AEROSPACE MATERIAL SPECIFICATION

AMS2408™ REV. L

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Superseding AMS2408K

Plating, Tin

RATIONALE

AMS2408L results from a Five-Year Review and update of this specification with changes to Ordering Information, Stress-Relief Treatment (see 3.1.1.3), Fixture/Electrical Contact Locations (see 3.1.4), Procedure (see 3.2.1.2), Thickness (see 3.4.1), Quality (see 3.5), Acceptance Tests (see 4.2.1), Periodic Tests (see 4.2.2 and 4.2.2.1), Sampling for Testing (see 4.3), Adhesion Testing (see 4.3.3.3.1), Control Factors (see 4.4.2.1), and Notes (see 8.2 and 8.10).

NOTICE

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

1. The purchase order shall specify not less than the following:

- AMS2408L
- Quantity of pieces to be plated
- Plating thickness (see 3.4.1)
- Basis metal to be plated
- Tensile strength or hardness of the basis metal
- If pre-plate stress relief is to be performed by the plating processor and if different from 3.1.1, time and temperature are to be specified
- If steel parts were machined, ground, cold formed, or cold straightened after heat treat (see 3.1.1)
- If steel parts have been shot peened, specify if required stress relief has been completed (see 3.1.1.3)
- Special features, geometry, or processing present on parts that requires special attention by the plating processor
- Hydrogen embrittlement relief to be performed by the plating processor (parameters or reference document), if different from 3.3.1
- Minimum thickness on internal surfaces, if required (see 3.4.1.4)

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/AMS2408L/

- Optional: fixture/electrical contact locations, when not specified (see 3.1.4)
- Optional: reflow of plating (see 3.3.2)
- Optional: solderability (see 3.4.3)
- Optional: porosity if required as an acceptance test (see 3.4.4)
- Optional: periodic testing frequency (see 4.2.2) and sample quantity (see 4.3.2)
- Optional: requirements for the prevention of tin whiskers (see 3.1.5)

2. Parts manufacturing operations such as heat treating, forming, joining, and media finishing can affect the condition of the substrate for plating or, if performed after plating, could adversely affect the plated part. The sequencing of these types of operations should be specified by the cognizant engineering organization (CEO) or the purchaser and is not controlled by this specification.

3. The parts manufacturer shall ensure that surfaces of metal parts supplied to the processor are free from blemishes, pits, tool marks, and other irregularities that will affect the quality of the finished parts (see 3.5.2).

1. SCOPE

1.1 Purpose

This specification covers the requirements for electrodeposition of tin on metals and the properties of the deposit.

1.2 Application

This process has been used typically to prevent galling or seizing of metal surfaces, to provide a surface for soft soldering, or to improve corrosion resistance, but usage is not limited to such applications (see 8.6).

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 that 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.

AMS2434 Plating, Tin-Zinc Alloy

AMS2451 Plating, Brush, General Requirements

AMS2750 Pyrometry

AMS2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

AIR4129 Metallic Whiskers

ARP4992 Periodic Test for Processing Solutions

AS2390 Chemical Process Test Specimen Material

AS7766 Terms Used in Aerospace Metals Specifications

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 B253 Preparation of Aluminum Alloys for Electroplating

ASTM B374 Terminology Relating to Electroplating

ASTM B487 Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

ASTM B499 Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

ASTM B504 Measurement of Thickness of Metallic Coatings by the Coulometric Method

ASTM B545 Electrodeposited Coatings of Tin

ASTM B568 Measurement of Coating Thickness by X-Ray Spectrometry

ASTM B571 Qualitative Adhesion Testing of Metallic Coatings

ASTM E376 Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods

2.3 Definitions

Terms used in AMS are defined in AS7766.

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress-Relief Treatment

All steel parts having a hardness of 40 HRC and above and that are machined, ground, cold formed, or cold straightened after heat treatment shall be cleaned to remove surface contamination and thermally stress relieved before plating. (Residual tensile stresses have been found to be damaging during electroplating.) Furnaces used for stress relief shall be controlled per AMS2750. The minimum requirements shall be Class 5 with Type D instrumentation. Temperatures to which parts are heated shall be such that stress relief is obtained while still maintaining hardness of parts within specified limits. Unless otherwise specified, the following treatment temperatures and times shall be used:

3.1.1.1 For parts, excluding nitrided parts, having a hardness of 55 HRC and above and for carburized and induction-hardened parts, stress relieve at 275 °F ± 25 °F (135 °C ± 14 °C) for 5 to 10 hours.

