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400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

**SAE**

AMS 2472D

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Superseding AMS 2472C

## (R) ANODIC TREATMENT OF ALUMINUM ALLOYS Sulfuric Acid Process, Dyed Coating

### 1. SCOPE:

#### 1.1 Purpose:

This specification establishes the engineering requirements for producing dyed anodic coatings on aluminum alloys and the properties of such coatings.

#### 1.2 Application:

This process has been used typically to increase corrosion resistance and to produce colored surfaces on aluminum alloy parts, but usage is not limited to such applications.

- 1.2.1 AMS 2470 or AMS 2471 should be specified for coatings to be used as a base for paint or other organic finishes. This process is not suitable for parts which contain joints or recesses in which the anodizing solutions may be retained.

#### 1.3 Classification: This specification covers two types of coating classified as follows:

- Class 1 Coatings for Identification
- Class 2 Coatings for Decorative Purposes

#### 1.4 Safety - Hazardous Materials:

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

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2. APPLICABLE DOCUMENTS:

The following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

- AMS 2470 Anodic Treatment of Aluminum Alloys, Chromic Acid Process
- AMS 2471 Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Undyed Coating
- AMS 2473 Chemical Film Treatment for Aluminum Alloys, General Purpose Coating
- AMS 4037 Aluminum Alloy, Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn, (2024; -T3 Flat Sheet, -T351 Plate), Solution Heat Treated

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

- ASTM B 117 Salt Spray (Fog) Testing
- ASTM B 137 Measurement of Mass of Coating on Anodically Coated Aluminum

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

- MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Solutions:

- 3.1.1 Electrolyte: Shall be an aqueous solution of sulfuric acid of suitable concentration maintained within  $\pm 2$  °F ( $\pm 1$  °C) of the temperature approved in 4.4.2.
  - 3.1.1.1 The nominal concentration of the electrolyte should be 15 to 20% by weight. The temperature should be selected from within the range 64 to 85 °F (18 to 29 °C).
- 3.1.2 Dye: Shall be as required to produce the specified color.
- 3.1.3 Sealer: Sealer should be an aqueous solution of nickel acetate or cobalt acetate.
  - 3.1.3.1 The acetate sealer shall be maintained at a pH of 5.5 to 6.0 and at a temperature of 190 to 212 °F (88 to 100 °C). Adjustments to the pH should be made by addition of acetic acid or sodium hydroxide.

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### 3.2 Procedure:

- 3.2.1 Preparation: All fabrication-type operations such as forming, shot peening, brazing, welding, perforating, machining, and heat treatment, shall be completed before parts are anodized.
- 3.2.2 Cleaning and Deoxidation: Parts shall have clean surfaces, free from water break, prior to immersion in the anodizing solution. Etching to achieve metal removal is required for cast surfaces.
- 3.2.2.1 Cleaning materials or products used for surface preparation containing iron, such as steel wool, iron oxide rouge, or steel wire, which may become embedded in the metal and accelerate subsequent corrosion, are prohibited.
- 3.2.3 Tight electrical contact shall be maintained during the anodic treatment to prevent contact arcing (burning) of parts, but small irregularities of coating at points of electrical contact are acceptable.
- 3.2.4 Coating: The cleaned parts shall be made the anode(s) in the electrolyte contained in a chemical-resistant tank which may also serve as the cathode. The processing shall be adjusted to obtain the required weight and quality of the coatings. The anodizing current shall be maintained within  $\pm 2$  amperes per square foot ( $\pm 21.5 \text{ A/m}^2$ ) of the nominal value. Alternatively, the anodizing current shall be ramped up over a five minute, or other preselected period, to the desired final voltage and maintained until the anodic coating reaches the desired thickness. After anodizing, parts shall be rinsed thoroughly in water at ambient temperature.
- 3.2.5 Dyeing: Prior to sealing, parts shall be dyed to the specified color by immersing in a appropriate dye solution. The temperature of the solution and the time of immersion shall be as necessary to produce the specified color. Either the parts or the solution shall be agitated during immersion. Parts shall then be rinsed in clean water at ambient temperature.
- 3.2.6 Sealing: Parts shall be immersed in the acetate sealer solution for a suitable time (See 8.2.8). After sealing, the parts shall be thoroughly rinsed in clean water at ambient temperature, rinsed in clean hot water, and dried.
- 3.2.7 Masking: Areas where anodizing is prohibited shall be masked.

### 3.3 Properties:

Coated parts shall conform to the following requirements:

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3.3.1 Coating Weight: The coating weight (See 4.3.2.1), determined in accordance with ASTM B 137, shall be not less than 600 mg/square foot ( $6.5 \text{ g/m}^2$ ) when AMS 2472, Class 1, is specified, and not less than 2500 mg/square foot ( $27 \text{ g/m}^2$ ) when AMS 2472, Class 2, is specified, except for wrought aluminum alloys of the 2000 series where copper is the major alloying element, and for aluminum casting alloys with a nominal copper content of 1% or higher, the coating weight when AMS 2472, Class 2, is specified shall be not less than 1400 mg/square foot ( $15 \text{ g/m}^2$ ).

3.3.1.1 If small parts, such as rivets or machine screws, are anodized in bulk in a container, the specified coating weight shall apply to not less than 75% of the parts treated together, determined by random sampling, but in no case shall any part show uncoated areas.

3.3.2 Corrosion Resistance: Panels (See 4.3.2.2) shall meet the following requirements, determined after exposure for not less than 336 hours to salt spray corrosion test in accordance with ASTM B 117, except that significant surface shall be inclined 6 degrees from vertical. Areas within 1/16 inch (1.6 mm) of identification markings or of an edge or at electrode contact marks shall not be included.

Fifteen scattered spots or pits, none larger than 1/32 inch (0.8 mm) diameter, on a total of 150 square inches ( $968 \text{ cm}^2$ ) of test area from five or more test pieces.

Five scattered spots or pits, none larger than 1/32 inch (0.8 mm) diameter, on any 30 square inches ( $194 \text{ cm}^2$ ) of test area from one or more test pieces.

### 3.4 Touch Up:

Parts on which the anodic coating has been scratched or damaged superficially may be coated using AMS 2473 or other method acceptable to the cognizant engineering organization. Touch-up, unless otherwise specified, shall not exceed 0.5 inch (13 mm) in its longest dimension, except that scratches that are essentially one dimensional (less than 0.03 inch (0.8 mm) wide) may be reworked. The total reworked area shall not exceed 5% of the total surface area.

### 3.5 Quality:

Anodic coating, as received by purchaser, shall be continuous, smooth, adherent, and uniform in appearance, and shall be free from powdery areas, loose films, discontinuities such as breaks or scratches (except at contact points), or other damage or imperfections detrimental to usage of the coating. Slight variations in color between cast and machined surfaces, between welds and adjacent areas, due to grain size or grain flow variations, or due to variation in alloy composition from lot to lot, are acceptable.

#### 4. QUALITY ASSURANCE PROVISIONS:

##### 4.1 Responsibility for Inspection:

The coating processor shall supply all samples for processor's tests and shall be responsible for performing all required tests. Parts, if required for tests, shall be supplied by purchaser. Processor may utilize his own or any other inspection facilities and services acceptable to purchaser. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

##### 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Quality and color (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Coating weight (3.3.1), corrosion resistance (3.3.2), and tests of cleaning and processing solutions to ensure that the anodic coating will conform to specified requirements are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of processed parts to a purchaser, when a change in material and/or processing requires approval by the cognizant engineering organization (See 4.4.2), and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, contracting officer, or request for procurement.

##### 4.3 Sampling and Testing:

Shall be not less than the following: a lot shall be all parts of the same part number, processed in a continuous series of operations (3.2.4 to 3.2.6, inclusive) in not longer than 24 consecutive hours, and presented for processor's inspection at one time.

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4.3.1 For Acceptance Tests: Shall be as shown in Table 1.

TABLE 1 - Sampling for Acceptance Testing

Number of Parts		Quality
In Lot		
Up to	7	All
8 to	15	7
16 to	40	10
41 to	110	15
111 to	300	25
301 to	500	35
Over	500	50

4.3.2 For Periodic and Preproduction Tests: Sample quantity and frequency shall be selected at the discretion of the processor, unless otherwise specified, except for corrosion testing, which shall be carried out at a frequency not less than monthly.

4.3.2.1 Coating Weight: Shall be determined on representative parts when size and shape permit accurate determination of surface area. If parts are of such size and shape that surface area cannot be determined readily, coating weight determinations shall be made on separate test panels 0.025 to 0.063 inch (0.64 to 1.60 mm) thick and not less than 3 inches (76 mm) square fabricated from AMS 4037 aluminum alloy.

4.3.2.1.1 Separate test panels, if used, shall be processed with the work they represent.

4.3.2.2 Corrosion Resistance: Shall be determined on separate test panels 0.025 to 0.63 inch (0.64 to 1.60 mm) thick and not less than 3 x 10 inches (76 x 254 mm) in width and length fabricated from AMS 4037 aluminum alloy.

4.4 Approval:

4.4.1 Processes, control factors, or preproduction sample part or test panel, or any combination thereof specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 Processor shall make no significant change to materials, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the parts.

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4.4.3 Control factors for anodizing shall include, but not be limited to, the following:

Cleaning procedure, including the compositions and temperatures of the baths used  
Deoxidation process  
Anodizing bath composition including impurity limits, temperature, and agitation method  
Rate of voltage rise, anodizing voltage, and time of anodizing  
Sealing solution composition including impurity limits, temperature, and pH  
Dye solution composition and temperature  
Purity of water used for sealing and rinsing  
Periodic test plan

4.5 Reports:

The processing vendor of coated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2472D, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If results of any acceptance test fail to meet specified test requirements, the parts in that lot may be stripped by a method acceptable to purchaser that does not roughen or pit the basis metal or adversely affect dimensional tolerances, pretreated, coated, post treated as defined herein, and tested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped by a method acceptable to purchaser that does not roughen or pit the basis metal or adversely affect dimensional tolerances, pretreated, coated, post treated as defined herein, and tested.

4.6.2 If results of any periodic test fail to meet specified test requirements, the process is nonconforming. No additional parts shall be plated until the process is corrected and new specimens are coated and tested. Results of all tests shall be recorded and, when requested, reported. Purchaser shall be notified of all parts coated since the last acceptable test.

5. PREPARATION FOR DELIVERY:

5.1 Coated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the coating are preserved.

5.2 Packages of coated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

5.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Level C, unless Level A is specified in the request for procurement.