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Interested committees:

Title: BS EN 4827 (P3) Aerospace series — Hexavalent chromium free anodizing of aluminium and aluminium alloys

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Introduction

This draft standard is based on European discussions in which the UK has taken an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent British Standard. Comment is particularly welcome on national, legislative or similar deviations that may be necessary.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	(7)
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/ Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

Aerospace series — Hexavalent chromium free anodizing of aluminium and aluminium alloys

Luft- und Raumfahrt — Anodisieren von Aluminium und Aluminiumlegierungen ohne hexavalentem Chrom

Série aérospatiale — Anodisation sans chrome hexavalent de l'aluminium et des alliages d'aluminium

Scope**Normative references****Terms and definitions**

- General terms

- Technical terms

General principles of the process

- Purpose of the process

- Applicability

- Limitations

- Classification

Process requirements

- Information for the processor

- Process conditions

- Water quality

- Periodic bath chemical analysis

- Re-anodizing

Test specimens requirements

- Definitions of test specimens

- Tests for the qualification

- Periodic tests

Parts requirements

- Condition of parts prior to the treatment

- Inspection before the treatment

- Inspection during the treatment

- Inspection on parts after anodizing

Quality assurance

- Process approval

- General points

Annex A (normative) Tests on test specimens for the qualification

Annex B (normative) Periodic tests on test specimens

Annex C (normative) Tests on parts

Annex D (normative) Levels of requirements for corrosion resistance of unpainted test specimens

Annex E (normative) Dye-spot test

Annex F (informative) Standard evolution form

Bibliography

1 Scope

This ~~European Standard~~document defines the requirements for hexavalent chromium free anodizing of aluminium and aluminium alloys for corrosion protection, bonding and painting. Hard anodizing and plasma electrolytic anodizing (micro-arc oxidation) are not covered by this European Standard.

The purpose of this ~~European Standard~~document is to give design, quality and manufacturing requirements. It does not give complete in-house process instructions; these are given in the processors detailed process instructions.

2 Normative references

EN 2284, Aerospace series — Sulphuric acid anodizing of aluminium and wrought aluminium alloys

EN 3665, Aerospace series — Test methods for paints and varnishes — Filiform corrosion resistance test on aluminium alloys

EN 4704, Aerospace series — Tartaric-Sulphuric-Acid anodizing of aluminium and aluminium wrought alloys for corrosion protection and paint pre-treatment (TSA)

EN 4707, Aerospace series — Acid pickling of aluminium and aluminium alloy without hexavalent chromium

EN 6072, Aerospace series — Metallic materials — Test methods — Constant amplitude fatigue testing

EN ISO 1463, Metallic and oxide coatings — Measurement of coating thickness — Microscopical method (ISO 1463)

EN ISO 2085, Anodizing of aluminium and its alloys — Check for continuity of thin anodic oxidation coatings — Copper sulfate test (ISO 2085)

EN ISO 2360, Non-conductive coatings on non-magnetic electrically conductive basis materials — Measurement of coating thickness — Amplitude-sensitive eddy-current method (ISO 2360)

EN ISO 2376, Anodizing of aluminium and its alloys — Determination of breakdown voltage and withstand voltage

EN ISO 2409, Paints and varnishes — Cross-cut test (ISO 2409)

EN ISO 2812-2, Paints and varnishes — Determination of resistance to liquids — Part 2: Water immersion method

EN ISO 9220, Metallic coatings — Measurement of coating thickness — Scanning electron microscope method (ISO 9220)

EN ISO 9227, Corrosion tests in artificial atmospheres — Salt spray tests (ISO 9227)

EN ISO 10289, Methods for corrosion testing of metallic and other inorganic coatings on metallic substrates - Rating of test specimens and manufactured articles subjected to corrosion tests

3 Terms and definitions

3.1 General terms

3.1.1

OEM

producer who has the design authority and manufactures products or components that are purchased by a company and retailed under that purchasing company's brand name

Note 1 to entry: the OEM can also apply the process.

