SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2478 | REV. E

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Superseding AMS2478D

Anodic Treatment of Magnesium Alloys Acid Type, Full Coat

RATIONALE

AMS2478E 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 an acid-type, anodic coating on magnesium alloys and the properties of the coating.

1.2 Application:

This process 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 This process is applicable to all magnesium alloys provided proper allowance is made for dimensional change. It should not be used on parts which will be flexed in service. Abrasion resistance is not as high as that provided with the alkaline electrolytic treatment of AMS 2476 but, when similarly painted or coated, other properties are equivalent. AMS 2478 coatings often exhibit poor adhesion to surfaces of castings. Thin coatings in accordance with AMS 2479 are preferred for castings.

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.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
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http://www.sae.org/technical/standards/AMS2478E

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.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2476	Electrolytic Treatment for Magnesium Alloys, Alkaline Type, Full Coat
AMS 2479	Anodic Treatment of Magnesium Alloys, Acid Type, Thin Coat
AMS 4352	Magnesium Alloy Extrusions, 5.5Zn - 0.45Zr (ZK60A-T5), Precipitation Heat-Treated

2.2 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 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 one of the compositions shown in Table 1, maintained within the temperature range 175 to 185 °F (79 to 85 °C). If the type of current is not specified, either alternating current (AC) or direct current (DC) may be used. Alternative processing solutions may be used if acceptable to purchaser.

TABLE 1A - Bath Composition, Inch/Pound Units

Ingredient	AC Process Quantity	DC Process Quantity
Ammonium Bifluoride, ounces (Avdp) per gallon ($NH_4F{\cdot}HF$)	30.0 to 60.0	40.0 to 60.0
Sodium Dichromate, ounces (Avdp) per gallon ($Na_2Cr_2O_7{\cdot}2H_2O$)	6.7 to 16.0	6.7 to 16.0
Phosphoric Acid, fluid ounces per gallon (85% H_3PO_4)	6.5 to 14.0	6.5 to 14.0

TABLE 1B - Bath Composition, SI Units

Ingredient	AC Process Quantity	DC Process Quantity
Ammonium Bifluoride, grams/L ($NH_4F{\cdot}HF$)	225 to 449	300 to 449
Sodium Dichromate, grams/L ($Na_2Cr_2O_7{\cdot}2H_2O$)	50 to 120	50 to 120
Phosphoric Acid, mL/L (85% H_3PO_4)	51 to 109	51 to 109

3.1.2 Sealer: Shall be an aqueous solution containing 6 to 8 ounces/gallon (45 to 60 grams/L) of sodium tetrasilicate ($Na_2Si_4O_9$) maintained at a temperature of 200 o 212 °F (93 to 100 °C).

3.2 Equipment:

3.2.1 Tanks: Shall be fabricated from a material or lined with a coating that is compatible with the anodizing bath and shall be equipped with temperature controls capable of controlling the bath temperature within specified limits.

3.2.2 Fixtures: Wire, hooks, clamps, and racks used to suspend parts in the electrolyte and which are in contact with the electrolyte shall be of magnesium or magnesium alloys, or from aluminum alloys containing magnesium (5000 or 6000 series). Such fixtures shall be protected with a suitable maskant at the electrolyte-air interface.

3.3 Preparation:

3.3.1 Masking: Parts which contain inserts other than 5000 or 6000 series aluminum alloys and parts not to be anodized all over shall be masked to seal off the non-magnesium or non-aluminum materials and the surfaces not to be anodized.

3.3.2 Cleaning: Parts shall be pickled and cleaned as necessary to ensure that surfaces are free from water break.

3.3.3 Racking:

3.3.3.1 AC Processing: Parts shall be distributed on both electrodes so that the surface areas of the parts on each electrode are approximately equal.

3.3.3.2 DC Processing: Parts shall be distributed on one electrode with the other electrode being separate steel plates except as noted in 3.4.1.

3.3.3.3 Attachment and Contact: Parts shall be firmly attached to the racks. Contact areas shall be kept as small as possible and, when practicable, shall be on surfaces not required to be coated. When parts are to be coated all over, contacts shall be located in areas indicated on the drawing. Parts shall, insofar as practicable, be hung to avoid gas entrapment during processing.

3.4 Procedure:

3.4.1 Processing: The cleaned and racked parts shall be immersed in the electrolyte (See 8.4.1). The parts shall be made the anode in the DC process and, for this process, the tank may serve as the cathode if it is made of unlined steel. Alternating or direct current, as applicable, shall be applied and the voltage raised manually or automatically during processing to maintain the required current density. Current density shall be maintained so that, in a processing time of not more than 30 minutes, the total power input will be not less than that shown in Table 2.

