SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2410 REV. K

Issued 1945-08
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Superseding AMS2410J

Plating, Silver
Nickel Strike, High Bake

RATIONALE

AMS2410K results from a Five Year Review and update of this specification.

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: [some provisions omitted because this spec is different]
   - AMS2410K
   - Pre-plate stress relief to be performed by plating processor (time and temperature) if different from 3.1.1
   - Plating thickness desired (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
   - Optional: Periodic testing frequency (4.2.2) and sample quantity (4.3.2)
   - Quantity of pieces to be plated

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 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/AMS2410K

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 (650 °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 724-776-4970 (outside USA), www.sae.org.

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

AS2390 Chemical Process Test Specimen Material

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 B 487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B 499 Measurement of Coating Thicknesses by The Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals

ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric Method

ASTM B 571 Qualitative Testing Adhesion of Metallic Coatings

ASTM E 376 Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress Relief Treatment

All steel parts having a hardness of 40 HRC and above and which are machined, ground, cold formed or cold straightened shall be cleaned to remove surface contamination and thermally stress relieved before plating for the relief of residual tensile stresses. Residual tensile stresses have been found to be damaging during electrofinishing.

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

3.1.1.2 For parts having a hardness less than 55 HRC, stress relieve at 375 °F ± 25 (191 °C ± 14) 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 or the cognizant engineering organization shall be consulted and shall approve the stress relief temperature.

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

3.1.3 Except for barrel plating, electrical contact points shall be as follows. For parts that are to be plated all over, locations shall be acceptable to the purchaser. For parts that are not to be plated all over, locations shall be on areas on which plating is not required.

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.

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

Treatment of steel parts shall be in accordance with AMS2759/9.

3.3.2 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 cool down 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. 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. Heating of nuts is not required. When this thermal treatment starts within four 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 on the drawing, determined on representative parts or on test specimens as in 4.3.3 in accordance with any of the following methods as applicable: ASTM B 487, ASTM B 499, ASTM B 504, ASTM E 376, 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 on the part drawing. 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 nondestructive 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.

3.4.3.2 Destructive Test

Adhesion on parts, other than nuts, after heating as in 3.3, shall meet the requirements of ASTM B 571 chisel-knife test.

3.4.3.3 Destructive Test

Nuts shall show no peeling of the silver when scratched using the knife option of the Chisel-Knife test in accordance with ASTM B 571.

3.5 Quality

Plating as received by the customer 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, pin holes, 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 plate 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.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all samples for 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 (3.4.1), adhesion (3.4.3), and quality (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 (3.4.2) is a periodic test and shall be performed at least quarterly unless frequency of testing is specified by the cognizant engineering organization. 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 8.3 and 4.4.3.

4.2.3 Preproduction Tests

All property verification tests (section 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 shall be all parts of the same part number, processed in a continuous series of operations (3.1 through 3.3), in not longer than 24 consecutive hours, and presented for processor’s inspection at one 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 (Non-Destructive)	Thickness (Destructive)	Adhesion (Destructive)
Up to 7	all	all	0	0
8 to 15	7	3	0	0
16 to 40	10	4	0	0
41 to 150	15	5	1	1
151 to 300	25	6	1	1
301 to 500	35	7	1	1
Over 500	50	8	2	2

4.3.1.1 When a statistical sampling plan has been agreed upon by purchaser and 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 (3.4.2) unless otherwise specified by the cognizant engineering organization.

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 For adhesion and thickness tests, specimens shall be 0.032-0.064 x 4 x 1 inch (0.8-1.6 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.

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 judgement of the cognizant engineering organization, could affect the properties or performance of the part.

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

Method of cleaning
Strike bath composition and composition limits
Strike and plating parameters (current density, bath temperature)
Test method and frequency of testing for bath compositions
Method of thickness determination
Periodic test for cleaning and processing solutions. See 8.3.