3.1.2

manufacturer

company or person who makes, manufactures, assembles components

Note 1 to entry: the manufacturer can also apply the process.

3.1.3

processor

company or person who applies the process

3.1.4

process instruction

document that describes the application scopes, detailed process (key parameters, detailed steps, etc.), quality management, environmental and safety regulations, etc.

3.1.5

batch

unless otherwise specified, it comprises parts of the same type (i.e. shape, size, material), processed at the same time in the same bath

3.2 Technical terms

3.2.1

de-anodizing

process, which removes the anodic oxide

3.2.2

smut

precipitations of alloying elements (e.g. Cu, Fe, Zn, Si) on the surface of parts after a process step normally after alkaline etching step

3.2.3

Mechanically Disturbed Layer

MDL

layer that is present at the surface resulting from the rolling process of the material

3.2.4

pit

surface corrosion defect at which the anodic coating is penetrated and/or perforated

Note 1 to entry: Typical characteristics of corrosion pits are:

- rounded or irregular or elongated geometry,
- comet tail or line or halo that emerges from the cavity,
- some corrosion by-products inside pits (on aluminium the by-product may be granular, powdery or amorphous and white, grey or black in colour).

To be considered as a corrosion pit, a surface cavity shall exhibit at least two of the above characteristics.

Note 2 to entry: See Figure 1.

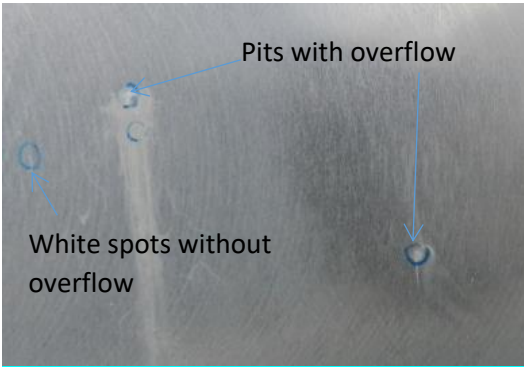
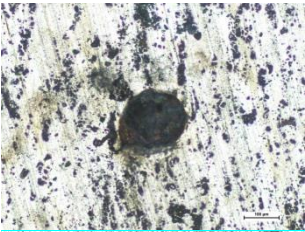
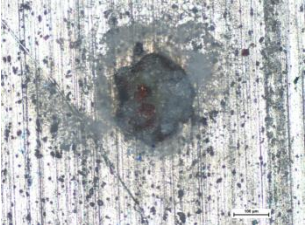
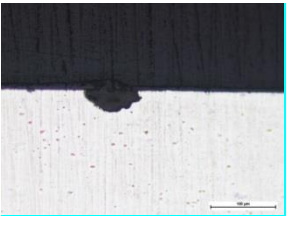
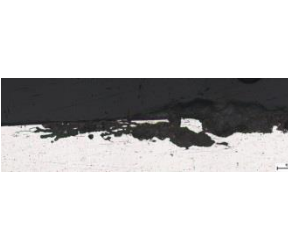
 Pits with overflow White spots without overflow	 	 
<i>Examples of corrosion pits on an aluminium alloy after exposure to neutral salt spray (NSS)</i>	<i>Examples of analysis of corrosion pits on machined 2024 T351 and laminated 2024 T3 that have been SAA treated</i>	

Figure 1 - Example of corrosion on an aluminium alloy after exposure to salt spray

3.2.5

re-anodizing

repetition of the anodizing process step after complete de-anodizing

3.2.6

sealing

chromate VI free sealing (of the anodized layers) is applied to close the pores produced by the acid anodizing process.

Note 1 to entry: It is usually applied in hot demineralized water bath with or without additives at different temperatures. Sealing improves the corrosion resistance performance of the anodic film.

4 General principles of the process

4.1 Purpose of the process

The anodizing is an electrochemical process voltage controlled allowing transforming the aluminium (and its alloys) surface in a nanoporous and amorphous oxide layer made of a structure close to alumina. The aim of this treatment is to ensure a protection against the corrosion, and/or to be used as an adhesion base before bonding or before painting. Anodizing is generally sealed for corrosion protection application (with or without painting or bonding) and can remain unsealed when the part is bonded or painted.

4.2 Applicability

4.2.1 Type A: unsealed anodizing

It shall be used either as surface preparation before the application of painting/bonding or any other finishing.

4.2.2 Type B: sealed anodizing

It is intended for corrosion protection. It shall be with or without dyeing and used with or without additional painting.

Table 1 – Different application cases

	Unsealed (type A)			Sealed (type B)	
	Unpainted	Painted	Bonding (structural)	Unpainted	Painted
Sulphuric acid anodizing (SAA) EN 2284	Not applicable	Applicable	Not applicable	Applicable	Applicable
Thin film sulphuric acid anodizing (TFSAA)					
Tartaric sulphuric acid anodizing (TSA) EN 4704					
Boric sulphuric acid anodizing (BSAA)					
Phosphoric acid anodizing (PAA)			Applicable	Not applicable	Not applicable
Sulphuric phosphoric acid anodizing (PSA)					

4.3 Limitations

All processes that can compromise the anodic film such as forming, or heat-treatment shall be performed prior to surface preparation of the parts to be anodized.

Anodizing shall not be applied:

- in electric conductivity zones/areas;
- for tubes, pipes and open holes with a length to diameter ratio higher than 10:1 (unless using specific cathode);
- for trapped holes with a length to a diameter ratio greater than 5:1;
- for parts or assemblies (e.g. spot-welded and riveted), which can permanently entrap treatment solutions;
- for components which can permanently entrap treatment solutions, except components that can be adequately masked.

NOTE The formation of oxide layer influences the dimensions of the part and is to be considered for close tolerance parts.

4.4 Classification

4.4.1 System types

Anodizing layer is classified by the two following types:

type A: unsealed anodizing: It shall be used as surface preparation before the application of painting/ bonding or any other finish;

type B: sealed anodizing: It is intended for corrosion protection. It shall be with or without dyeing and used with or without additional painting.

4.4.2 Layer thickness

See Table 2.

Table 2 – Layer thicknesses corresponding to the class type

Class type	Typical thickness	Anodizing process
Class 1	$\leq 1 \mu\text{m}$	Phosphoric acid anodizing (PAA) Sulphuric phosphoric acid anodizing (PSA) ^a
Class 2	$2 \mu\text{m}$ to $8 \mu\text{m}$ ^{b, c}	Tartaric sulphuric acid anodizing (TSA) Boric sulphuric acid anodizing (BSAA) Thin film sulphuric acid anodizing (TFSAA)
Class 3	$8 \mu\text{m}$ to $25 \mu\text{m}$	Sulphuric acid anodizing (SAA)
^a $\leq 5 \mu\text{m}$ for some aluminium alloys under agreement between the processor and the OEM/manufacturer. ^b For wrought alloys. ^c $12 \mu\text{m}$ maximum for castings.		

5 Process requirements

5.1 Information for the processor

type and class designation,
substrate standard reference and heat treatment,
areas to be anodized,
anodizing thickness measuring points,
electrical contact points or areas where these are inadmissible,
specification for testing on parts and/or test specimens.

5.3 Process conditions

5.3.1 Tooling

The tools, bars, electrical contact systems, and metal masking tooling shall be free of oxidation/corrosion or any other damage which may be detrimental to the treatment during use. The part racks and tools shall be designed and set up in such a manner as to:

— avoid any retention of air or treatment solution in the parts,

- facilitate neutralization and removal of solutions during rinsing operations,
- the electrical contacts shall be kept in good condition for the correct passage of the current,
- electrical contact points should be defined between the processor and the OEM/manufacturer,
- the contact is preferably achieved at several points in order to ensure better current distribution,
- avoid any accidental contact between the parts to be treated and the tank equipment or electrodes, and between the different parts during all the process,
- the fixturing tools (e.g. made of aluminium alloy or titanium) shall provide effective electrical contact with the parts.

