SAE The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2451

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Submitted for recognition as an American National Standard

PLATING, BRUSH
General Requirements

1. SCOPE:

1.1 Purpose:

This specification and its supplementary detail specifications establish the requirements and process controls for electrodeposition of metals by brush plating.

1.2 Application:

This process has been used typically to improve surface properties such as corrosion resistance, wear resistance, and brazeability or to repair damaged, worn, or mismachined parts, but usage is not limited to such applications. This process is particularly useful for plating localized areas on-site, especially on large parts or assemblies, and for minimizing masking.

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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchaser order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2759 Heat Treatment of Steel Parts - General Requirements
AMS 2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
TO PLACE A DOCUMENT ORDER: (724) 776-4970 FAX: (724) 776-0790
SAE WEB ADDRESS: http://www.sae.org

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 16428-2959.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 487	Measurements 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 Metal
ASTM B 504	Measurement of Thickness of Metallic Coatings by the Coulometric Method
ASTM B 530	Measurements of Coating Thicknesses by Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates
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 290	Semi-Guided Bend Test for Ductility of Metallic Materials
ASTM E 376	Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods
ASTM E 384	Microhardness of Materials
ASTM F 519	Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 Steel parts which have been ground or formed after heat treatment to 180 ksi (HRC 40) or higher, shall be stress relieved before plating in accordance with the process controls of AMS 2759. The stress-relieving temperature shall be 375 °F (191 °C), or 50 °F (10 °C) below the tempering temperature, except for parts tempered below 375 °F, the stress-relieving temperature shall be 275 °F (135 °C).

3.1.2 Surfaces to be plated shall be free of waterbreak prior to plating.

3.1.3 Electrical contacts shall be in areas where plating is not required or in other areas acceptable to the purchaser.

3.2 Procedure:

3.2.1 The equipment, materials, and procedures used to process specimens and parts shall conform to a schedule of control factors (see 4.4.2) and to the recommendations of the manufacturer of the selective plating equipment and processing materials.

3.2.2 Parts and samples, and specimens shall be plated by trained operators who have been approved initially and periodically thereafter for plating on the basis material with the equipment and processing materials to be used. Operator training shall include plating of simulated parts and specimens, and approval shall be based on evaluation of the operator's familiarity with the brush plating equipment/solutions, and the specification requirements. The company (facility) should have a program of training or instruction which includes study of equipment/solutions and the practice of brush plating.

3.2.3 After plating, parts shall be rinsed with water, to remove residual plating solution, and immediately dried.

3.2.4 Hydrogen Embrittlement Relief: Of steel parts shall be performed in accordance with AMS 2759/9 except as follows:

3.2.4.1 It is not required for parts plated with cadmium in accordance with B96AK/4 if plated specimens have passed the test of ASTM F 519 (see 3.3.2.6) without hydrogen embrittlement relief.

3.2.4.2 Parts plated with copper in accordance with B96AK/6 shall be treated as specified in AMS 2759/9 for cadmium-plated parts.

3.3 Properties:

3.3.1 The following requirements apply to all detail specifications:

3.3.1.1 Thickness: Plating thickness shall be as specified on the drawing/purchase order and shall be determined on representative specimens or parts in accordance with ASTM E 376, ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 530, ASTM B 567, ASTM B 568, or other method acceptable to the purchaser. Unless otherwise specified, plating thickness shall be uniform within ± 20%, except within 1/8 inch (3.2 mm) of exterior edges and corners where thicker plating (buildup) is permissible.

3.3.1.2 Adhesion to Parts: There shall be no visual evidence of plating separation from the basis metal when the following test is performed. Tape, one-inch (25 mm) wide or wider, having adhesive strength of not less than 60 ounces per inch (0.66 N/mm) of width, shall be firmly applied to the plated area. It shall then be pulled manually from the plated area at approximately 90 degrees to the plated surface in one sharp movement. When both unplated and plated areas can be covered by the tape, it shall be pulled from the unplated area toward the plated area.

3.3.1.2.1 When plating is to be subsequently machined, this test may be omitted if acceptable to the cognizant engineering organization.

3.3.2 The following requirements only apply when specified in a detail specification.

3.3.2.1 Adhesion to Specimens: Specimens (see 4.3.3) shall be bent around a diameter equal to the thickness of the specimen in accordance with ASTM E 290. There shall be no evidence of separation of plating from the basis metal when examined at 4X magnification; cracks which do not result in flaking or peeling of the plate are acceptable.

3.3.2.2 Hardness: Hardness values shall be as specified and shall be determined in accordance with ASTM E 384.

3.3.2.3 Stress: The residual surface stress in the deposit shall be as specified in a detailed specification and shall be determined by X-Ray diffraction or another method which is acceptable to the purchaser.

