SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

AMS 2470M

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Superseding AMS 2470L

Anodic Treatment of Aluminum Alloys
Chromic Acid Process

RATIONALE

This specification revision was issued as part of the SAE Five Year Review process.

ORDERING INFORMATION: The following information shall be provided to the processor by the purchaser.

1) Purchase order shall specify not less than the following:
   - AMS 2470M
   - Basis metal to be anodized
   - Required color, if dyed
   - Special features, geometry or processing present on parts that requires special attention by the processor
   - Quantity of pieces to be anodized

2) Parts manufacturing operations such as heat treating, forming, joining and media finishing can affect the condition of the substrate and adversely affect the finished part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

1. SCOPE

1.1 Purpose

This specification establishes the requirements for anodic coatings on aluminum alloys.

1.2 Application

This process has been used typically to increase corrosion resistance and to provide surfaces which will promote adherence of paint and other organic finishes, and has been found useful for assemblies which have faying surfaces and/or which may trap electrolyte, but usage is not limited to such applications.

1.2.1 This process is primarily applicable to aluminum and aluminum alloy parts which have nominal copper content not greater than 5% by weight or total nominal alloy content not greater than 7.5% by weight, AMS 2471 being recommended for parts having higher alloy content. Coating may be dyed if specified, but AMS 2472 is recommended where a colored finish is required.

1.3 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 measure to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS 2471	Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Undyed Coating
AMS 2472	Anodic Treatment of Aluminum Alloys, Sulfuric Acid Process, Dyed 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 International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 137	Measurement of Mass of Coating on Anodically Coated Aluminum
ASTM D 1193	Reagent Water
ASTM D 3762	Adhesive Bonded Surface Durability of Aluminum (Wedge Test)

3. TECHNICAL REQUIREMENTS

3.1 Solutions

3.1.1 Electrolyte

The electrolyte shall be an aqueous chromic acid solution. Use of surfactants and anti-misting additives shall be approved by the cognizant engineering organization. If surfactants have been approved for use and if anodized parts are to be subsequently adhesively bonded, purchaser shall notify processor of the need to perform the adhesive bond verification test of 3.4.3.

3.1.2 Dye, when used, shall be as required to produce the specified color.

3.1.3 Sealer

Unless otherwise permitted, the sealer shall be water of suitable purity and controlled pH maintained at a suitable temperature (See 8.2.10 - 8.2.12).

3.2 Preparation

3.2.1 Cleaning and Deoxidation

Parts shall have clean surfaces, free from water break, prior to immersion in the anodizing bath.

3.2.1.1 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.

3.2.2 Masking

Areas where anodizing is prohibited shall be masked.

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. For parts which are to be anodized all over, contact locations shall be acceptable to purchaser. For parts which are not to be anodized all over, locations shall be in areas on which anodize is not required.

3.3 Procedure:

3.3.1 Anodizing

The cleaned parts shall be made the anode(s) in the electrolyte contained in a suitable 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 rate of increase of the voltage shall be maintained within a range of two volts per minute of the nominal value, and the anodizing voltage shall be maintained within two volts of the nominal value. After anodizing, parts shall be rinsed thoroughly in water at ambient temperature and sealed (See 3.3.3) unless dyeing (See 3.3.2) or other treatment is specified.

3.3.2 Dyeing

Parts shall be dyed, when specified, to the color required by immersing in an appropriate dye solution. The anodic coating shall not be allowed to dry before dyeing. 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.

3.3.3 Sealing

Parts shall be immersed in the sealant solution for a suitable time and temperature (See 8.2.11 and 8.2.12), then rinsed. The rinse shall be thorough, but slight staining resulting from the sealant solution is acceptable. Rinsing is not required if reagent water (ASTM D 1193 Type IV) is used for sealing.

3.4 Properties

Coated parts shall conform to the following requirements:

3.4.1 Coating Weight

The coating weight (See 4.3.2.1), determined in accordance with ASTM B 137, shall be not less than 200 mg/square foot (2 g/m^2) on parts which are not to be dyed, and not less than 500 mg/square foot (5 g/m^2) on parts which are to be dyed.

3.4.1.1 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.

3.4.2 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 the significant surface shall be inclined 6 degrees from the 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 from incipient corrosion or pits, none larger than 1/32 inch (0.8 mm) diameter, on a total of 150 square inches (968 cm^2) of test area from five or more test pieces. Five scattered spots from incipient corrosion or pits, none larger than 1/32 inch (0.8 mm) diameter, on any 30 square inches (194 cm^2) of test area from one or more test pieces.

