SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2487 | REV. A

Issued 1993-04
Revised 2000-03
Reaffirmed 2011-10

Superseding AMS 2487

(R) Anodic Treatment of Titanium and Titanium Alloys Solution pH 12.4 Maximum

1. SCOPE:

1.1 Purpose:

This specification describes the engineering requirements for producing an electrically-insulating, non-powdery anodic coating on titanium and titanium alloys and the properties of such coatings.

1.2 Application:

This process has been used typically to increase resistance to galvanic and high temperature corrosion and voltage breakdown and to form a receptive base for the application of lubricants and paints on titanium and titanium alloys, but usage is not limited to such applications.

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 form 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.

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/AMS2487A

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 3084	Lubricant, Solid Film, Minimal Outgassing
AMS 4001	Aluminum Sheet and Plate, 0.12Cu (1100-0), Annealed
AMS 4911	Titanium Alloy Sheet, Strip, and Plate, 6Al - 4V, Annealed
MAM 4911	Titanium Alloy Sheet, Strip, and Plate, 6AL - 4V, Annealed (Metric)
AMS 4928	Titanium Alloy Bars, Wire, Forgings, and Rings, 6Al - 4V, Annealed

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
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 D 257	D-C Resistance or Conductance of Insulating Materials
ASTM D 2714	Calibration and Operation of the Falex Block-On-Ring Friction and Wear Testing Machine

2.3 U.S. Government Publications:

Available from DODSSP Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

FED-STD-141	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling and Testing
MIL-L-46010	Lubricant, Solid Film, Heat Cured, Corrosion Inhibiting
MIL-PRF-81329	Lubricant, Solid Film, Extreme Environment

3. TECHNICAL REQUIREMENTS:

3.1 Solutions:

3.1.1 Electrolyte: Shall be any suitable solution with a pH not higher than 12.4.

3.2 Equipment:

3.2.1 Tanks and Cathodes: Processing tanks shall be fabricated from a material which is suitable for containment of the electrolyte being used. Cathode materials shall be insoluble in the electrolyte.

3.2.2 Fixturing: Racks, wires, hooks, and clamps, in contact with the parts or the electrolyte, which are used to suspend parts in the electrolyte shall be made of titanium or titanium alloys.

3.3 Preparation:

3.3.1 Cleaning parts shall be free of water break. The use of halogenated solvents is prohibited.

3.3.2 Electrical Contacts: Contact points shall be in areas acceptable to the purchaser.

3.3.3 Suspension in Electrolyte: Parts shall be positioned in a manner to avoid gas entrapment.

3.4 Procedure:

The cleaned and racked parts shall be immersed in the electrolyte. Current shall be applied and the voltage raised manually or automatically to maintain the required current density for the time necessary to achieve the required coating thickness. Air agitation shall be used to minimize entrapment of gas in the coated surface. After anodizing, parts should be thoroughly rinsed and dried.

3.5 Properties:

Coatings on parts shall conform to the following requirements:

3.5.1 Thickness: May be specified by AMS 2487 and a suffix number designating the nominal thickness in ten-thousandths of an inch (2.5 µm); thus AMS 2487-1 designates a coating thickness of 0.0001 inch (2.5 µm) and AMS 2487-3 designates a finished coating thickness of 0.0003 inch (7.6 µm). A tolerance of ±0.00005 inch (1.27 µm) per 0.0001 inch (2.5 µm) of nominal coating thickness will be permitted. If thickness is not specified, coating thickness shall be 0.0001 inch (2.5 µm).

3.5.1.1 Thickness of coating shall be determined on representative parts or on specimens to the nearest 0.0001 inch (2.5 µm) by direct micrometer measurement, by eddy current measurement in accordance with ASTM B 244, or by other method acceptable to purchaser. Specimens, if used, shall be fabricated from the same alloy as the parts they represent and shall be processed with the parts represented. In case of dispute, eddy current method shall govern. Coating thickness requirements shall not apply to blind holes or recesses with depth greater than seven times the diameter unless a specific coating thickness is specified on those areas.

3.5.2 Color: Shall be substantially uniform on anodized parts of the same alloy, with a similar surface finish, processed to the same nominal coating thickness.

3.5.3 Voltage Breakdown Resistance: Shall be not less than 75 volts, alternating current on a 0.0001-inch (2.5-µm) thick coat applied to specimens fabricated from AMS 4911 or MAM 4911 titanium alloy, determined in accordance with the procedure in 3.5.3.1 through 3.5.3.2. Specimens shall be processed with the parts they represent. Voltage breakdown resistance for other thicknesses shall be as agreed upon by purchaser and processor.

3.5.3.1 Equipment:

3.5.3.1.1 Voltage source for testing shall be supplied by an alternating current power source capable of supplying a voltage from 0 to 300 volts AC; voltage shall be controlled so that it can be increased uniformly at a rate of 25 volts per second until breakdown occurs.

3.5.3.1.2 Electrode(s) shall be made of brass, bronze, or copper and shall have smooth contact surfaces. The electrode used for contacting the coated surface shall have a spherical apex of 0.125-inch (3.18-mm) radius. Electrodes shall be insulated to ensure that personnel are protected from electrical shock. Electrodes shall be examined for damage or roughness prior to use and shall be repolished if necessary.

3.5.3.2 Test Procedure:

3.5.3.2.1 Attach one probe to the specimen to be tested; this probe must make contact with the base substrate. Contact with the base substrate shall be made by scratching through the finish on an area which is not a functional area, or by making contact with an area not coated.

