

**2.10.18****reference specimen**

test specimen produced under conditions agreed between the anodizer and the customer

**2.10.19****significant surface**

part of the aluminium article covered or to be covered by an anodic oxidation coating and for which this coating is essential for serviceability and/or appearance

**2.10.20****standard specimen**

test specimen produced in accordance with specified conditions

**2.10.21**

**surface abrasion resistance**

resistance of an anodic oxidation coating to loss of mass due to the abrasive removal of the outer few micrometres of its thickness

**2.10.22**

**test specimen**

specimen on which a test is to be carried out

**2.11 Properties and performance**

**2.11.1**

**anodizing quality**

characteristic related to the porosity of an anodic oxidation coating adjacent to its surface before sealing

Note 1 to entry: Excessive dissolution of an anodic oxidation coating leads to high surface porosity and possibly a limiting thickness. Soft films can exhibit poor anodizing quality.

**2.11.2**

**bloom**

<weathering> whitening of an anodic oxidation coating caused by exposure to the weather particularly in an industrial atmosphere

Note 1 to entry: This effect is not readily removed by simple cleaning techniques.

**2.11.3**

**breakdown voltage**

maximum electrical potential difference that an anodic oxidation coating can sustain before failure of the dielectric occurs

**2.11.4**

**chalking**

powdering

<weathering> formation of a whitish, powdery deposit on an anodized surface occurring during weather exposure and usually caused by poor anodizing quality

**2.11.5**

**coating ratio**

mass of anodic oxidation coating divided by the mass loss of aluminium metal caused by the formation of the coating

**2.11.6**

**crazing**

stress cracking

development of small cracks in an anodic oxidation coating caused by internal strain resulting from mechanical deformation or thermal effects

**2.11.7**

**image clarity**

$C_v$

ability of the surface of an anodic oxidation coating to produce a clear image of an object facing the surface

Note 1 to entry: A method of calculating this taking into account image clearness, image direction and haze is described in ISO 10215.[8]

**2.11.8**

**resmutting**

<weathering> appearance of anodized aluminium occurring during weathering, which is similar to the appearance of sealing smut

Note 1 to entry: Resmutting can be removed by using a mild abrasive.