International Standard 8079

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Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, dyed coating

Procédés de traitement dans l'industrie aérospatiale — Traitement anodique des alliages d'aluminium — Traitement à l'acide sulfurique pour revêtement coloré

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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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Aerospace process — Anodic treatment of aluminium alloys — Sulfuric acid process, dyed coating

1 Scope and field of application

This International Standard specifies requirements for producing and testing a dyed anodic coating on aluminium alloys where the coating is not required to withstand prolonged exposure to weathering and direct sunlight. The anodic coating is produced by the sulfuric acid process.

The anodizing process is applied in the manufacture of aerospace products to improve resistance to corrosion, produce coloured surfaces for aesthetic reasons or to colour code parts for identification purposes.

2 References

ISO 2064, *Metallic and other non-organic coatings — Definitions and conventions concerning the measurement of thickness.*

ISO 2106, *Anodizing of aluminium and its alloys — Determination of mass per unit area (surface density) of anodic oxide coatings — Gravimetric method.*

ISO 2360, *Non-conductive coatings on non-magnetic basis metals — Measurement of coating thickness — Eddy current method.*

ISO 2859, *Sampling procedures and tables for inspection by attributes.*

ISO 3768, *Metallic coatings — Neutral salt spray test (NSS test).*

3 Technical requirements

3.1 Materials to be anodized

The alloys shall be of a chemical composition amenable to sulfuric acid anodizing.

The base metal shall be sufficiently free from surface defects caused by metalworking processes or handling, and free from grease, pitting, corrosion, heavy etching, etc. which will be detrimental to the application of anodized coatings capable of meeting all requirements of this International Standard.

3.2 Process requirements

The processes employed shall be such that they will consistently produce coatings to the requirements of this International Standard.

3.3 Process details

3.3.1 Electrolyte

The electrolyte shall be an aqueous solution of sulfuric acid, technical grade (ϱ 1,83) at a nominal concentration of 15 % (m/m) (allowable range: 150 to 200 g H_2SO_4 per litre). The maximum dissolved aluminium content in the electrolyte shall not exceed 15 g/l. The chloride content, measured as NaCl, shall not exceed 0,2 g NaCl per litre. The temperature of the bath shall be maintained at 21 ± 2 °C.

3.3.2 Dye

The colouring agent shall be such as to produce the required colour on all coatings produced to the requirements of this International Standard. After application, it shall maintain its colour without fading under all reasonable expected conditions of storage and service. Fading due to exposure to ionizing radiation shall not be considered as a reasonably expected condition of service.

3.3.3 Water quality

The quality of the water used shall be such that its initial conductivity does not exceed 1,000 µS/m. Total dissolved solids should not be greater than 12 ppm (sulfates, chlorides, etc.), including a maximum of 4 ppm SiO_2. The pH value shall be held between 5,5 and 6,9. Acetic acid or ammonia may be used to maintain the required pH level.

3.3.4 Sealer

This shall be an aqueous solution of nickel acetate or cobalt acetate at a concentration of 0,4 to 0,8 % (m/m) $(CH_3COO)_2Ni$ or $(CH_3COO)_2Co$ in hot water (3.3.3). The pH value shall be held between 5,5 and 5,8. When specified, a second sealer may be used, after the acetate sealing treatment, consisting of an aqueous solution of sodium dichromate or potassium dichromate at a concentration of 1 to 3 % (m/m) $Na_2Cr_2O_7 \cdot 2H_2O$ or $K_2Cr_2O_7 \cdot 2H_2O$. The pH value shall be held between 5,0 and 6,0. Adjustments in the pH value of both the acetate and dichromate solutions shall be made by the addition of acetic acid or sodium hydroxide, as required.

NOTE — The use of the second sealer (dichromate) can cause a colour change in the dye. When such a change is undesirable, the second sealing should be omitted.

3.3.5 Preparation for anodizing

All fabrication processes, insofar as is practicable, shall be completed before anodizing. Unless authorized by the purchaser, the anodic coating shall not be applied to assemblies where the electrolyte cannot be removed or is likely to be trapped in recesses or joints. Where authorized, suitable masking may be used to prevent the electrolyte entry.