3.1.1.2 For parts having a hardness less than 55 HRC and for nitrided parts, stress relieve at 375 °F ± 25 °F (191 °C ± 14 °C) for a minimum of 4 hours. Higher temperatures shall be used only when specified or approved by the CEO.

3.1.1.3 For peened parts: If stress-relief temperatures above 375 °F (191 °C) are specified, the stress relieve shall be performed prior to peening.

3.1.2 The plating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.3 Parts shall be within specified dimensional limits before plating, except as specified in 3.1.3.1.

3.1.3.1 All engine and propeller utility parts, having part numbers with the prefix AN, MS, or AS, required to be plated in accordance with this specification shall be made to such dimensions that parts will be within specified limits after plating. Undercutting before plating shall not be permitted, unless specifically authorized by the CEO.

3.1.4 Fixture/Electrical Contact Locations

3.1.4.1 Except for barrel plating, for parts that are to be electroplated all over, and contact locations are not specified, contact locations shall be at the discretion of the processor.

3.1.4.2 For parts that are not to be electroplated all over and contact locations are not specified, contact locations may be in areas on which plate/coating is not required or may be in the areas being plated/coated provided the parts are moved to prevent contact marks/voids within the plating/coating.

3.1.4.3 Alternative methods for process completion of fixture contact points is permitted when approved by the CEO (see 8.10).

3.1.5 For electronic parts where tin plate becomes the final coating, the plating process and control factors shall be controlled in accordance with 4.4 to minimize or eliminate the propensity for tin whisker formation and growth (see 8.6).

3.2 Procedure

3.2.1 Except as stated in 3.2.1.2 or 3.2.2, tin shall be electrodeposited directly on the basis metal from a suitable tin plating bath.

3.2.1.1 Spotting-in and double plating are prohibited.

3.2.1.2 Aluminum and aluminum alloys shall be zinc treated in accordance with ASTM B253 or other method acceptable to the CEO prior to plating. When specified, nickel alloys, cobalt alloys, and corrosion-resistant steels may be given a nickel or other suitable metal strike prior to tin plating.

3.2.2 Prior to electrodeposition of tin for solderability on aluminum or copper-zinc alloy parts, a copper plate shall be deposited to a thickness of 0.0002 to 0.0003 inch (5 to 8 μm).

3.2.3 After plating, parts shall be thoroughly rinsed and dried.

3.3 Post-Treatment

3.3.1 Hydrogen-embrittlement relief of steel parts shall be in accordance with AMS2759/9.

3.3.2 When specified, the tin plate shall be reflowed by a short immersion in a suitable reflow oil at 510 °F ± 40 °F (266 °C ± 22 °C) (see 8.6 and 8.7).

3.4 Properties

Plating shall conform to the following requirements:

3.4.1 Thickness

Thickness shall be as follows, determined in accordance with ASTM B487, ASTM B499, ASTM B504, ASTM B568, and ASTM E376, direct dimensional inspection (provided the resolution of the measuring instrument is ten times more precise than the attribute being measured), or other method acceptable to the CEO. In case of dispute, the metallographic methods of ASTM B487 shall apply.

3.4.1.1 Plate thickness may be specified by this specification number and a suffix number designating the minimum thickness in ten-thousandths of an inch (2.5 µm); thus, AMS2408-1 designates a plate thickness of 0.0001 to 0.0003 inch (3 to 8 µm), AMS2408-6 designates a thickness of 0.0006 to 0.0008 inch (15 to 20 µm), etc. A tolerance of +0.0002 inch (5 µm) will be allowed (see 8.7).

3.4.1.2 Where “tin flash” is specified, plate thickness shall be approximately 0.0001 inch (3 µm).

3.4.1.3 The plate shall be substantially uniform in thickness on significant surfaces except that slight buildup on exterior corners or edges will be permitted provided finished specified dimensions are met.

3.4.1.4 All surfaces of the part, except those that cannot be touched by a sphere 0.75 inch (19 mm) in diameter, shall be plated to the specified thickness. Unless otherwise specified, surfaces such as holes, recesses, threads, and other areas where a controlled deposit cannot be obtained under normal plating conditions may be under the specified limit provided they show visual plating coverage.

