SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS2476 | REV. C

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Superseding AMS2476B

Electrolytic Treatment for Magnesium Alloys Alkaline Type, Full Coat

RATIONALE

AMS2476C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Purpose:

This specification establishes the engineering requirements for producing anodic coatings on magnesium and magnesium alloys, from an alkaline electrolyte, and the properties of those coatings.

1.2 Application:

This coating has been used typically to increase corrosion and abrasion resistance and to provide surfaces which will improve paint adhesion, but usage is not limited to such applications.

1.2.1 The process is applicable to all cast and wrought magnesium alloys, after proper allowances are made for dimensional changes intrinsic to the process, but should not be employed on parts which are subject to flexure.

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 measures 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2476C

2.1 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 244	Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments
ASTM B 487	Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

3. TECHNICAL REQUIREMENTS:

3.1 Solutions:

3.1.1 Electrolyte: Shall be an aqueous solution of the composition shown in Table 1. Variations in solution composition may be used provided the coating meets the requirements of 3.4.

TABLE 1 - Coating Electrolyte Composition

Ingredients	Ounces/Gallon	Grams/Liter
Potassium Hydroxide	16.0 to 24.0	120 to 180
Aluminum Hydroxide (dried gel) $Al(OH)_3$	4.0 to 5.0	30 to 37
Potassium Fluoride	4.0 to 5.0	30 to 37
Trisodium Phosphate	4.0 to 5.0	30 to 37
Potassium Permanganate	2.0 to 3.0	15 to 22

3.1.1.1 The solution temperature shall be maintained at a 70 to 86 °F (21 to 30 °C).

3.1.2 The post treatment solution shall be as shown in Table 2.

TABLE 2 - Post Treatment Solution Composition

Ingredients	Ounces/Gallon	Grams/Liter
Sodium Dichromate	2.5 to 3.0	19 to 22
Ammonium Bifluoride	13.0 to 13.5	97 to 101

3.1.2.1 The solution shall be used at room temperature.

3.2 Preparation:

Prior to coating, parts shall be cleaned in a suitable alkaline solution to provide a water-break-free surface. Cathodic, direct current may be used to reduce cleaning time. Following cleaning, parts shall be rinsed in cold flowing water.

3.3 Procedure (See 8.2):

3.3.1 Parts shall be firmly attached to the racks. Contact areas shall be kept to minimum size and, when practical, shall be on surfaces not required to be coated. When parts are to be coated all over, electrical contact shall be on areas indicated on the drawing.

3.3.2 Parts shall be distributed equally on the electrodes so that surface area of each group is approximately the same.

3.3.3 Parts shall be hung to minimize trapped gas or air.

3.3.4 Alternating current shall be applied and voltage raised manually or automatically to maintain a current density of 15 to 30 amperes/square foot (161 to 323 A/m^2), based on total area exposed immersed metal. Completion of coating is indicated by a minimum of 85 volts across the work and a uniform brown color free from definite light areas on the parts when examined wet after a water rinse.

3.3.5 Immediately following coating and rinsing, the parts shall be immersed in the solution shown in Table 2, held for 40 to 50 seconds, drained, and dried without rinsing.

3.3.6 Parts which have been coated and post treated shall be aged for four to six hours at 175 °F ± 10 (79 °C ± 6) and 85% ± 5 relative humidity. Moisture condensation on the parts shall be avoided.

3.4 Properties:

Coated parts shall conform to the following requirements:

3.4.1 Thickness: Dimensional increase resultant from coating shall be 0.0013 to 0.0017 inches (33 to 43 µm), determined in accordance with 4.4.1.

3.4.2 Coating Weight: If the dimensional change as a result of anodic coating cannot be determined accurately because of irregular shape of parts, determination of coating weight may be used as an alternative for dimensional change requirement. Coating weight shall be 5.2 to 6.8 grams/square foot (56 to 73 grams/m^2), determined in accordance with 4.4.2.

3.4.3 Abrasion Resistance: Specimens, tested in accordance with 4.4.3, shall not exhibit scratches which penetrate to the basis metal.

3.5 Quality:

Coating, as received by purchaser, shall be continuous, smooth, adherent, and uniform in appearance, and shall be free from powdery areas, loose film, discontinuities such as breaks or scratches, except at contact points, or other damage or imperfections detrimental to usage of the coating.

