Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 2411C
Superseding AMS 2411B
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SILVER PLATING
For High Temperature Applications

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electrodeposition of silver on other metals, usually with a nickel strike between the basis metal and the silver, and the properties of the deposit.

1.2 Application: Primarily to prevent galling or seizing of surfaces of parts, such as fasteners, made of low-alloy steel, corrosion and heat resistant steel, and nickel alloys for use up to 1400°F (760°C).

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 5616 - Steel Bars, Forgings, Tubing, and Rings, Corrosion and Moderate Heat Resistant, 13Cr - 2.0Ni - 3.0W
AMS 5640 - Steel Bars and Forgings, Corrosion Resistant, 18Cr - 9.0Ni (SAE 30303, SAE 30303Se, SAE 30303Mod), Free Machining
AMS 5643 - Steel Bars, Forgings, Tubing, and Rings, Corrosion Resistant, 16Cr - 4.0Ni - 0.30(Cb + Ta) - 4.0Cu
AMS 5709 - Alloy Bars and Forgings, Corrosion and Heat Resistant, Nickel Base, 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 1.4Al, Consumable Electrode or Vacuum Induction Melted, 1975°F (1080°C) Solution, Stabilization, and Precipitation Heat Treated
AMS 5732 - Steel Bars, Forgings, Tubing, and Rings, Corrosion and Heat Resistant, 15Cr - 25.5Ni - 1.3Mo - 2.1Ti - 0.006B - 0.30V, Consumable Electrode Melted, 1800°F (982°C) Solution and Precipitation Heat Treated
AMS 6304 - Steel Bars, Forgings, and Tubing, Low-Alloy, Heat-Resistant, 0.95Cr - 0.55Mo - 0.30V (0.40 - 0.50C)

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
ASTM B499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM B504 - Measurement of the Thickness of Metallic Coatings by the Coulometric Method
ASTM E376 - Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods

Printed in U.S.A.

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

2.3.2 ANSI Publications: Available from American National Standards Institute, 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 Prior to cleaning, texture of surfaces to be plated on parts other than nuts shall, unless otherwise specified, be not rougher than 80 microin. (2 µm), determined in accordance with ANSI B46.1.

3.1.2 Parts shall have chemically clean surfaces, prepared with minimum abrasion, erosion, or pitting, prior to immersion in the plating solution.

3.1.2.1 After cleaning and prior to immersion in the plating solution, parts may be etched in a suitable solution, such as ferric chloride-hydrochloric acid, to promote adhesion.

3.1.3 Electrical contacts between the parts and power source shall be made in such a manner as will ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur. If parts are to be plated all over, contact points shall be located where specified or where agreed upon by purchaser and vendor. If parts are not required to be plated all over, contact points shall be located in areas on which plating is not required or is optional.

3.2 Procedure:

3.2.1 Parts shall be plated in the following sequence:

Nickel Strike
Silver Strike
Silver Plate

3.2.1.1 When approved by purchaser, another procedure may be substituted for the nickel strike.

3.2.2 The plated parts shall be removed from the plating solution, thoroughly rinsed, and dried.

3.3 Properties: The deposited silver shall conform to the following requirements:

3.3.1 Thickness: Shall be as follows, determined on representative parts or test panels in accordance with ASTM B487, ASTM B499, ASTM B504, ASTM E376, or other method agreed upon by purchaser and vendor:

3.3.1.1 Where silver flash is specified, plate thickness shall be approximately 0.0001 in. (3 µm).

3.3.1.2 Thickness of plate other than flash shall be as specified on the 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.

3.3.2 Composition: Silver as plated shall be not less than 99.9% pure; the process of plating shall be controlled to produce this purity.

3.3.3 Adhesion: Plated silver shall be firmly and continuously bonded to the underlying metal, determined on representative parts or test panels as follows:

3.3.3.1 Parts or test panels to be adhesion tested shall be heated in an air atmosphere to the following applicable temperature, held at heat within ±15°F (±8°C) for not less than 2 hr, and cooled in still air.

3.3.3.1.1 Parts or test panels made of low-alloy steels, such as AMS 6304, and martensitic or precipitation-hardenable corrosion resistant steels, such as AMS 5616 or AMS 5643, shall be heated at 900°F (480°C).

3.3.3.1.2 Parts or test panels made of austenitic corrosion resistant steels, such as AMS 5640, and precipitation hardenable, corrosion and heat resistant steels, such as AMS 5732, shall be heated at 1200°F (650°C).

3.3.3.1.3 Parts or test panels made of precipitation-hardenable, corrosion and heat resistant nickel alloys, such as AMS 5709, shall be heated at 1400°F (760°C).

3.3.3.1.4 Parts or test panels made of materials of a type not listed in 3.3.3.1.1 through 3.3.3.1.3 shall be heated at the temperature specified on the drawing.

3.3.3.2 After heating as in 3.3.3.1, parts or test panels shall be examined at 10X magnification. Parts shall be free of detrimental blisters and of indications of poor bond such as flaking and lifting of the plating. Numerous small blisters are acceptable provided the parts meet the adherence requirements of 3.3.3.3. Blisters 0.015 in. (0.38 mm) and larger diameter, measured under 10X magnification, are not acceptable.

3.3.3.3 After visual examination as in 3.3.3.2, parts or test panels, shall be shear or chisel tested as follows to indicate quality of the bond: a sharp knife or other blade shall be positioned on the plating, with the plane of the blade at an angle of approximately 45 deg to the plane of the plating, and drawn with steady pressure over the plating on significant surfaces of the part; direction of motion of the blade shall be such as to produce a chiseling or whittling action on the plate. There shall be no signs of peeling of the plating from the underlying metal except where the chiseling or whittling action cuts through blisters permitted by 3.3.3.2. If parts show lifting and/or peeling of the plating except where the cutting is through blisters, all parts of the lot represented shall be rejected unless there is indication of shearing or cutting effect on the plating adjacent to the area from which blisters have been removed.

3.4 Quality:

3.4.1 Silver plate which is not subsequently machined shall be sound, smooth, continuous, uniform Ø in color, and free from blisters and other imperfections detrimental to usage of the parts. Selectively plated areas shall be sharply defined.

3.4.2 Silver plate which is to be machined shall be sound, and free from excessive nodulation or Ø treeing at edges. Finished parts shall be free from visible pits, excessive porosity, and other imperfections detrimental to usage of the parts.

3.4.3 Abrasion of plating on corners and edges of threaded fasteners is acceptable but plate shall be continuous on the threads. Marking of the cone section of self-locking nuts, produced in offsetting the locking beams or other deformation, is acceptable.

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 performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform such confirmatory testing as deemed necessary to ensure that processing conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for thickness (3.3.1) and quality (3.4) are classified as acceptance tests and shall be performed to represent each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for composition (3.3.2) and adhesion (3.3.3) and of cleaning and plating solutions to ensure that the plate will conform to the requirements of this specification are classified as periodic tests and shall be performed at a frequency selected by the processing vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the initial shipment of plated parts to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be not less than the following; a lot shall be all parts made of the same alloy, plated to the same range of plate thicknesses in the same solutions in each consecutive 8-hr period of operation, and presented for vendor's inspection at one time:

4.3.1 For Acceptance Tests:

4.3.1.1 Thickness: Three parts from each lot.

4.3.1.2 Quality: As agreed upon by purchaser and vendor.

4.3.2 For Periodic Tests and Preproduction Tests: As agreed upon by purchaser and vendor.

4.3.3 When plated parts are of such configuration or size as to be not readily adaptable to the specified tests, separate test specimens cleaned and plated with the parts they represent may be used. For adhesion tests, such specimens shall be strip of the same type of alloy as the parts being plated approximately 0.032 x 4 x 1 in. (1 x 100 x 25 mm) and for thickness and quality tests shall be panels of the same size and type or shall be bars approximately 0.5 in. (15 mm) in diameter and 4 in. (100 mm) long.

4.4 Approval:

4.4.1 Plated parts shall be approved by purchaser before parts for production use are supplied, unless such approval be waived. Results of tests on production parts shall be essentially equivalent to those on the approved sample parts.