3.5.3.2.2 Bring the conical shaped electrode in contact with the coated surface, (care should be taken not to damage the coating) to maintain a uniform pressure to ensure an accurate reading.

3.5.3.2.3 Raise applied voltage at a rate of 25 volts per second until specified voltage is attained or until breakdown occurs.

3.5.4 Galvanic Corrosion Resistance: There shall be no evidence of galvanic corrosion of bare AMS 4001 aluminum specimens when coupled to AMS 4911 or MAM 4911 titanium alloy specimens anodized to a thickness of 0.0001 inch (2.5 µm) after exposure for not less than 168 hours to salt spray corrosion test in accordance with ASTM B 117. After exposure, aluminum specimens shall show no evidence of galvanic corrosion. Specimens shall be prepared in accordance with 4.3.2.1.

3.5.5 Abrasion Resistance: Weight loss for a 0.0001 inch (2.5 µm) coating shall not exceed 10 milligrams, determined in accordance with FED-STD-141, Method 6192.1, using CS-17 wheels with a 1000-gram load. The test shall be run for 100 cycles. Specimens may be placed in a desiccator prior to and following test to establish constant weight.

3.5.6 Wear Resistance of Lubricated Surfaces: Test rings and blocks made of AMS 4928 titanium alloy, anodized as specified herein (AMS 2481-1) and coated with 0.0003 to 0.0005 inch (7.6 to 12.7 µm) of AMS 3084, MIL-L-8937 to MIL-PRF-81329 solid film lubricant shall have an average life of 75,000 oscillatory cycles, determined in accordance with 3.5.6.1.

3.5.6.1 Test Procedure: Using a block-on-ring test machine calibrated and operated in accordance with ASTM D 2714, mount an anodized and dry-film lubricated test ring on the test machine in accordance with manufacturers' instructions. Place sufficient weight on the bale rod to achieve 630 pounds normal force (2802 N) when load is applied. Start machine. After one minute, gently apply load to the lever system. Terminate the test when the coefficient of friction equals 0.20. Repeat the room temperature test twice using new anodized and lubricated test blocks and rings in each test.

3.5.7 Foil Test: There shall be no evidence of burning of AMS 4911 or MAM 4911 foil, nominally 0.008 x 1 x 3 inches (0.20 x 25 x 76 mm), when anodized to a minimum coating thickness of 0.0001 inch (2.5 µm).

3.5.8 Electrical Resistance: Shall be not less than 1×10^{12} ohms determined in accordance with ASTM D 257 on AMS 4911 or MAM 4911 titanium alloy anodized to a thickness of 0.0001 inch (2.5 µm). The resistance of coatings with other thicknesses or on other materials shall be agreed upon by purchaser and processor.

3.6 Quality:

Coating, as received by purchaser, shall be essentially uniform in thickness, texture, and appearance, adherent to basis metal, and free of scratches, chips, and burned or powdery areas. Small irregularities at points of electrical contact are permissible.

3.7 Tolerances:

When parts are specified to be selectively coated, a tolerance of -0, +1/16 inch (+1.6 mm) will be permitted on the extent of the anodized area.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

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

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.5.1), color (3.5.2), voltage breakdown resistance (3.5.3), electrical resistance (3.5.8), and quality (3.6) are acceptance tests and shall be performed on each lot. The voltage breakdown resistance of coatings with other thicknesses or on other materials may be agreed upon by purchaser and processor, or, where not specified or agreed upon, the results of tests on AMS 4911 or MAM 4911 coated as in AMS 2487-1 in the same manner at the same time shall be acceptable.

4.2.2 Periodic Tests: Galvanic corrosion resistance (3.5.4), abrasion resistance (3.5.5 and 3.5.6), and foil test (3.5.7) and tests of cleaning and processing solutions to ensure that the anodic coating will conform to specified requirements (See 8.5) 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 and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be as follows; a lot shall be all coated parts of the same part number made from the same alloy, processed to the same coating thickness in the same set of solutions in a 24-hour period, and presented for processor's inspection at one time.

4.3.1 For Acceptance Tests: Shall be as shown in Table 1.

TABLE 1 - Sampling for Acceptance Tests

Lot Size	Color and Quality	Thickness, Voltage Breakdown and Electrical Resistance
1 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 Periodic Tests and Preproduction Tests: Sample quantities shall be selected at the discretion of the processor, unless otherwise specified.

4.3.2.1 Specimens for galvanic corrosion resistance shall be made of AMS 4911 or MAM 4911 titanium alloy and AMS 4001 aluminum strips approximately 0.062 x 1 x 6 inches (1.57 x 25 x 152 mm) with a 0.250 inch (6.35 mm) hole at an edge distance of 0.50 inch (12.7 mm) from each end. The AMS 4911 or MAM 4911 specimens shall be fastened to the AMS 4001 specimen by means of nylon bolts and nuts.

4.4 Approval:

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

4.4.2 The processor of coated parts 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.

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

Surface preparation and cleaning
Anodizing bath composition and control limits
Anodizing bath temperature and controls
Method for determining film thickness
Stripping procedure, when applicable
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 the parts conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2487A, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If the results of any acceptance test fails to meet specified requirements, the parts may be stripped with the approval of the cognizant engineering organization by a method that does not roughen, pit, or adversely affect part dimensions, pretreated, coated, sealed 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 with the approval of the cognizant engineering organization by a method that does not roughen, pit, or adversely affect part dimensions, pretreated, coated, sealed, if specified, as defined herein, and tested.

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. 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 physical characteristics and properties of the coating are preserved.