AEROSPACE MATERIAL SPECIFICATION

AMS2642™	REV. F
Issued 1972-11 Revised 2021-11 Superseding AMS2642E	

Structural Examination of Titanium Alloys Etch-Anodize Inspection Procedure

RATIONALE

AMS2642F results from a Five-Year Review and update of this specification adding Ordering Information, clarifying Purpose (1.1), allowing purer grades of acid to be used for Back Strip Solution (3.1.3), replaced Fixture/Electrical Contact Location (3.3.2) with standardized wording, clarified Etch-Anodize Macrostructure Procedure (3.3.4) by stating that the steps are to be performed sequentially and that specimens may be rinsed or immersed, moved test specimen from 4.1 to 3.3.4.6, added Macrostructure (3.4) requirement as it was required but not in properties, reworded Microstructure (3.5) for clarity, added that the Microstructure (3.5.3) shall conform to the material specification, moved hydrogen pickup from acceptance test (4.1) to periodic test (4.2), added NOTICE (8) regarding restricted or banned substances, and changed shall to should in 8.2.7.

NOTICE

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

1. Purchase order shall specify not less than the following:
   - AMS2642F
   - Quantity of pieces to be inspected
   - Titanium alloy of parts being inspected
   - Optional: Fixture/Electrical contact locations, when not specified (3.3.2)
   - Hydrogen pick-up test frequency (see 4.2)
2. Parts manufacturing operations such as heat treating, forming, joining and media finishing can affect the condition of the substrate for anodizing, or if performed after anodizing, could adversely affect the anodized part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

1. SCOPE

1.1 Purpose

This specification covers a procedure, typically referred to as Blue Etch Anodize, for revealing the macrostructure and microstructure of selected titanium alloys.

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/AMS2642F/

1.2 Application

This procedure has been used typically for detecting segregation, inclusions, and other defects in alpha-beta and certain alpha titanium alloys.

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.

AMS4901 Titanium Sheet, Strip, and Plate, Commercially Pure, Annealed, 70.0 ksi (485 MPa)

ARP1917 Clarification of Terms Used in Aerospace Metals Specifications

ARP4992 Periodic Test for Processing Solutions

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 E1447 Determination of Hydrogen in Titanium and Titanium Alloys by Inert Gas Fusion Thermal Conductivity/Infrared Detection Method

2.3 ASME Publications

Available from ASME, P.O. Box 2900, 22 Law Drive, Fairfield, NJ 07007-2900, Tel: 800-843-2763 (U.S./Canada), 001-800-843-2763 (Mexico), 973-882-1170 (outside North America), www.asme.org.

ASME B46.1 Surface Texture (Surface Roughness, Waviness, and Lay)

3. TECHNICAL REQUIREMENTS

3.1 Materials and Solutions

3.1.1 Etch Solution

An aqueous acid salt solution shall be prepared, the concentration of which shall be adjusted to maintain a metal removal rate of 0.00003 to 0.00005 inch (0.76 to 1.27 µm) in 80 to 100 seconds after the onset of gas evolution. Operation shall be at room temperature.

3.1.2 Anodize Solution

An aqueous solution of 13 to 17 oz (weight)/gal (97 to 127 gr/L) of hydrated trisodium phosphate ($Na_3PO_4 \bullet 12H_2O$) shall be prepared and maintained at 8.5 pH ± 0.5 pH at room temperature (see 8.3).

3.1.3 Back Strip Solution

An agitated aqueous solution of 42.5 to 51.5 oz (weight)/gal (320 to 385 g/L) of technical grade nitric acid and 1.3 to 4.7 ounces (weight)/gal (10 to 35 g/L) technical grade hydrofluoric acid shall be maintained at room temperature. Using purer grades of acid to make up or control the solution is permitted.

3.1.4 Specimens for Macrostructure

3.1.4.1 Bars, Extrusions, Plates, and Stock for Forging or Extruding

Specimens shall be transverse cross-sections not less than 0.50 inch (12.7 mm) thick, cut from the product to be tested. Specimens shall be machined to have surface texture of 70 microinches (1.8 µm) AA or finer, determined in accordance with ASME B46.1.

3.1.4.2 Forgings

When dimensions permit, forgings shall be machined all over to remove approximately 0.040 inch (1.0 mm) of metal to ensure freedom from alpha case. If forgings are to be inspected by ultrasonic inspection procedures, the configuration used for such inspection is acceptable. Surface roughness shall be 70 microinches (1.8 µm) AA or finer, determined in accordance with ASME B46.1.

3.1.4.3 Finished Parts

Specimens shall be complete parts. No special preparation is required.

3.2 Equipment

3.2.1 A DC voltage source shall be capable of providing direct current with a maximum of 6% ripple at 30 VDC (under no load) and shall be capable of ramping up the voltage to 30 VDC in 1 to 3 seconds. Automatic control is preferred. The equipment shall include a volt and amp meter.

3.2.2 Fixtures shall be free of distortion, loose fittings, worn areas, and corrosion.

3.3 Preparation

3.3.1 Specimens shall be free from water breaks. If water breaks are observed, parts shall be recleaned and reinspected for water break until no water breaks are observed (see 8.5).

3.3.2 Fixture/Electrical Contact Locations

3.3.2.1 Tight electrical contact shall be maintained during the anodic treatment, to prevent contact arcing (burning) of parts, but small irregularities of coating at points of electrical contact are acceptable.

3.3.2.2 For parts which are to be anodized all over, and fixture contact points are not specified, contact locations shall be at the discretion of the processor.

