AEROSPACE MATERIAL SPECIFICATION

AMS2412 REV. K

Issued 1945-08
Revised 2015-01

Superseding AMS2412J

(R) Plating, Silver
Copper Strike, Low Bake

RATIONALE

AMS2412K 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:

    - AMS2412K
    - Plating thickness desired (See 3.4.1)
    - Basis metal to be plated
    - Tensile strength or hardness of the basis metal
    - Preplate stress relief to be performed by plating processor (time and temperature) if different from 3.1.1
    - 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 3.4.1.2)
    - 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: +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/AMS2412K

1. SCOPE

1.1 Purpose

This specification covers the requirements for silver deposited on metal parts with a copper strike between the basis metal and the silver deposit.

1.2 Application

This process has been used typically to provide a bearing surface and to prevent galling or seizing of metal surfaces of parts made of materials where a high baking temperature may be detrimental to the properties of the basis material.

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 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

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 B487 Measurement of Metal and Oxide Coating Thicknesses 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 of Metallic Coatings

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

ASTM F519 Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environment

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

ASME B46.1 Surface Texture

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress Relief Treatment

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

3.1.1.1.1 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 (135 °C ± 14) for 5 to 10 hours.

3.1.1.1.2 For parts having a hardness less than 55 HRC, and for nitrided parts, 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.

3.1.1.1.3 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.

3.1.2 Plating shall be applied over a clean and active surface that will result in a deposit that shall meet the adhesion and quality requirements of this specification. The pretreatment process shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.3 Surface texture of surfaces to be plated other than that of nuts shall be 80 microinches (2 µm) RHR or smoother determined in accordance with ASME B46.1.

3.1.4 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 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 other location acceptable to the cognizant engineering organization.

3.2 Procedure

3.2.1 Parts shall be silver plated by electrodeposition over a preliminary plating of copper 0.0005 inch (13 µm) maximum. The copper strike may be omitted in plating copper and copper alloys, except for copper alloys containing zinc in quantities of 30% or more by weight. A nickel flash shall be used before the copper strike when plating corrosion-resistant steels. The use of organic base grain refining and brightener additives shall be prohibited in the both the silver strike and silver plate solutions.

3.2.2 Double plating and spotting in are prohibited.

3.3 Post Treatment

3.3.1 Hydrogen embrittlement relief of steel parts 40 HRC or higher shall be in accordance with AMS2759/9.

3.3.2 Other parts not covered by 3.3.1, except nuts, shall be heated to 300 to 500 °F (149 to 260 °C) after plating, rinsing and drying and held at heat for not less than 2 hours. If such heating would lower the hardness of the parts below drawing limits, or otherwise damage the parts, the heating shall be accomplished at the highest practicable temperature that will maintain specified properties of the basis metal.

3.4 Properties

Plated parts shall conform to the following requirements:

3.4.1 Thickness of the deposit shall be as specified on the drawing, determined in accordance with any of the following methods as applicable: ASTM B487, ASTM B499, ASTM B567, ASTM B568, ASTM B748, ASTM B504, ASTM E376, or other method acceptable to the cognizant engineering organization.

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

3.4.1.2 All surfaces of the part, except those which 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 Composition

The deposit shall be not less than 99.9% silver determined by a method acceptable to the cognizant engineering organization.

3.4.3 Adhesion

The deposit shall be firmly and continuously bonded to the underlying metal as determined by the following tests:

3.4.3.1 Parts, shall show no blisters or other indications of poor bond.

3.4.3.2 Nuts shall show no peeling of the silver when scratched with a knife or other sharp tool.

3.4.3.3 Parts, other than nuts, shall meet the requirements of ASTM B571 by the Burnish Test, Chisel-Knife Test, Heat-Quench Test, or the Bend Test method using a 4T mandrel.

3.4.3.4 When specified, glass bead peening shall be used as an alternative to the above (See 8.9).

3.4.4 Hydrogen Embrittlement

The plating process shall not cause hydrogen embrittlement in steel parts, determined in accordance with 4.3.4.

3.5 Quality

3.5.1 Plating, as received by purchaser, which is not subsequently machined, shall be smooth, continuous, uniform in appearance, and visually free from blisters and other imperfections detrimental to the usage of the parts. Slight staining or discoloration is permissible. Selectively plated areas shall be sharply defined. There shall be no evidence of electrical arcing or local overheating. There shall be no evidence of spotting-in or double plating.

3.5.2 Silver plate which is to be machined shall be free from excessive modulation or treeing at edges. Finished parts shall be free from visible pits excessive porosity, and other imperfections detrimental to fabrication or to performance of parts.

3.5.3 Abrasion of plating on corners and edges of nuts is acceptable but plate shall be continuous on threads. Marking 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 required for tests, such 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 specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

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

4.2.2 Periodic Tests

Composition (3.4.2) and hydrogen embrittlement (3.4.4) are periodic tests and shall be performed at least once each month that parts are processed. Adhesion (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.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 8.4.and 4.4.3.

4.2.3 Preproduction Tests

All property verification tests (3.4) are preproduction tests and shall be performed prior to production and when the cognizant engineering organization deems confirmation testing necessary.