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. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.4.1) or coating weight (3.4.2) and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Abrasion resistance (3.4.3) and tests of cleaning and processing solutions (See 8.4) to ensure that the 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 reapproval by the cognizant engineering organization (See 4.5.2), and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be as follows; a lot shall be all parts of the same part number, processed in the same solutions in not longer than eight consecutive hours and presented for processor's inspection at one time:

4.3.1 For Acceptance Tests: As shown in Table 3.

TABLE 3 - Sampling for Acceptance Testing

Number of Parts in Lot	Quality	Thickness or Coating Weight
Up to 7	All	3
8 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
Over 500	50	8

4.3.2 For Periodic Tests: Sample quantity and frequency shall be selected at the discretion of the processor, unless otherwise specified.

4.4 Test Methods:

Tests shall be performed on actual parts, whenever possible. Nondestructive test methods shall be selected wherever practical and where permitted by the specification. When destructive tests are required and coated parts are of a configuration or value as to be impossible, impractical, or uneconomical to test, separate specimens cleaned, coated, and post treated with the parts represented may be used. Specimen composition shall be generically similar to that of the parts represented. Specimens for determination of coating weight (3.4.2) shall have a total surface area of not less than 24 square inches (156 cm^2).

4.4.1 Coating Thickness: Shall be determined on parts or representative specimens by direct micrometer measurement or in accordance with ASTM B 244, ASTM B 487, or other method acceptable to purchaser. Micrometer measurements shall be calibrated against microscopic measurements on specimens of the same alloy processed to the same nominal coating thickness as the parts. Micrometers shall have an accuracy of 0.0001 inch (2.5 µm). If specimens are used, they shall be uniformly distributed throughout the lot and processed with the parts they represent.

4.4.1.1 When the direct micrometer method is used to determine coating thickness, it is necessary to divide the dimensional increase by two, if both sides of the part or specimen are coated, and multiply the resultant number by 1.3 to establish the true coating thickness. The correction is necessary because the coating process not only removes basis metal but also deposits an anodic film.

4.4.2 Coating Weight: Parts or specimens shall be weighed and the value recorded (W_1). Immerse the specimens in an aqueous solution containing 300 grams/liter, chemically pure, sulphate-free chromic acid, heated to 120 °F ± 5 (49 °C ± 3), and hold for ten minutes. During the stripping operation, maintain a strip of commercially pure aluminum in the bath to minimize the loss of magnesium metal. Prevent contact between the aluminum strip and the magnesium specimen. Remove the specimen from the strip solution, rinse, thoroughly dry, and reweigh (W_2). Repeat the stripping operation using a five minute immersion period, rinsing, drying, and weighing each time the specimen is removed from stripping solution. Stripping is considered complete when the weight difference between subsequent weighings is not more than 1.0 milligram per square inch (0.155 mg/cm^2). Calculate the coating weight using Equation 1.

$$\text{grams/square foot} = \frac{W_1 - W_2}{A} \qquad \text{(Eq. 1)}$$

where:

W_1 = Initial weight of coated specimen
W_2 = Weight of stripped specimen
A = Total area of specimen

4.4.3 Abrasion Resistance: Place an anodized panel on a flat surface and wet the exposed surface. Using a 3/16 inch (4.8 mm) diameter, fire polished pyrex glass rod, rub the surface of the specimen using a one inch (25 mm) reciprocal motion, applying enough pressure on the glass rod to cause abrasion of the fire polished surface of the rod. When the glass rod exhibits an abraded surface, examine the surface of the specimen. The surface of the specimen shall not show evidence of scratches which penetrate to the basis metal.

4.5 Approval:

4.5.1 The process control procedures, a preproduction sample, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.5.2 Processor of coated parts shall make no significant change in bath, 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 effect the properties or performance of the coating.

4.5.3 Control factors shall include, but not be limited to, the following:

Surface preparation and cleaning procedures
Coating bath composition limits
Racking setup
Temperature limits of coating bath
Current/voltage limits and controls
Post treatment time and temperature
Coating thickness measurement method
Periodic test plan.

4.6 Reports:

The processing vendor shall furnish with each shipment a report stating that the parts have been processed in accordance with specified requirements and that they conform to the technical requirements. This report shall include the purchase order number, lot number, AMS 2476C, part number, and quantity.

4.7 Resampling and Retesting:

4.7.1 If any lot acceptance test fails to meet specified requirements, parts in that lot may be stripped by a method acceptable to purchaser that does not roughen, pit or embrittle the basis metal or adversely affect part dimensions, 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 pit, roughen, embrittle the basis metal, or adversely affect the part dimensions, pretreated, coated, post-treated as defined herein, and tested. After any stripping and recoating, parts shall meet the dimensional requirements of the drawing.

4.7.2 If any periodic test fails to meet specified requirements, the process is nonconforming. No additional parts shall be processed until the process is corrected and new specimens are coated and retested. Purchasers 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 required physical characteristics and properties of the coating are preserved.