3.3.5.1 Racking of parts

The racking and suspension of parts shall be by such means as to provide good electrical contact and current distribution and to permit free circulation of the liquid to all work areas. Small parts may be placed in perforated containers of suitable material which shall incorporate means for maintaining electrical current between the parts and the container and shall permit adequate circulation of the liquid within the container.

3.3.5.2 Cleaning

The cleaning method used shall produce a clean surface with no water breaks and free of pits and abrasion marks. Solvent degreasing and cleaning in a non-etching or inhibited alkaline cleaner may be used, followed by a cold water rinse. If the alkaline cleaner is silicated, the bath composition and the subsequent rinsing shall be controlled to prevent the formation of a siliceous residue on work surfaces, causing consequent interference with anodic film formation. If so desired, an etch-type alkaline cleaner may be used to remove metal from as-extruded or as-forged surfaces at an etching rate of 0,015 to 0,025 mm/min. Such an alkaline cleaner shall not cause an intergranular attack or alter dimensions beyond defined limits.

3.3.5.3 Deoxidizing

After cleaning, parts shall be immersed in a deoxidant, followed by a cold deionized water rinse, to remove natural oxides and provide a slightly etched surface. The deoxidant used shall not degrade metallurgical properties, including fatigue behaviour, initiate pitting, alter dimensions, or increase roughness beyond defined limits.

3.3.6 Anodizing procedure

The cleaned parts shall be made the anode in the sulfuric acid electrolyte, contained in a suitable tank. The cathode in the electrical circuit may be stainless steel plates, or the tank itself, if made from metal resistant to the electrolyte, or lead lined. Depending on the alloy being anodized, a voltage of between 16 to 22 V shall be applied for 25 to 50 min to produce an anode current density of 110 to 160 A/m^2. During the anodizing, means for agitating the electrolyte should be provided. After anodizing, the parts shall be rinsed in cold, running water, the quality of which is specified in 3.3.3.

3.3.7 Dyeing

Parts shall be dyed to the specified colour by immersing in the appropriate dye solution. The temperature of the bath and the immersion time shall be sufficient to produce the specified colour. The bath shall be agitated during the immersion period so as to inhibit the segregation and settling of dye particles.

After removal from the dye solution, the parts shall be thoroughly rinsed in cold, running water for not longer than 5 min.

3.3.8 Sealing

The parts shall be immersed in each sealer bath for 10 to 15 min at a bath temperature of 97 ± 2 °C. After the final sealing, parts shall be thoroughly rinsed in clean, cold, running water, then in clean, hot water, and dried.

3.3.9 Temperature control

The temperature control equipment for control of solution temperatures shall maintain the temperature at ± 2 °C of the control set point.

4 Quality assurance provisions

4.1 Responsibility for inspection

Unless otherwise negotiated, the processor is responsible for the performance of all quality assurance requirements of this International Standard.

4.2 Definition

For the purpose of this International Standard, the following definition applies.

lot: All parts treated in the same bath at the same time.

4.3 Lot acceptance tests

Tests for a production lot of parts to determine conformance to the requirements for visual examination, mass per unit area of the coating, and/or thickness of coating (as specified by the purchaser), and effectiveness of sealing (colorant stain test) shall be classed as lot acceptance tests.

4.4 Process qualification tests

Process qualification tests shall consist of the lot acceptance tests specified in 4.3, together with tests to determine corrosion resistance of finished (unpainted) parts.

4.5 Sampling procedures

4.5.1 Visual examination in accordance with 4.7.1 shall be applied to all parts.

4.5.2 Tests for thickness of coating (specified in 4.7.4) and effectiveness of sealing (specified in 4.7.2), in the case of small parts, i.e. bolts, washers, etc., shall be determined by selecting at random (rivets excepted), in accordance with single sampling plan table 2A) inspection level S-3 and acceptance quality level (AQL) of 1,5 (see ISO 2859). For larger parts, a minimum of one part per anodizing lot is adequate for the purpose.