4.3 Sampling for testing shall be not less than the following; a lot shall be all parts of the same part number, plated to the same range of plate thickness in the same set of solutions in each consecutive 24 hours of operation, and presented for processor's inspection at one time.

4.3.1 Acceptance Tests

Test samples shall be randomly selected from all parts in the lot. 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
Up to 7	All	All or 3*
8 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 quantities shall be selected at the discretion of the processor, unless otherwise specified. For adhesion tests, four test specimens of each generic class of alloy, as defined by AS2390, that have been be 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 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 tests, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts. When used, separate test specimens shall be made of the same generic class of alloy as the parts, distributed within the lot, cleaned, plated, and post-treated with the parts represented. For thickness on tests, such specimens shall be panels of annealed, low-carbon steel approximately 0.032 x 1 x 4 inch (1 x 25 x 100 mm). For adhesion tests, such specimens shall be made of the same generic class of alloy as defined by AS2390 processed. 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).

4.3.4 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F519, Type 1a.1, using notched round bars, unless a different specimen is specified by the cognizant engineering organization, stressed in tension under sustained load. For test purposes, the plating thickness shall be 0.002 inch ± 0.0002 (51 µm ± 5) measured on the smooth unnotched sections of the specimen, but with visual evidence of plating in the root of the notch. Testing beyond the 200 hour test period is not required.

4.4 Approval

4.4.1 The process and control factors and/or a preproduction part, 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 purchaser for process reapproval 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 parts.

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

Surface preparation and cleaning method
Plating bath composition and composition control limits
Plating bath temperature limits and controls
Thermal post treatment times and temperatures
Method for determining plating thickness
Stripping procedure, when applicable
Rack locations
Current density (amps per part or amps per total surface area of the parts plated at one time in each tank)
Periodic test plan for cleaning and processing solutions (See 8.4).

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 the specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS2412K, part number, lot identification and quantity.

4.6 Resampling and Retesting

4.6.1 If any acceptance test fails to meet specified test requirements, the parts in that lot may be stripped, pretreated, plated, and post treated as defined herein and retested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped, pretreated, plated, post treated as defined herein, and retested. After stripping and replating, parts shall meet the dimensions on the drawing.

4.6.1.1 When stripping is performed, the method shall be acceptable to the cognizant engineering organization and shall not roughen, pit, or embrittle the basis metal or adversely affect part dimensions, pretreated, coated, and post treated as defined herein. When parts have been stripped and replated, the processor shall document the process.

4.6.2 If any periodic test fails to meet specified test 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. The cognizant engineering organization shall be notified of all parts plated since the last acceptable test. Alternatively, adhesion test failures on plated parts may be dispositioned as specified in 4.6.1.

5. PREPARATION FOR DELIVERY

5.1 Plated parts shall be handled and packaged in such a manner as will ensure that the required physical characteristics and properties of the plating are preserved.

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

6. ACKNOWLEDGMENT

The processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

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

8. NOTES

8.1 A change bar (l) 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 Part manufacturing operations, such as heat treatment, forming, joining, and media finishing, can affect the condition of the substrate for plating, or, if performed after plating, could adversely affect the plate. The sequencing of these operations should be specified by the cognizant engineering organization and is not controlled by this specification.

8.3 The parts manufacturer should ensure that the surfaces of the metal parts supplied to the plater shall be free from blemishes, pits, tool marks, and other irregularities that will affect the quality of the finished parts. Defects and variations in appearance that arise from surface conditions of the substrate, such as porosity, scratches, or inclusions, that persist in the finish plate despite the observance of accepted industry practices shall not be cause for rejection.

8.4 ARP4992, Periodic Test Plan for Process Solutions, is recommended to satisfy the requirements for the control of processing solutions.

8.5 An acid dip may be used for surface activation or neutralization of residual alkaline cleaner. However, the immersion time should be minimized to preclude pitting.

8.6 Terms used in AMS are clarified in ARP1917. ASTM B374 “Terminology Relating to Electroplating” should be utilized as a reference and referee document when areas of design definition or technical interpretation arise.

8.6.1 Plating is intended to be deposited in an uninterrupted process except as may be required by the operator for making thickness measurements. After the plate has dried, resumption of plating can result in detectable visual discontinuities or weak interlaminar adhesion that may not be readily apparent. Such resumption of plating is known as ‘double plating’ and localized addition of plate is known as ‘spotting-in.’

8.7 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.

8.8 Similar Specifications

Federal QQ-S-365 is listed for information only and shall not be construed as an acceptable alternate unless all requirements of this AMS are met.

8.9 Glass bead peen-blasting has been shown as an acceptable alternative to conventional adhesion testing methods shown in ASTM B571. Typical peen blast parameters for silver plate have been 4 to 6 inches nozzle to work distance, 30 psi pressure using a suction type machine with the hopper at or slightly higher than the suction nozzle or 10 psi using a pressure type machine, and 20 seconds minimum per square inch of plated area. Glass beads should be of a size to create a peening action and the machine should have separation equipment to remove broken glass.

PREPARED BY AMS COMMITTEE "B"