TABLE 2 - Power Input

Type of Current	Total Power Input
AC Process	460 ampere minutes/square foot (85 A·second/m^2)
DC Process	300 ampere minutes/square foot (55 A·second/m^2)

3.4.1.1 Completion of processing is indicated by a uniform, dark green color, free from definite bare or light colored areas except as permitted in 3.6, examined, while wet, after rinsing in cold water.

3.4.2 Sealing: When specified, immediately after coating and rinsing, parts not to be painted or which are to be only partly painted shall be immersed in the sealer solution for approximately 15 minutes.

3.4.3 Rinsing and Drying: After anodizing, or after sealing when specified, parts shall be rinsed thoroughly in cold, running tap water, rinsed in clean, hot water, and dried.

3.5 Properties:

The coating shall conform to the following requirements:

3.5.1 Coating Thickness: Coating shall result in a dimensional increase of 0.0009 to 0.0016 inch (23 to 40 µm) per surface, determined on representative parts or specimens (4.3.3) in accordance with ASTM B 244, ASTM B 487, by direct micrometer measurements, or by other method acceptable to purchaser.

3.5.2 Coating Weight: If the size or shape of parts is such that coating thickness cannot be determined accurately, determination of coating weight may be substituted for determination of thickness. Coating weight shall be 3.600 to 6.400 grams/square foot (38.75 to 68.89 g/m^2), determined as in 3.5.2.1.

3.5.2.1 Weigh an oven dried coated part or a coated test specimen (4.3.3). Strip the coating in a fresh, sulfate-free solution containing approximately 40 ounces/gallon (300 g/L) of chromic acid. Repeat the immersion in the stripping solution until the weight difference between successive weighings is less than 1.0 milligram/square inch (0.155 mg/cm^2). After each stripping operation, wash the part or test specimen with distilled water and oven dry thoroughly before weighing. Determine coating weight by subtracting the weight of the stripped specimen from the weight prior to stripping and dividing by the surface area.

3.6 Quality:

Surfaces of coated parts, as received by purchaser, shall be uniform in texture and appearance except that dark striations on parts made of extruded AMS 4352 magnesium alloy will be acceptable if no pitting is present. Powdery areas, laminations, excessive buildup, and darkening of corners and edges are not acceptable. There shall be no bare or definite light-colored areas except as approved by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor shall supply all specimens for processor's tests and shall be responsible for the performance of all required tests. Where parts are to be tested, such parts shall be supplied by purchaser. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the coating conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Coating thickness (3.5.1) or coating weight (3.5.2), as applicable, and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Cleaning and processing solution tests (See 8.6) 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.

4.3 Sampling:

Shall be not less than the following; a lot shall be all parts of the same basis material, processed in the same solutions under the same conditions in not longer than eight consecutive hours, and presented for processor's inspection at one time:

4.3.1 For Acceptance Tests: Shall be as shown in Table 3.

TABLE 3 - Sampling for Acceptance Testing

Number of Parts in Lot	Quality	Coating Weight or Coating Thickness As Applicable
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.

4.3.3 Coating Thickness and Coating Weight: Shall be determined on representative parts when size and shape permit accurate determinations. If parts are of such size and shape that accurate determination cannot readily be made, coating thickness and coating weight tests shall be made on separate specimens, having surface area not less than 24 square inches (155 cm^2), made of the same generic class of alloy as the parts represented. Separate specimens, if used, shall be processed with the parts they represent. In case of dispute, results of tests on actual parts shall govern.

4.4 Approval:

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

4.4.2 The 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.

4.4.2.1 Control factors for the process shall include, but not be limited to, the following:

Cleaning procedure
Composition limits for electrolyte
Electrolyte operating temperature and limits
Racking setup
Coating current density
Current density limits
Sealer composition limits
Thickess determination method
Periodic test plan

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. The report shall include the purchase order number, lot number, AMS 2478E, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If any acceptance test fails to meet specified requirements, parts in that lot may be stripped by a method acceptable to purchaser which 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 roughen, pit, embrittle the basis metal, or adversely affect part dimensions, pretreated, recoated, post-treated as defined herein, and tested. After any stripping and recoating, parts shall meet the dimensional requirements of the drawing.

4.6.2 If the results of 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. 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 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.