AEROSPACE MATERIAL SPECIFICATION

AMS2413	REV. F

Issued 1961-01
Reaffirmed 2007-04
Revised 2013-08

Superseding AMS2413E

Plating, Silver-Rhodium

RATIONALE

AMS2413F 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:

- AMS2413F
- Plating thickness desired. See 3.4.1.
- Basis metal to be plated
- Tensile strength or hardness of the basis metal
- Pre-plate stress relief to be performed by plating processor (time and temperature) if different from 3.1.2
- 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
- Minimum thickness on internal surfaces, if required. See 3.4.1.1.
- Optional: Periodic testing frequency (4.2.2) and sample quantity (4.3.2)
- Quantity of pieces to be plated
- If internal surfaces as defined in 3.4.1.4 are required to be plated to a specified thickness, notes on the drawing shall so specify

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: +1 724-776-4970 (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/AMS2413F

1. SCOPE

1.1 Purpose

This specification covers the requirements for electrodeposited silver and rhodium deposits.

1.2 Application

This electrodeposit has been used typically to provide a conductive surface for electrical contacts or a reflective coating for waveguide surfaces for parts operating up to 300 °F (149 °C), but usage is not limited to such applications.

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.

AMS2750 Pyrometry

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 B117 Operating Salt Spray (Fog) Testing Apparatus

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

ASTM B568 Measurement of Coating Thickness by X-Ray Spectrometry

ASTM B571 Adhesion of Metallic Coatings

ASTM F519 Qualitative Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Parts shall be within drawing dimension limits before plating. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.2 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 electrofinishing.) 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 drawing limits. Unless otherwise specified, the following treatment temperatures and times shall be used:

3.1.2.1.1 For parts, excluding nitrided 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 5 to 10 hours.

3.1.2.1.2 For parts having a hardness less than 55 HRC, stress relieve at 375 °F ± 25 (191 °C ± 14) for a minimum of 4 hours. Nitrided parts fall into this category. Higher temperatures shall be used only when specified or approved by the cognizant engineering organization.

3.1.2.1.3 For peened parts: If stress relief temperatures above 375 °F (191 °C) are elected, the stress relieve shall be performed prior to peening, or the cognizant engineering organization shall be consulted and shall approve the stress relief temperature.

3.1.3 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.

3.2 Procedure

Parts shall be plated in the following sequence, using the solution specified; parts shall be immersed in each plating solution with the current on:

3.2.1 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 cognizant engineering organization. For parts which are not to be plated all over, locations shall be in areas on which plating is not required, or locations shall be acceptable to the cognizant engineering organization.

3.2.2 Copper Flash or Copper Strike

Except as specified in 3.2.2.1, a copper flash or copper strike shall be electrodeposited from a suitable copper plating solution.

3.2.2.1.1 When parts to be plated are made of a corrosion-resistant alloy, a nickel flash or nickel strike shall be electrodeposited instead of the copper flash or copper strike.

3.2.3 Silver Plating

Parts shall be plated by electrodeposition of silver from a suitable silver plating solution directly onto the flash or strike surfaces of 3.2.2 or 3.2.2.1.

3.2.4 Rhodium Plating

Parts shall be plated by electrodeposition of rhodium from a rhodium sulfate, rhodium phosphate, or other suitable rhodium plating solution onto the silver plating surfaces.

3.2.5 Spotting in is not permitted.

3.3 Hydrogen Embrittlement Relief

After plating, rinsing and drying, ferrous parts shall be treated in accordance with AMS2759/9 using the parameters specified for silver.

3.4 Properties

The silver-rhodium plating shall conform to the following requirements:

3.4.1 Thickness

Thickness of plating shall be as specified on the drawing, determined in accordance with any of the following methods as applicable: ASTM B487, ASTM B568, or other method permitted by the cognizant engineering organization.

3.4.1.1 Minimum plating thickness shall be as follows:

3.4.1.1.1 Copper or Nickel Flash or Strike

Not less than 0.0001 inch (2.5 µm).

3.4.1.1.2 Silver Plate

Not less than 0.0005 inch (12.7 µm).

3.4.1.1.3 Rhodium Flash

Not less than 0.00002 inch (0.5 µm).

3.4.1.2 Thickness requirements apply to surfaces that can be touched by a sphere 0.75 inch (19 mm) in diameter. Plating thickness in such areas shall be substantially uniform, except that that slight build-up on exterior corners or edges is permitted if within drawing dimensional requirements.

3.4.1.3 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.

