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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 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.

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 unracking

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 a 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^2.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.

2.11.9
sealing quality
property of an anodic oxidation coating defined by its porosity and absorption capacity

2.11.10
soft film
anodic oxidation coating with a low surface abrasion resistance

2.11.11
surface density
coating mass
coating weight
mass of anodic oxidation coating per unit area of anodized surface

Note 1 to entry: A method of measuring this is described in ISO 2106.[9]

2.11.12
thickness class
grade of anodic oxidation coating according to its minimum average thickness in micrometres

EXAMPLE A product with an anodic oxidation coating of thickness class AA 20 has a minimum average thickness of 20 µm and a minimum local thickness of 16 µm (ISO 7599[10]).

Note 1 to entry: Thickness classes are designated by the letters "AA" followed by the thickness grade (ISO 7599[10]).

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[10] ISO 7599, *Anodizing of aluminium and its alloys — General specifications for anodic oxidation coatings on aluminium*

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