3.4.2 Adhesion

Adhesion shall be determined in accordance with ASTM B571, heat quench test on plated parts, or 180-degree bend test to fracture. There shall be no indication of separation of the plating from the base metal or internal delamination. Adhesion testing is not required when plated parts have been reflowed in accordance with 3.3.2.

3.4.3 Solderability

When specified, solderability of the plating shall be in accordance with ASTM B545. The method of test shall be as specified by the CEO.

3.4.4 Porosity

When specified, plating on ferrous parts, having a plating thickness of 0.0004 inch (10 µm) or more, shall be subjected to the porosity test of ASTM B545 and the result evaluated according to the procedure described. When specified, plating on copper or copper alloys shall be subjected to the porosity test for copper basis metal given in ASTM B545; the specimens shall be considered to have failed if pores in the coating are blackened by the polysulfide test.

3.5 Quality

3.5.1 Plating, as received by the purchaser, shall be smooth, continuous, free from delamination within the plating, uniform in appearance, and free from imperfections detrimental to usage of the plating. Plating shall be visually free from frosty areas, pinholes, porosity, blisters, nodules, and pits. Slight staining or discoloration is permissible.

3.5.2 Imperfections in appearance that arise from surface conditions of the substrate, such as weld areas, variations in surface finish roughness, porosity, scratches, or inclusions, that persist in the finished plating/coating despite observance of industry-accepted plating practices shall not be considered as cause for rejections (see 8.2).

3.5.3 If the plating is specified to be subsequently ground or machined, the above requirements are not required to be inspected for.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all samples for the processor’s tests and shall be responsible for the performance of all required tests. Parts, if required for test, shall be supplied by the purchaser. The CEO reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (see 3.4.1), quality (see 3.5), when specified, solderability (see 3.4.3), and when specified porosity of plating (see 3.4.4) are acceptance tests and shall be performed on parts, or samples representing parts when permitted herein, from each lot (see 4.3.3.1).

4.2.2 Periodic Tests

Adhesion (see 3.4.2) is a periodic test that shall be performed no less than daily for each generic class of alloy as defined by AS2390 processed during that day. Porosity (see 3.4.4), when not required for acceptance testing, is a periodic test and shall be performed monthly unless frequency of testing is specified by the CEO. Tests of cleaning and plating solutions are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant quality organization (see 4.4.2.1 and 8.4).

4.2.2.1 Periodic testing may be suspended in any test period when parts are not processed but shall be performed before or at time such processing is resumed. Preproduction testing may be required by the cognizant quality organization upon resumption of processing.

4.2.3 Preproduction Tests

All property verification tests (see 3.4) are preproduction tests and shall be performed prior to or on the first-article shipment of plated parts to a purchaser and when the CEO requires confirmatory testing.

4.3 Sampling for Testing

Shall be not less that the following: a lot is a group of parts, all of the same part number, processed through the same chemical solutions in the same tanks under the same conditions, which have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at the same time.

4.3.1 Acceptance Tests

Test samples shall be randomly selected from all parts in the lot. Unless the cognizant quality organization specifies a sampling plan, the minimum number of samples shall be as shown in Table 1.

Table 1 - Sampling for acceptance tests

Lot Size	Quality	Thickness	Solderability, Porosity (if required)
1 to 6	All	All or 3*	All or 3*
7 to 15	7	4	4
16 to 40	10	4	4
41 to 110	15	5	5
111 to 300	25	6	6
301 to 500	35	7	7
Over 500	50	8	8

*Whichever is less.

4.3.2 Periodic Tests

Sample quantity and frequency of testing shall be at the discretion of the processor unless a test frequency is specified by the cognizant quality organization or is stated in 4.2.2. For adhesion tests, four test specimens of each generic class of alloy, as defined by AS2390, that have been processed through the same cleaning and plating operations as the parts that they represent. These adhesion test specimens shall be processed prior to the first production lot of parts or with the first production lot of parts.

4.3.3 Sample Configuration

Nondestructive testing shall be performed wherever practical. Except as noted, actual parts shall be selected as samples for tests. Since properties, such as thickness, may differ on panels, correlation with actual parts shall be established.

4.3.3.1 Test Specimens

Separate test specimens may be used under any one of the following circumstances: the plated parts are of such configuration or size as to be not readily adaptable to the specified test, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts.

4.3.3.2 Acceptance Tests

Specimens shall be made of the same generic class of alloy as the parts, established in accordance with AS2390, distributed within the lot, cleaned, plated, and post-treated with the parts.