3.4.1.4 If internal surfaces as defined in 3.4.1.3 are required to be plated to a specified thickness, notes on the drawing shall specify thickness.

3.4.2 Adhesion

Plating shall be firmly and continuously bonded to the underlying metal, determined on representative parts or test panels in accordance with a method described in ASTM B571. A test shall be selected from ASTM B571 from those specified for silver electrodeposits.

3.4.3 Corrosion Resistance

Ferrous metal parts or representative test panels as in 4.3.3 shall show no evidence of corrosion of the basis metal, determined by exposure for 100 hours to salt spray corrosion test conducted in accordance with ASTM B117.

3.4.4 Hydrogen Embrittlement

The plating process after baking shall not cause hydrogen embrittlement in steel parts determined in accordance with 4.3.3.3.

3.5 Quality

Plating, as received by purchaser, shall be sound, smooth, continuous, adherent to the basis metal, uniform in color, and free from blisters and other imperfections detrimental to usage of the plating. There shall be no evidence of double plating and spotting-in.

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 actual parts are required for tests, such parts shall be supplied by 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 requirements of this specification.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (3.4.1), adhesion (3.4.2), 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

Corrosion resistance (3.4.3) is a periodic test and shall be performed at least monthly unless frequency of testing is specified by the cognizant engineering organization. Hydrogen embrittlement when required (3.4.4) is a periodic test and shall be performed in accordance with 4.3.3.3 at least once in each month that steel parts 36 HRC and over are plated unless frequency of testing is specified by the cognizant engineering organization. Tests of cleaning and processing 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 8.5.

4.2.2.1 Periodic testing may be suspended in any test period (e.g., month or quarter) when parts are not processed.

4.2.3 Preproduction Tests

All property verification tests (section 3.4) are preproduction tests and shall be performed prior to production and when the cognizant engineering organization requires confirmatory testing.

4.3 Sampling for Testing

4.3.1 Acceptance Tests

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, 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 TEST

Number of Parts in Lot	Quality	Thickness and Adhesion
1 to 6	all	3 or all*
7 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
501 to 700	50	8
701 to 1200	75	10
Over 1200	125	15

* Whichever is less

4.3.2 Periodic Tests

Sample quantity shall be four for corrosion resistance. For hydrogen embrittlement, sample quantity shall be as specified in ASTM F 519 unless otherwise specified by the cognizant engineering organization.

4.3.3 Sample Configuration

Nondestructive testing shall be performed wherever practical. Except as noted, actual parts shall be selected as samples for tests. When representative specimens are used for acceptance testing, values so obtained shall be correlated with those of parts since properties, such as thickness, may differ between parts and representative test specimens.

4.3.3.1 Representative test specimens may be used in lieu of parts 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, representative 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 Corrosion Testing

When ferrous alloy parts are processed within the test period (quarter), representative test specimens shall be low carbon or low alloy steel 0.025 inch (0.6 mm) minimum thickness and not less than 4 x 6 inches (102 x 152 mm) or bars approximately 0.5 inch (13 mm) in diameter and four inches (102 mm) long having a surface roughness not to exceed 40 microinches (1 µm) AA. Representative test specimens for aluminum alloy parts (same specimen size as for steel) shall be made of either 2024-T3 or the same generic class of alloy as the parts processed within the test period when aluminum alloy parts are plated. Representative test specimens, made of the predominant generic class of alloy as the parts and plated within the test period may be used when permitted by the cognizant engineering organization. Alternative alloy or configuration may be used when permitted by the cognizant engineering organization. Plating thickness shall be 0.0005 inch (13 µm) maximum.

4.3.3.3 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F519 Type 1a.1 using round notched specimens, unless a different specimen is specified by the cognizant engineering organization, stressed in tension under constant load. For test purposes, the minimum plating thickness measured on the smooth section of the specimen shall be 0.0005 to 0.0007 inch (13 to 18 µm), Specimen shall show visual plating coverage at the root of the notch.

4.4 Approval

4.4.1 The process and control factors, a preproduction sample, or both, whichever is specified, shall be approved by the cognizant engineering organization 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 cognizant engineering organization for process reapproval 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 plated parts.

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

Surface preparation and cleaning method
Current density
Bath types and composition control limits
Bath temperature/time limits and controls
Stripping procedure if used
Method for determining plating thickness
Type of adhesion test
Periodic test plan for cleaning and processing solutions. See 8.5.

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 specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, part number, AMS2413F, and quantity.