3.3.2.4 Heat Resistance:

3.3.2.4.1 Plated ferrous and corrosion-resistant parts or specimens shall withstand without blistering, cracking, or debonding, being heated in air to 700 °F ± 15 (371 °C ± 8) and held at temperature for not less than 23 hours, followed by heating in air to 1000 °F ± 15 (538 °C ± 8) and holding at temperature for not less than 60 minutes, then air cooling to room temperature.

3.3.2.4.2 Plated aluminum and aluminum-alloy parts or specimens, and copper and copper-alloy parts or specimens, shall pass the heat-quench test of ASTM B 571.

3.3.2.5 Corrosion Resistance: Representative specimens shall be plated and post-plating treated as specified in a detail specification. There shall be no visual evidence of corrosion of the basis metal on plated surfaces after continuous exposure to salt spray, in accordance with ASTM B 117, for 48 hours, -0, +1, unless another period is specified.

3.3.2.6 Hydrogen Embrittlement: When steel parts, heat treated to 180 ksi (HRC 40) minimum or higher, are to be plated in accordance with B96AK/4, three specimens conforming to Type 1a or Type 2a of ASTM F 519, shall be plated. Plating thickness shall be 0.0003 to 0.0006 inch (8 to 15 µm) except in the notch of Type 1a specimens, only visual evidence of plating is required. The specimens shall be tested in accordance with ASTM F 519 except that the specimens shall not be baked between plating and testing.

3.4 Quality:

To the unaided eye, the plating shall be continuous and free from plating defects such as frosty areas, pin holes, blisters, porosity, nodules, and pits; slight staining or discoloration is permissible. Parts shall be free from evidence of arcing and of overheating.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor shall be responsible for performance of all tests and shall supply all specimens required for processor's tests. When parts are to be tested, such parts shall be supplied by purchaser. The purchaser reserves the right to sample and perform any confirmatory testing deemed necessary to ensure that plating conforms to the specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.3.1.1), adhesion to parts (3.3.1.2), and quality (3.4) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Adhesion to specimens (3.3.2.1), hardness (3.3.2.2), stress (3.3.2.3), heat resistance (3.3.2.4), corrosion resistance (3.3.2.5), hydrogen embrittlement (3.3.2.6), and tests of preparatory and plating solutions to ensure that deposited metal will conform to specified requirements are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by the purchaser.

4.2.3 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed for each schedule of control factors prior to initial shipment of plated parts to a purchaser, when a change in material and/or processing requires reapproval as in 4.4.3, and when purchaser deems confirmatory testing is required.

4.3 Sampling and Testing:

A lot shall be all parts plated by the same schedule of control factors, processed without a change of setup within a seven-day period by the same operator, and presented for processor's inspection at one time.

4.3.1 Sampling for Acceptance Tests: The number of parts in the sample shall conform to Table 1. Parts to be tested for thickness (3.3.1.1) and adhesion (3.3.1.2) shall be selected randomly from the entire lot.

TABLE 1 - Sampling For Acceptance Tests

Number of Parts in lot	Quality	Thickness	Adhesion
1 to 6	All	All	All
7 to 15	All	7	All
16 to 40	All	8	16
41 to 100	All	10	20
101 to 300	All	12	24
301 to 500	All	14	28
over 500	All	16	32

4.3.2 Process Monitoring: Processing shall be monitored to verify conformance to 3.2.

4.3.3 When impractical to perform a specified test on parts, separate test specimens may be used. Specimens shall be of the same class of material as the parts represented and shall be processed with the parts. Specimens with the following dimensions are acceptable: Flat -0.040 x 1 x 4 inches (1 x 25 x 102 mm); round - 1-inch (25 mm) diameter x 4 inches (102 mm); specimens having alternative dimensions may be used providing they are suitable for the test.

4.4 Approval:

4.4.1 The schedule of control factors (4.4.2) shall be approved by the cognizant engineering organization before production parts are supplied. In addition, if specified by the purchaser, a preproduction sample part shall be approved by the cognizant engineering organization before production parts are supplied. The schedule of control factors shall contain a level of detail sufficient to ensure reproduction of preproduction characteristics in production parts. (If supplier-proprietary information is involved, the supplier may certify that the information is proprietary and is available for review by the cognizant engineering organization.)

4.4.2 The schedule of control factors shall be maintained and shall include:

Basis metal and condition
Stress relief treatment prior to plating, if any
Surface preparation and cleaning
Equipment description
Anode design/designation
Plating solution composition or manufacturer's designation
Voltage and current ranges
Relative motion between anode and workpiece during deposition
Restrictions on interrupted plating
Embrittlement relief time and temperature, if required
Test methods
Periodic test plan

4.4.3 The processor shall make no significant change to materials, processes, or control factors from those on which 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, would affect the properties or performance of the part.

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 AMS B96AK and applicable slash (/) number, and that they conform to the specified requirements. This report shall include the purchase order number, lot number, part number, and quantity.