AEROSPACE MATERIAL SPECIFICATION

AMS2410™	REV. M
Issued 1945-08 Revised 2024-12 Superseding AMS2410L	

Plating, Silver
Nickel Strike, High Bake

RATIONALE

AMS2410M results from a Five-Year Review and update of this specification with changes to Ordering Information, Stress-Relief Treatment (see 3.1.1), Cleaning (see 3.1.2), Fixture/Electrical Contact Locations (see 3.1.3), High-Temperature Bake (see 3.3.2), Thickness (see 3.4.1), Visual Test (see 3.4.3.1), Quality (see 3.5.2 and 3.5.3), Periodic Tests (see 4.2.2), Acceptance Tests (see 4.3.1), Sampling for acceptance tests (see Table 1), control factors (see 4.4.3), and Notes (see 8.6, 8.7, 8.8, and 8.9).

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:

- AMS2410M
- If pre-plate stress relief is to be performed by 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)
- Plating thickness desired (see 3.4.1)
- Basis metal to be plated
- Tensile strength or hardness of the basis metal
- Special features, geometry, or processing present on parts that requires special attention by the plating processor
- Hydrogen embrittlement relief to be performed by plating processor (parameters or reference document) if different from 3.3.1
- Minimum thickness on internal surfaces, if required (see 3.4.1.4)
- Optional: periodic testing frequency (see 4.2.2) and sample quantity (see 4.3.2)

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AMS2410M/

- Quantity of pieces to be plated
- If desired, destructive testing for thickness (see 3.4.1)
- Optional: fixture/electrical contact locations, when not specified (see 3.1.3)

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 or 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 electrodeposited silver on other metals, usually with a nickel strike between the basis metal and the silver.

1.2 Application

Silver plating has been used typically to provide a bearing surface and to prevent galling or seizing of surfaces of parts made of corrosion-resistant steels and of parts made of other metals not deleteriously affected by high-temperature baking, but usage is not limited to such applications. Silver plating is the most commonly used coating for turbine engine fasteners providing an even degree of lubrication up to a maximum service temperature of about 1200 °F (649 °C).

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.

AMS2451	Plating, Brush, General Requirements
AMS2750	Pyrometry
AMS2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts
ARP4992	Periodic Test for Processing Solutions
AS2390	Chemical Process Test Specimen Material
AS7799	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 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 B567 Measurement of Coating Thickness by the Beta Backscatter Method

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 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)

2.4 Definitions

2.4.1 Terms used in AMS are defined in AS7766.

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

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 and Type D instrumentation. Temperatures to which parts are heated shall be such that stress relief is obtained while still maintaining hardness of parts within drawing 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 cognizant engineering organization.

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

3.1.2 Cleaning

The plating shall be applied over a clean surface that will result in a deposit that meets the adhesion and quality requirement of this specification. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.3 Fixture/Electrical Contact Locations

3.1.3.1 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.

3.1.3.2 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 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.

3.1.3.3 Alternative methods for process completion of fixture contact points is permitted when approved by the cognizant engineering organization (see 8.8).

3.2 Procedure

3.2.1 Parts shall be plated in the following sequence except as permitted by 3.2.1.1, 3.2.1.2, or 3.2.1.3:

Nickel strike
Silver strike
Silver plate

3.2.1.1 The nickel strike may be omitted when plating copper and copper alloys.

3.2.1.2 A gold or palladium strike may be used in place of the silver strike when approved by the cognizant engineering organization (see 8.8).

3.2.1.3 When approved by the cognizant engineering organization, silver may be plated directly onto the substrate without the use of either the nickel or silver strike.

3.2.2 Parts shall be plated by electrodeposition of silver from a suitable plating bath. Spotting-in or double plating are not permitted. The use of organic base grain refining and brightener additives shall be prohibited in both the silver strike and silver plate solutions unless approved by the cognizant engineering organization.

3.3 Post-Treatment

3.3.1 Hydrogen Embrittlement Relief

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

3.3.2 High-Temperature Bake

Except as specified herein, all parts, except nuts, shall be heated to 935 to 965 °F (502 to 518 °C) after plating, rinsing, and drying and held at heat for 20 to 60 minutes. Heat-up and cooldown times should be minimized to prevent undesirable changes in the coating or substrate, e.g., oxidation or diffusional changes. Dwell times at 400 °F (204 °C) shall not exceed 7 hours during the heating and cooling thermal cycle. Above 400 °F (204 °C), the heating and cooling medium shall be a neutral or reducing atmosphere (except that hydrogen shall not be used) or shall be a neutral or nonoxidizing molten salt bath. Furnaces used for high-temperature baking shall be controlled per AMS2750; the minimum requirements shall be Class 3 and Type D instrumentation. If such heating would lower hardness or properties of parts below drawing limits or otherwise deleteriously affect the parts, heating shall be at the highest practicable temperature that will maintain specified properties. When this thermal treatment starts within 4 hours after the parts have been removed from the plating bath, hydrogen embrittlement relief in accordance with 3.3.1 is not required.