3.3.2.3 For parts which are not to be anodized all over, and fixture contact locations are not specified, locations shall be in areas on which anodize is not required.

3.3.3 Areas on finished parts that are not to be etch-anodize-inspected shall be protected by a suitable masking material.

3.3.4 Etch-Anodize Macrostructure Procedure

The following steps are to be performed in sequential order.

3.3.4.1 Specimens shall be immersed for 80 to 100 seconds after the onset of gassing in an agitated acid salt solution in accordance with 3.1.1. Immersed parts shall be agitated to remove entrapped air. Immediately after removal, specimens shall be immersed or rinsed in clean water. Specimens shall be pressure sprayed as required to remove smut.

3.3.4.2 Specimens shall be immersed in agitated anodize solution in accordance with 3.1.2 and then an anodic voltage of 30 VDC ± 1 VDC shall be applied for 30 seconds ± 1 second using equipment in accordance with 3.2.1. Specimens shall not be agitated when the voltage is applied. Specimens shall be removed from the anodizing solution and immersed or rinsed in clean water. DO NOT TOUCH THE SPECIMEN WITH BARE HANDS. If the current does not fall below 1 ampere, the part may be anodized for up to four more additional 30 second cycles until current falls to less than 1 ampere.

3.3.4.3 Specimens shall be immersed in solution in accordance with 3.1.3 until a light blue-to-gray background color is obtained and maximum contrast between any segregation and the background develops.

3.3.4.4 Specimens shall be rinsed and dried.

3.3.4.5 The specimens shall be immediately inspected for macrostructure and defects such as segregation, laps, folds, cracks, inclusions, arc outs, and pitted areas using 1 to 10X magnification and light intensity not lower than 200 foot-candles (2153 lx) (see 8.6).

3.3.4.6 The hydrogen pick-up permitted when this inspection procedure is used on parts shall not exceed 20 ppm when tested in accordance with ASTM E1447. Test specimen shall be a 0.040 inch (1.0 mm) maximum thickness titanium test strip in accordance with AMS4901.

3.4 Macrostructure

The macrostructure determined in 3.3.4.5 shall conform with the acceptance criteria stated in the material specification unless otherwise specified by the cognizant engineering organization. If the macrostructure is inconclusive, the microstructure shall be examined as stated in 3.5.

3.5 Microstructure

If performed, the microstructure of etch-anodized specimens shall be determined by the following procedure.

3.5.1 Specimens may be cut for examination of other planes as required.

3.5.2 Polish and etch the specimens to be examined using metallographic techniques or replication techniques that will clearly reveal the microstructure (see 8.7).

3.5.3 Specimens shall be inspected to determine the microstructure and the nature of indications found in the macrostructure. The microstructure shall conform to the acceptance criteria listed in the material specification unless otherwise specified by the cognizant engineering organization.

3.6 All parts shall be uniform in color and appearance after inspection.

4. QUALITY ASSURANCE PROVISIONS

4.1 Acceptance Tests

Macrostructure (3.3.4), visual color and appearance (3.5), and, when applicable, microstructure (3.4) are acceptance tests and shall be performed to determine product acceptance.

4.2 Periodic Tests

Hydrogen pick-up (3.3.4.6) is a periodic test shall be performed at a frequency established by the cognizant engineering organization. Tests to maintain all of the solutions used herein are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization (see 8.4).

5. PREPARATION FOR DELIVERY

Not applicable.

6. ACKNOWLEDGMENT

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

7. REJECTIONS

Not applicable.

8. NOTES

NOTICE

This specification may reference the use of substances, products, or processes that are restricted or banned by local (regional) chemical substance regulations. Users of this specification should consider the implications of local legislation on the products, substances, and processes referred to within the document.

8.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 Equipment

8.2.1 The tanks for the solutions of 3.1.1 and 3.1.3 should be lined with polyvinyl chloride or comparable lining material; all others may be unlined. Compatible plastic tanks could also be used.

8.2.2 Temperature indicators and controllers should be used with the alkaline cleaner, anodizing, and water tanks.

8.2.3 For best results mechanical stirrers and/or air agitation are recommended in the alkaline cleaner tank, acid tanks, and the anodizing tank.

8.2.4 Timers should be used on both acid tanks and the anodizing tanks.

8.2.5 A non-ramp controlled rectifier should be equipped with a time actuated switch that, in less than 3 seconds after turning on the current, cut out a 1.2 ohm resistor installed in series with the load (resistor reduces the initial surge of current and thereby reduces the chance of arcing). A ramp-controlled rectifier should provide voltage/current regulation with an adjustable current ramp regulator that has a zero to maximum rise time between 1 and 3 seconds.

8.2.6 Fixtures should be designed so that no nontitanium surfaces are exposed to any of the processing solutions.

8.2.7 Contact surfaces of fixtures should be contoured to match the contour of specimens in the contact areas and should be kept clean and bright to prevent arcing and pitting.

8.3 The pH of the trisodium phosphate solution of 3.1.2 can be controlled by additions of phosphoric acid (H_3PO_4) to lower the pH or of sodium hydroxide (NaOH) to raise it.

8.4 ARP4992 is recommended to satisfy the requirements for the control of processing solutions.

8.5 Specimens should be cleaned in an alkaline cleaner prior to the etch-anodize macrostructure procedure. Specimens that do not contain recesses, in which solvent could be trapped, may be vapor degreased before cleaning in the alkaline cleaner.

8.6 Appearance

Various types of segregation appear as follows: