

Plating, Silver
Copper Strike, Low Bake

RATIONALE

This specification revision was issued as part of the SAE Five Year Review process.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the plating processor by the purchaser.

Purchase order shall specify not less than the following:

1. AMS 2412H
 - 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.

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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
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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.

AMS 2759/9 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 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 567	Measurement of Coating Thickness by the Beta Backscatter Method
ASTM B 568	Measurement of Coating Thickness by X-Ray Spectrometry
ASTM B 571	Adhesion of Metallic Coatings
ASTM E 376	Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods
ASTM F 519	Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals

2.3 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 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 Steel parts having a hardness of 40 HRC or higher and which have been ground, machined, or cold straightened after heat treatment shall be cleaned to remove surface contamination and stress relieved before preparation 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 not less than five hours for parts having hardness of 55 HRC or higher or not less than 375 °F (191 °C) for not less than four hours for other parts.
- 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 AMS 2759/9.
- 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 two 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 B 487, ASTM B 499, ASTM B 568, ASTM B 748, ASTM B 504, ASTM E 376, 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 Nuts, and other parts, shall show no blisters or other indications of poor bond.

3.4.3.2 Parts, other than nuts, shall meet the requirements of ASTM B 571 by the Bend Test method using a 4T mandrel.

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

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), adhesion (3.4.3), 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. 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 (section 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 and Adhesion
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.

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, specimens shall be panels approximately 0.032 x 1 x 4 inches (1 x 25 x 102 mm) fabricated from a material generically similar to the parts.

4.3.4 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F 519, Type 1a.1, using notched round bars, unless a different specimen is specified by the cognizant engineering organization, stressed in tension under constant load. For test purposes, the plating thickness shall be 0.002 inch \pm 0.0002 (51 μ m \pm 5) measured on the smooth unnotched sections of the specimen, but with visual evidence of plating in the root of the notch.

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.