5.3.2 Masking

The parts shall be at least degreased prior to masking.

Component areas which shall not be coated shall be masked with suitable material.

5.3.3 Surface pre-treatment

Surface preparation means any method able to eliminate completely all surface contaminations.

In case of chemical pre-treatment, the final step prior to anodizing shall be acidic pickling, preferably chromate-free.

Anodizing shall be performed immediately after pickling (in accordance with aluminium and aluminium alloys pickling standard EN 4707).

5.3.4 Anodizing

During the anodizing process:

- distance between electrode and part(s) and between parts shall be adopted to avoid damage of parts by short-circuits and electric arc discharge;
- parts should be fully immersed;
- the parts shall not be subjected to any tensile, flexure, torsion or other stress;
- the process shall be performed in such a way that parts remain wet between each step of the process;
- the anodizing parameters (temperature, voltage, time) shall be adapted to the material and to the chemical composition of the bath;
- in case of re-anodizing, the former protection will have to be totally removed before (chemically or mechanically) (see 5.5).

5.3.5 Anodizing post-treatments

After the anodizing procedure:

- parts have to be adequately rinsed with water according to 5.4.4;
- afterwards, the parts shall be either:
 - dried immediately afterwards and painted within 16 h; this time can be extended in accordance with the OEM/manufacture requirements. In this case, it is recommended to handle the parts after anodizing treatment with gloves.
 - dried immediately afterwards and bonded within 8 h; this time can be extended in accordance with the OEM/manufacture requirements. In this case, it is recommended to handle the parts after anodizing treatment with gloves.
 - sealed with chromate VI free solution to achieve the desired corrosion resistance of the anodic film.

5.4 Water quality

5.4.1 General

All water used for bath make-up and addition in the anodizing bath, for the final rinsing step as well as for the sealing process shall be demineralized.

5.4.2 Anodizing bath

The water shall comply with the following requirements:

- pH value at 25 °C: 5,0 to 8,0
- total residue [mg/l]: ≤ 5
- conductivity [$\mu\text{S}/\text{cm}$]: ≤ 20

5.4.3 Sealing and dyeing baths

The water shall comply with the following requirements:

- pH value at 25 °C: 5,0 to 8,0
- total residue [mg/l]: ≤ 5
- conductivity [$\mu\text{S}/\text{cm}$]: ≤ 20
- Silica content [mg/l]: ≤ 1

5.4.4 Final rinsing bath

The water shall comply with the following requirements:

- pH value at 25 °C: 5,0 to 8,0
- total residue [mg/l]: ≤ 5
- conductivity [$\mu\text{S}/\text{cm}$]: ≤ 20

5.5 Periodic bath chemical analysis

The baths composition shall be in the limits as specified in the processors detailed process instruction. The periodicity of the analysis shall be defined considering the ageing, contamination and the efficiency of the baths, the production rate and the re-adjustment or refilling of the baths.

5.6 Re-anodizing

Any re-anodizing shall be agreed between the processor and the OEM/manufacturer.

6 Test specimens requirements

6.1 Definition of test specimens

6.1.1 General

Unless otherwise stipulated by the OEM/manufacturer, the qualification authorises the treatment of all types of aluminium alloy.

6.1.2 For the qualification

See Table 3 for class 1: PAA, PSA.

See Table 4 for class 2: TFSAA, TSA, BSAA.

See Table 5 for class 3: SAA.

6.1.3 For periodic tests

See Table 6 for class 1: PAA, PSA.

See Table 7 for class 2: TFSAA, TSA, BSAA.

See Table 8 for class 3: SAA.