3.4.2.1 Panels which are acceptable to the criteria of 3.4.2 but which exhibit patchy dark gray areas (spots, streaks, or marks) with a white chalky film on the surface shall be examined at 10X magnification. Pits, if discovered, shall be added to those found with the unaided eye and the acceptance criteria reapplied.

3.4.3 Adhesive Bond Verification Test

When an anti-misting agent or surfactant is used as in 3.1.1, the effect of such agents on adhesive bond strength shall be determined in accordance with ASTM D 3762, using panels primed and adhesively bonded with materials and procedures acceptable to purchaser. Test panels shall be conditioned by exposure to 100% RH at a temperature of 100 °F ± 5 (49 °C ± 3) for 60 minutes, minimum. Crack growth in excess of 0.25 inch (6.4 mm) or any evidence of adhesion failure at the anodize/primer interface shall be cause for failure.

3.5 Touch Up

Parts on which the anodic coating has been scratched or damaged superficially may be coated using AMS 2473 or another method acceptable to the cognizant engineering organization. Touch-up, unless otherwise specified, shall not exceed 0.5 inches (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.

3.6 Quality

3.6.1 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 discoloration from dripping, bleedout or rundown of the anodize or sealing solution from joints and recesses shall be acceptable

3.6.2 Parts sealed in sodium dichromate solution may have a characteristic yellow color, and those sealed in nickel acetate solution may have a characteristic gray-green color. 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 processor shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. Parts, if required for tests, shall be supplied by 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 (3.6) and color (3.3.2), if specified, are acceptance tests and shall be performed on parts, or samples representing parts when permitted, from each lot.

4.2.2 Periodic Tests

Coating weight (3.4.1), corrosion resistance (3.4.2), adhesive bond verification (3.4.3) when required by purchaser, and tests of cleaning and processing solutions to ensure that the anodic coating will conform to the specified requirements are periodic tests. Coating weight and adhesive bond verification shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser. Corrosion testing shall be performed not less than monthly.

4.2.3 Preproduction Tests

All property verification tests (section 3.4) are preproduction tests and shall be performed prior to or on the initial shipment of processed parts to a purchaser and when the purchaser deems confirmatory testing to be required.

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 (3.3.1 to 3.3.3, inclusive), in not longer than 24 consecutive hours, and presented for the processor's inspection at one time.

4.3.1 Acceptance and Preproduction Tests: Test samples shall be randomly selected from the lot. The minimum number of samples shall be as shown in Table 1, and as follows. For preproduction tests for coating weight and corrosion resistance, sample quantity shall be selected by the processor unless quantity is specified by purchaser.

4.3.1.1 Adhesive bond verification tests (3.3.3) shall be determined on three samples fabricated from AMS 4037 aluminum alloy, using dimensions in ASTM D 3762.

TABLE 1 - SAMPLING FOR ACCEPTANCE TESTS

Number of Parts In Lot	Quality and Color
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 Periodic Tests

Sample quantity shall be selected at the discretion of the processor, unless otherwise specified.

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 0.063 inch (0.64 to 1.60 mm) thick and not less than 3 × 10 inches (76 × 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 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the purchaser for process reapproval, 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.

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
Anti-misting agents and surfactants, composition and concentration, if used
Rate of voltage rise, anodizing voltage, and time of anodizing
Sealing solution composition (including impurity limits), temperature, and pH
Touch up method, if used
Purity of water used for sealing and rinsing
Periodic test plan (See 8.4)

4.5 Reports

The processor 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 identification, AMS 2470M, part number, and quantity.

4.6 Resampling and Retesting

4.6.1 If any acceptance test fails to meet specified requirements, the parts in that lot may be stripped, 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, pretreated, coated, post treated as defined herein, and retested. After stripping and reanodizing, parts shall meet the dimensions on the drawing.

4.6.1.1 When stripping is performed, the method shall be acceptable to the purchaser and shall not roughen, pit, or embrittle the basis metal or adversely affect part dimensions. When parts have been stripped and reanodized, the purchaser shall be informed.

4.6.2 If any periodic test fails to meet specified requirements, the process is nonconforming. No additional parts shall be coated 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.

6. ACKNOWLEDGMENT

The processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts on which the coating does not conform to this specification, or to modifications authorized by purchaser, will be subject to rejection.