4.3.3.3 Periodic Tests

4.3.3.3.1 Adhesion Testing

When test specimens are used for adhesion testing, four test specimens of each generic class of alloy, as defined by AS2390, that have been processed through the same cleaning and plating operations as the parts that they represent. These adhesion test specimens shall be processed prior to the first production lot of parts or with the first production lot of parts.

4.4 Approval

4.4.1 Process and control factors, a preproduction sample part, or both, whichever is specified, shall be approved by the CEO before production parts are supplied.

4.4.2 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the CEO for process reapproval unless the change is approved by the CEO. A significant change is one which, in the judgment of the CEO, would affect the properties or performance of the plated parts.

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

Surface preparation method(s)
Fixture/electrical contact locations when approval is required by the CEO
Composition limits of plating solutions
Temperature limits of plating baths
Plating current (or voltage) limits
Frequency of analysis of plating solutions (see 8.4)
Method used for reflow
Stripping process, if used
Periodic test plan (see 4.2.2)

4.5 Reports

The processor of plated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with this specification and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS2408L, 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, pretreated, plated, post-treated, and retested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and nonconforming parts may be stripped, pretreated, plated, post-treated, and retested.

4.6.1.1 When stripping is performed, the method shall be acceptable to the CEO and shall not roughen, pit, or embrittle the basis metal or adversely affect part dimensions. When parts have been stripped and replated, the purchaser shall be informed.

4.6.2 If any periodic test fails to meet specified requirements, the process is nonconforming. No additional parts shall be plated until the process is corrected and new specimens are plated and tested. Results of all tests shall be recorded and, when requested, reported. All previous purchasers shall be notified of all parts plated since the last acceptable test.

5. PREPARATION FOR DELIVERY

5.1 Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plate are preserved.

5.2 Packages of plated 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 plated parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

The processor shall mention AMS2408L in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts on which plating does not conform to this specification, or to modifications authorized by the CEO, will be subject to rejection.

8. NOTES

8.1 Revision Indicator

A change bar (I) 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 The purchaser or the cognizant quality/engineering organization may choose to place parts exhibiting imperfections in appearance due to the condition of the substrate on material review pending further testing or analysis (see 3.5.2).

8.3 ARP4992 is recommended to satisfy the requirement for control of processing solutions.

8.4 An acid dip may be used for surface activation or neutralization of alkaline cleaners. However, the immersion time should be minimized to preclude pitting or hydrogen embrittlement.

8.5 When using tin plating for electronics and precision moving parts applications, the potential for formation of tin whiskers should be considered. High-purity tin plate, especially processes that employ brighteners, has been shown to accelerate whisker formation and growth. Plating process parameters such as bath temperature, bath agitation, and current density can have a subsequent effect on the formation and growth of whiskers. In general, factors that increase the residual compressive stress of the tin plate and factors that promote diffusion within the tin plate can increase whisker formation. Under certain circumstances, metal whiskers grow from surfaces of tin electrodeposits. The tin whiskers are electrically conductive, and some have measured 40 to 80 millionths of an inch in diameter with lengths up to 0.375 inch. Whiskers can have serious effects, such as causing short circuits in integrated circuits and microelectronic components. When engineering electronic designs, it is recommended that AIR4129 be reviewed, especially when short-circuit failure from tin whiskers is a likely mode of failure. In the case of precision moving parts, displaced whiskers can cause mechanical interference. Tin-zinc plate (refer to AMS2434) and reflowed tin surfaces are less susceptible to the formation of whiskers.

8.6 Plating thickness greater than 0.0003 inch (8 µm) may result in tearing and de-wetting during reflow.

8.7 ASTM B374 should be utilized as a reference and referee document when areas of design definition or technical interpretation arise.

8.8 Plating is intended to be deposited in an uninterrupted process except as may be required by the processor for making thickness measurements.

8.9 Dimensions and properties in inch/pound units and the Fahrenheit temperatures are primary; dimensions and properties in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.10 For large parts and parts with complex geometries requiring coating in areas of fixture contact locations, where movement of parts is not practical during the coating process, alternative methods of coating completion at the contact locations may be necessary, e.g., selective coating in accordance with AMS2451 and applicable slash documents (see 3.1.4.3).

PREPARED BY SAE AMS B FINISHES PROCESSES AND FLUIDS COMMITTEE