SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2488 | REV. D

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Superseding AMS 2488C

(R) Anodic Treatment - Titanium and Titanium Alloys Solution pH 13 or Higher

1. SCOPE:

1.1 Purpose:

This specification establishes the engineering requirements for producing an anodic coating on titanium and titanium alloys and the properties of the coating.

1.2 Application:

These coatings have been used typically as a lubricating and anti-galling coating for elevated temperature forming, as an isolating film for increased resistance to galvanic corrosion, to provide improved wear resistance and as a pretreatment for the application of solid film lubricants, but usage is not limited to such applications.

1.3 Classification:

Coatings are classified by end-product application, as follows:

Type 1 As a coating for elevated-temperature forming.

Type 2 As an anti-galling coating without additional lubrication or as a pretreatment for improving adherence of film lubricants and in application where increased resistance to galvanic corrosion is required. Such coatings also are compatible with hypergolic propellants such as hydrazine-unsymmetrical-dimethylhydrazine and nitrogen tetroxide (See 8.4), and are electrically semiconductive.

1.3.1 Type 2 shall be furnished unless Type 1 is specified.

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1.4 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.

1.5 Precautions:

The use of hypergolic propellents as test media presents a special hazard. Test vessels should be contained in such a manner that breakage or inadvertent spills will be safely contained (See 8.4).

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 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 3084	Lubricant Solid Film, Minimal Outgassing
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, 6A1 - 4V, Annealed

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 15248-2959.

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 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.

MIL-PRF-26539	Propellant, Nitrogen Tetroxide
MIL-PRF-27402	Propellant, Hydrazine-Uns-Dimethylhydrazine (50% N_2H_4 - 50% UDMH)
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 an alkaline solution with pH of 13 or higher.

3.2 Equipment:

3.2.1 Tanks: Shall be fabricated from a material which is suitable for containment of the electrolyte being used. Cathode material shall be insoluble in the electrolyte.

3.2.2 Fixtures: Wire, hooks, clamps, and racks in contact with the parts or electrolyte which are used to suspend parts in the electrolyte shall be of titanium or titanium alloys.

3.3 Preparation:

3.3.1 Cleaning: Parts shall be clean and free of water break. The use of halogenated solvents is prohibited.

3.3.2 Racking: Racks and clamps shall be free of anodic film.

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

3.4 Procedure:

3.4.1 Processing: The cleaned and racked parts shall be immersed in the electrolyte. Direct current shall be applied with the voltage being raised manually or automatically to maintain the required current density during processing. Completion of the process is indicated by total decay of the amperage (zero amperage).

3.4.1.1 Complex parts shall be agitated while totally immersed in the electrolyte in order to minimize entrapment of air in pockets and blind holes and shall be repositioned periodically to bring the electrolyte into contact with uncoated areas and to prevent attack at the electrolyte/air interface of such pockets and blind holes.

3.4.2 Rinsing and Drying: Parts shall be thoroughly rinsed and dried.

3.5 Properties:

Coating shall conform to the following requirements:

3.5.1 Coating Thickness:

3.5.1.1 Type 1: Anodizing shall produce a dimensional increase of 0.0002 to 0.0004 inch (5 to 10 µm) per surface, determined by measuring the same location on parts or specimens before and after anodizing using a micrometer accurate to 0.0001 inch (2.5 µm), by eddy current measurements in accordance with ASTM B 244, or other method acceptable to purchaser. If specimens are used, they shall be fabricated from the same alloy and condition as the parts and shall be processed with the parts represented.

3.5.1.2 Type 2: Shall be such that there is no measurable dimensional change when measured with a micrometer accurate to 0.0001 inch (2.5 µm).

3.5.2 Wear Resistance (Type 2): Test rings and blocks made of AMS 4928 titanium alloy anodized as specified herein and coated with 0.0003 to 0.0005 inch (8 to 13 µm) of AMS 3084, MIL-L-46010, Type 1 or MIL-PRF-81329 solid film lubricant shall have a life of 75,000 cycles, determined in accordance with 4.5.1.

3.5.3 Propellant Compatibility: When specified, Type 2 anodic coating shall not react, dissolve, disperse, change propellant color, or show any other evidence of deterioration during 30 days exposure to MIL-PRF-27402 hydrazine-unsymmetrical dimethylhydrazine and MIL-PRF-26539 nitrogen tetroxide, determined in accordance with 4.5.2. Persistent gas escape or continuous streaming of bubbles from the anodic coating which results in a pressure increase exceeding 50 psi (345 kPa), when immersed in non-agitated propellant, shall be evidence of incompatibility.

3.6 Quality:

Anodic coating, as received by purchaser, shall be continuous, smooth, adherent to basis metal, uniform in texture and appearance, and free from burned or powdery areas, loose films, 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 coating processor shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. Parts if required for tests, 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 (3.5.1.1) of Type 1 and quality (3.6) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: 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 is specified by the 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 made of the same alloy, coated to the same range of coating thickness in the same set of solutions in each consecutive 24 hours of operation, 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

Number of Parts in Lot	Thickness For Type 1	Quality
1 to 7	3	All
8 to 15	4	7
16 to 40	4	10
41 to 110	5	15
111 to 300	6	25
301 to 500	7	35
Over 500	8	50

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

4.4 Approval:

4.4.1 Processes and control factors, a preproduction sample coated part, and/or whichever is specified, shall be approved by the cognizant engineering organization before production coated 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.

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

Cleaning and surface preparation
Solution limits and control
Voltage limits and control
Temperature limits and control
Solid film lubricant used in wear test
Stripping procedure, when applicable
Periodic test plan

4.5 Test Methods:

4.5.1 Wear Resistance:

4.5.1.1 Equipment: A block-on-ring test machine calibrated and operated in accordance with ASTM D 2714.

4.5.1.2 Procedure: Mount an anodized and dry-film-lubricated AMS 4928 test ring on the block-on-ring test machine according to manufacturer's 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. The average of test results shall not be less than 75,000 cycles.

4.5.2 Propellant Compatibility:

4.5.2.1 Test Specimens: Shall be AMS 4911 or MAM 4911 titanium alloy sheet 0.063 inch ± 0.006 (1.60 mm ± 0.15) thick by approximately 3/4 inch (19 mm) wide by 3 inches (76 mm) long.

4.5.2.2 Procedure (See 8.4):

4.5.2.2.1 50% N_2H_4 - 50% UDMH Compatibility: Place each anodized test specimen in a clean glass tube capable of being tightly closed and provided with a pressure relief and pressure monitoring system. Cover the test specimen with approximately three ounces (85 grams) of MIL-PRF-27402 propellant. Close the test tube and heat to 160 °F ± 5 (71 °C ± 3) and hold at temperature. Examine each working day for noticeable color change, excessive pressure buildup, solubility, or other evidence of deterioration.