4.5.3 The mass per unit area of the coating shall be determined in accordance with ISO 2106 for 10 % of the lots processed to the requirements specified in 4.7.3. If parts are of such size and shape that the surface area cannot be determined readily, mass per unit area determinations shall be made on three separate coupons of the same material in the same heat treatment state and with the same surface finish. These separate coupons shall be processed with the work they represent. These coupons shall be not less than 75 mm × 75 mm in length and width and from 0,6 to 1,6 mm in thickness.

4.5.4 Corrosion resistance shall be determined in accordance with ISO 3768 on three representative parts or separate panels, as described in 4.7.5. This test shall be performed on a monthly basis for the purpose of process control verification.

4.6 Solution control

4.6.1 Anodizing bath

The composition of the anodizing bath shall be controlled by chemical analysis, performed at least once a week during weeks when the bath is in use.

4.6.2 Sealing baths

The sealing baths shall be checked for conductivity, pH value and for acetate or dichromate content, as appropriate. These tests should be performed weekly or at a frequency to ensure 3.3.4 is met.

4.7 Inspection and testing of coatings

4.7.1 Visual examination

Anodic coatings shall be smooth, continuous, adherent, and of the specified colour. They shall be free from burn marks, powdery areas, loose films and, except at contact points, discontinuities, such as breaks and scratches. All similar parts in a lot shall be uniform in appearance but slight variations that are not related to unsatisfactory processing shall be considered acceptable. There shall be no visible damage or imperfections detrimental to the parts.

4.7.2 Effectiveness of sealing

This property is measured by the coating's loss of absorptive power when subjected to the anthraquinone violet drop test (colorant stain test). This test is applicable to all dye colours except black and dark shades of blue, purple, etc. The test is based on the observation that an unsealed or improperly sealed coating is easily and permanently coloured by a few drops of colorant, while a well sealed coating rejects the dye. The surface of the anodized specimen is degreased, after which a few drops of 1 % (m/m) anthraquinone violet in an ethanol or isopropyl alcohol solution are deposited on an area of about 1 cm^2 of the specimen. The solution is left to act for 5 min. The surface is then cleaned by rubbing with a cotton swab under running water for 2 min. It is then washed in a neutral soap solution, rinsed thoroughly and dried. There shall be no residual indelible stain following the test.

4.7.3 Mass per unit area of coating

The mass per unit area of coating for dyed, sulfuric acid anodized parts shall be not less than 15 g/m^2 for wrought alloys and casting alloys with a copper content of 1 % (m/m) and greater. For other wrought and casting alloys, mass per unit area shall not be less than 27 g/m^2. The mass per unit area of the coating shall be determined in accordance with ISO 2106 on parts which have been anodized and sealed.

4.7.4 Thickness of coating

The minimum local thickness of the coating, as defined in ISO 2064, shall be determined by the eddy current method (see ISO 2360) and shall be 10 µm for alloys with a copper content greater than or equal to 1 % (m/m) and 20 µm for alloys with a copper content less than 1 % (m/m).

4.7.5 Corrosion resistance

Non-clad aluminium alloy sheet test panels of nominal composition 4,5 % (m/m) copper, 1,5 % (m/m) magnesium and 0,6 % (m/m) manganese (for example 2024 or equivalent), and at least 200 cm^2 in area, processed in accordance with this International Standard, shall withstand exposure to salt spray (see ISO 3768) for 500 h without showing corrosion spots or pits, except in those areas within 1,5 mm of identification markings and at electrode marks remaining after processing.

4.8 Approval

4.8.1 Sample coated parts and panels shall be approved by the purchaser and, if necessary by the quality assurance authority responsible, before production parts are supplied, unless such approval be waived.

4.8.2 Complete documentation of all quality control procedures and tests shall be made available to the purchaser upon request.

4.8.3 The processor shall use manufacturing procedures, processes and methods of inspection on production parts which are the same as those used on the approved sample parts. No deviation from the procedures shall be permitted without reapproval by the purchaser.

5 Packaging and delivery

5.1 Packaging

Anodized parts shall be packaged in such a manner as to ensure that the parts will be protected during shipment and storage against damage due to mishandling, exposure to the weather, or any normal hazard.

5.2 Delivery

Anodized parts shall be prepared for shipment and delivery in accordance with good standard practice prevailing in the industry to ensure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

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