3.4 Properties

The deposited silver shall conform to the following requirements:

3.4.1 Thickness

Thickness of silver shall be as specified, determined nondestructively on parts or on test specimens as in 4.3.3 by a dimensional gauging method provided the resolution of the measuring instrument is ten times more precise than the attribute being measured, or in accordance with ASTM B499, ASTM B504, ASTM B567, ASTM B568, ASTM E376, or other method acceptable to the cognizant engineering organization. If destructive testing is specified, it shall be determined in accordance with ASTM B487 or other method acceptable to the cognizant engineering organization.

3.4.1.1 Where silver flash only is specified, plate thickness shall be approximately 0.0001 inch (2.5 µm).

3.4.1.2 Thickness of plate, other than flash, shall be as specified. If machining of plated metal is required, plate thickness as deposited shall be sufficient to allow machining of all areas of plated surfaces to the dimensions specified on the drawing.

3.4.1.3 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 evidence of plating coverage.

3.4.2 Composition

Silver, as plated, shall be not less than 99.9% pure, determined by a method acceptable to the cognizant engineering organization. The plating process and solution chemistry shall be controlled to ensure the required purity.

3.4.3 Adhesion

Both visual and destructive tests shall be performed.

3.4.3.1 Visual Test

Plated metal shall be firmly and continuously bonded to the underlying metal. Plating, after heating in accordance with in 3.3, shall show no evidence of blisters or other indications of poor bond. Visual inspection shall be performed without use of magnification.

3.4.3.2 Destructive Chisel-Knife Test

Adhesion on parts, other than nuts, after heating as in 3.3, shall meet the requirements of ASTM B571 chisel-knife test.

3.4.3.3 Destructive Scratch Test

Nuts shall show no peeling of the silver when scratched using the knife option of the chisel-knife test in accordance with ASTM B571.

3.5 Quality

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 after plating and during storage.

3.5.1 Abrasion of plating on corners and edges of nuts is acceptable, but plating shall be continuous on the threads. Marking or marring of the cone section of self-locking nuts, produced in offsetting the locking beams or other locking feature, is acceptable.

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 despite observance of industry-accepted plating practices shall not be considered as cause for rejection (see 8.9).

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. When parts are to be tested, the parts shall be supplied by the purchaser. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to the specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (see 3.4.1) and quality (see 3.5) are acceptance tests and shall be performed on parts, or specimens representing parts when permitted herein, from each lot (see 4.3.3).

4.2.2 Periodic Tests

Composition (see 3.4.2) is a periodic test and shall be performed at least quarterly. 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 engineering organization (see 4.4.3 and 8.3). Adhesion (see 3.4.3) 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.

NOTE: If both "nuts" and "parts other than nuts" are processed during the same day, two separate adhesion tests will be required as per 3.4.3.2 and 3.4.3.1. If the basis material of both "nuts" and "parts other than nuts" are similar as based upon AS2390, the same test specimens may be used for both tests listed in 3.4.3.2 and 3.4.3.1.

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 cognizant engineering organization requires confirmatory testing.

4.3 Sampling for Testing

4.3.1 Acceptance Tests

Acceptance test samples shall be randomly selected from all parts in the lot. 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, that have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at the same time. Unless the cognizant engineering organization provides a sampling plan, the minimum number of samples shall be as shown in Table 1.

Table 1 - Sampling for acceptance tests

Number of Parts in Lot	Visual for Adhesion, Coverage, and Quality	Thickness (Nondestructive)	Thickness (Destructive)
Up to 7	All	All or 3[(1)]	0
8 to 15	7	3	0
16 to 40	10	4	0
41 to 150	15	5	1
151 to 300	25	6	1
301 to 500	35	7	1
Over 500	50	8	2

(1) Whichever is less.

4.3.1.1 When a statistical sampling plan has been agreed upon by the cognizant quality organization and the processor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.5 shall state that such plan was used.

4.3.2 Periodic Tests

One sample shall be used for composition (see 3.4.2) unless otherwise specified by the cognizant engineering organization. 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

4.3.3.1 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 specified tests, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts. Except as specified below, acceptance test 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 represented.

4.3.3.2 Thickness test specimens shall be 0.032 to 0.064 x 4 x 1 inch (0.8 to 1.6 x 102 x 25 mm). For thickness tests, bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long may be used. Because thickness may differ from parts on specimens, correlation with actual parts shall be established. Test specimens for adhesion testing shall be made of the same generic class of alloy as defined by AS2390. The test specimens shall be 0.025 inch (0.6 mm) minimum thickness and not less than 1 x 4 inches (25 x 102 mm).

4.4 Approval

4.4.1 The process and control procedures, a preproduction sample plated part, or both, whichever is specified, 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 controls from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one that, in the judgment of the cognizant engineering organization, could affect the properties or performance of the part.