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Superseding AMS2479C	

Anodic Treatment of Magnesium Alloys
Acid Type, Thin Coat

RATIONALE

AMS2479D 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 ensure maximum 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 for parts flexed in service. Abrasion resistance is not as high as is provided with the alkaline electrolytic treatment of AMS 2476 or the full-coat, acid treatment of AMS 2478 but, when similarly painted or resin-coated, other properties are equivalent.

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.

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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.

AMS 2476 Electrolytic Treatment for Magnesium Alloys, Alkaline Type, Full Coat
 AMS 2478 Anodic Treatment of Magnesium Alloys, Acid Type, Full Coat
 AMS 4352 Magnesium Alloy Extrusions, 5.5Zn - 0.45Zr (ZK60A-T5), Precipitation Heat-Treated

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 range 160 to 180 °F (71 to 82 °C). If neither alternating or direct current is specified, either may be used.

TABLE 1A - Bath Composition, Inch/Pound Units

Ingredient	AC Process Quantity	DC Process Quantity
Ammonium Bifluoride, ounces (Avdp) per gallon (NH ₄ F·HF)	30 to 60.0	40.0 to 60.0
Sodium Dichromate, ounces (Avdp) per gallon (Na ₂ Cr ₂ O ₇ ·2H ₂ O)	6.7 to 16.0	6.7 to 16.0
Phosphoric Acid, (fluid) ounces per gallon (85% H ₃ PO 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 ($\text{NH}_4\text{F}\cdot\text{HF}$)	225 to 449	300 to 449
Sodium Dichromate, grams/L ($\text{Na}_2\text{Cr}_2\text{O}_7\cdot 2\text{H}_2\text{O}$)	50 to 120	50 to 120
Phosphoric Acid, mL/L (85% H_3PO_4)	51 to 109	50 to 109

3.1.2 Sealer: Shall be an aqueous solution containing 6 to 8 ounces/gallon (45 to 60 g/L) of sodium tetrasilicate ($\text{Na}_2\text{Si}_4\text{O}_9$) maintained at a temperature within the range 200 to 212 °F (93 to 100 °C).

3.2 Equipment:

3.2.1 Tanks: Shall be fabricated from materials which are compatible with the solutions and temperature required for processing parts and shall be equipped with facilities for maintaining the solutions within the operating temperature ranges specified.

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 (5000 or 6000 series) aluminum alloys containing magnesium. 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 of water break.

3.3.3 Racking, 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.

3.3.3.1 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.

3.4 Procedure:

- 3.4.1 Processing: The cleaned and racked parts shall be immersed in the electrolyte (See 8.3.1). 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 shall be as shown in Table 2.

TABLE 2 - Power Input

Type of Current	Total Power Input
AC Process	80 to 100 ampere minutes/square foot (14.5 to 18.0 A·second/m ²)
DC Process	50 to 60 ampere minutes/square foot (9.0 to 11.0 A·second/m ²)

- 3.4.1.1 Completion of processing is indicated by a uniform, light green to gray 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 which will not be painted or which are to be partially painted shall be immersed in the sealer solution (3.1.2) for approximately 15 minutes immediately after coating.
- 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:

Coatings shall conform to the following requirements:

- 3.5.1 Coating Thickness: Shall be such that the dimensional increase will be 0.0001 to 0.0005 inch (2.5 to 12.7 μm) per surface, determined by measuring before and after anodizing at the same locations, with a micrometer accurate to 0.0001 inch (2.5 μm), dividing by two if opposite faces are anodized. Coating thickness may be determined by multiplying by 1.3.
- 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 0.400 to 2.000 grams/square foot (4.30 to 21.53 g/m²), determined as in 3.5.2.1.

3.5.2.1 Weigh an oven-dried coated part or a coated test specimen as in 4.3.3. Strip the coating in a fresh, sulfate-free solution containing approximately 40 ounces/gallon (300 g/L) of chromic acid until the weight difference between successive weighings is less than 1.0 milligram/square inch (0.155 mg/cm²). 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. Oven drying temperature shall not be higher than 250 °F (121 °C).

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 pitting is not 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 samples 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 (3.6) are acceptance tests and shall be performed on each lot.
- 4.2.2 Periodic Tests: Cleaning and processing solution tests (See 8.5) to ensure that the deposited coating will conform to the requirements of this specification 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 coated 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 and Testing:

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 of testing 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 determinations cannot be made, coating thickness, and coating weight tests shall be made on separate specimens, having surface area not less than 24 square inches (155 cm²), made of the same generic class of alloy as the parts represented. Separate specimens, if used, shall be processed with the work they represent. In case of dispute, results of tests on actual parts shall govern.

4.4 Approval:

4.4.1 The process and control factors, 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
- Racking set-up
- Composition limits for electrolyte
- Current and/or voltage control
- Frequency of solution(s) analysis
- Precleaning process
- 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. This report shall include the purchase order number, lot number, AMS 2479D, part number, type of current used, and quantity.

4.6 Resampling and Retesting:

4.6.1 If acceptance test fails to meet specified requirements, the parts in that lot may be stripped by a method acceptable to purchaser which does not roughen, pit, 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 fail to meet the 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 coated parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT:

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