AEROSPACE MATERIAL SPECIFICATION

AMS2476™	REV. D

Issued 1957-09
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Revised 2022-11

Superseding AMS2476C

Electrolytic Treatment for Magnesium Alloys Alkaline Type, Full Coat

RATIONALE

AMS2476D results from a Five-Year Review and update of this specification with the addition of ordering information, fixture/electrical contact locations (3.2.2) per general agreement, suspension of periodic testing (4.2.2.1) per general agreement, and lot definition (4.3) per general agreement.

NOTICE

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

1. Purchase order shall specify not less than the following:
   - AMS2476D
   - Quantity of pieces to be anodized
   - Basis metal to be coated
   - Special features, geometry or processing present on parts that requires special attention by the processor
   - Electrical contact locations, when specified (3.2.2)
2. Parts manufacturing operations such as heat treating, shot peening, media finishing, forming, joining, brazing, welding, perforating, and machining performed prior to anodic coating, can affect the condition of the substrate and if performed after coating, can adversely affect the finished coating. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

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**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2476D/

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 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 +1 724-776-4970 (outside USA), www.sae.org.

ARP4992 Periodic Test Plan for Processing Solutions

AS7766 Terms Used in Aerospace Metals Specifications

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 B244 Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments

ASTM B487 Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of 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

3.2.1 Cleaning

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.

3.2.2 Fixture/Electrical Contact Locations

Tight fixture/electrical contact shall be maintained during the anodic coating process, in order to prevent damage or contact arcing (burning) of parts, but small irregularities of coating at points of fixture/electrical contact, are acceptable.

3.2.2.1 For parts that are to be coated all over, and contact locations are not specified, contact locations shall be at the discretion of the processor.

3.2.2.2 For parts that are not to be coated all over, and contact locations are not specified, locations shall be in areas on which coating is not required.

3.3 Procedure

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

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

3.3.3 Alternating current shall be applied, and voltage raised manually or automatically to maintain a current density of 15 to 30 amperes per 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.

3.3.4 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.

3.3.5 Parts which have been coated and post treated shall be aged for 4 to 6 hours at 175 °F ± 10 °F (79 °C ± 6 °C) 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 per 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.

4.2.2.1 Periodic testing may be suspended in any test period when parts are not processed; however, preproduction testing may be required by the cognizant quality organization upon resumption of processing.

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 is a group of parts, all of the same part number, processed through the same chemical solutions in the same tanks under the same conditions, which have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at the same 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 B244, ASTM B487, 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 g/L, chemically pure, sulphate-free chromic acid, heated to 120 °F ± 5 °F (49 °C ± 3 °C), and hold for 10 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 5 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 weightings is not more than 1.0 milligram per square inch (0.155 mg/cm^2). Calculate the coating weight using Equation 1.

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

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 glass rod, rub the surface of the specimen using a 1 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 affect 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
Fixture/electrical contact location when approval is required by the cognizant engineering organization
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