SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2413E

Issued JAN 1961
Revised APR 2002
Reaffirmed APR 2007

Superseding AMS 2413D

Plating, Silver-Rhodium

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for electrodeposition of silver and rhodium and the properties of the deposit.

1.2 Application:

This electrodeposit has been used typically to provide a conductive surface for electrical contacts, 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 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

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

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 487	Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
ASTM B 568	Measurement of Coating Thickness by X-Ray Spectrometry
ASTM B 571	Adhesion of Metallic Coatings
ASTM F 519	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.

3.1.2 Steel parts having hardness of 40 HRC or higher and which have been roll threaded or ground after heat treatment shall be cleaned to remove surface contamination and stress relieved before cleaning for plating. Temperatures to which parts are heated shall be such that maximum stress relief is obtained without reducing hardness of parts below drawing limits, but, unless otherwise specified, not less than 275 °F (135 °C) for five hours for parts 55 HRC or over; for other parts, use 375 °F (191 °C) for four hours.

3.1.3 Parts shall have clean surfaces, free from water break, prior to immersion in the plating solution.

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 which are to be plated all over, locations shall be acceptable to purchaser; for parts which are not to be plated all over, locations shall be in areas where plating is not required.

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 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 AMS 2759/9 using the parameters specified for cadmium.

3.4 Properties:

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

3.4.1 Thickness: Shall be as follows, unless otherwise specified, determined on representative parts or on test panels as in 4.3.3 in accordance with ASTM B 487, ASTM B 568, or other method acceptable to purchaser.

3.4.1.1 Copper or Nickel Flash or Strike: Not less than 0.0001 inch (2.5 µm).

3.4.1.2 Silver Plate: Not less than 0.0005 inch (12.7 µm).

3.4.1.3 Rhodium Flash: Not less than 0.00002 inch (0.5 µm).

3.4.1.4 The plate shall be uniform in thickness on significant surfaces except that slight build-up on exterior corners or edges will be permitted provided drawing dimensions are met.

3.4.1.5 Thickness requirements apply to surfaces that can be touched by a sphere 0.75 inch (19 mm) in diameter. Other areas, such as surfaces of holes, recesses, internal threads, or contact areas of parts plated all over, where a controlled deposit cannot be obtained under normal plating conditions, shall show evidence of plating.

3.4.1.5.1 If internal surfaces as defined in 3.4.1.5 are required to be plated to a specified thickness, notes on the drawing shall so specify.

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 B 571. A test shall be selected from ASTM B 571 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 B 117.

3.4.4 Hydrogen Embrittlement: The plating process shall not cause hydrogen embrittlement in ferrous metals. Testing in accordance with the requirements of ASTM F 519 Type 1A using notched round specimens, unless a different specimen type is specified by the purchaser, stressed in tension under constant load, is required only when parts 36 HRC or higher are plated. For test purposes, plating thickness shall be measured on the smooth section of the specimen, but with visual plating at the root of the notch.

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 processing vendor shall supply all samples for vendor's tests and shall be responsible for the performance of all required tests. Where actual parts are to be tested, such parts shall be supplied by purchaser. Purchaser 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 each lot.

4.2.2 Periodic Tests: Corrosion resistance (3.4.3), hydrogen embrittlement when required (3.4.4), and tests of cleaning and plating solutions (see 8.7) to ensure that the deposited metal will conform to specified requirements, are periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of plated parts to a purchaser, when a change in material and/or processing requires reapproval by the cognizant engineering organization (See 4.4.2), and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be not less than the following; a lot shall be all parts of the same part number, made of the same alloy, plated to the same range of plate thickness in the same set of solutions within a consecutive 24-hour period of operation, and presented for processor's inspection at one time.

4.3.1 For Acceptance Tests: Test samples shall be selected randomly from all parts in a lot. Unless purchaser specifies 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	Quality	Thickness and Adhesion
1 to 6	all	3
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

4.3.1.1 Thickness and Adhesion Tests: Separate test panels of the same generic class of alloy as the parts distributed throughout the lot, cleaned, plated, and post treated with parts represented shall be used when plated parts are of such configuration or size as to not be readily adaptable to the specified tests or when nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts.

4.3.1.2 Corrosion Tests: Panels shall be low carbon steel approximately 0.032 x 4 x 6 inches (0.8 x 102 x 152 mm) or bars approximately 0.5 inch (13 mm) in diameter and 4.0 inches (102 mm) long.

4.3.2 For Periodic Tests: Sample quantity and frequency of testing shall be at the discretion of the processor unless a test frequency is specified by the purchaser. Tests for hydrogen embrittlement are applicable only when parts having hardness of 36 HRC or higher are plated.

4.3.3 Sample Configuration: Nondestructive testing shall be performed wherever practical and authorized herein. Except as noted, actual parts shall be selected for tests.

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 The processor of plated parts shall make no significant change to materials, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, could affect the properties or performance of the plated parts.