

Plating, Brush
General Requirements

RATIONALE

AMS 2451B is a Five Year Review and update of this specification.

1. SCOPE

1.1 Purpose

This specification and its supplementary detail specifications establish the requirements 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 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.

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

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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 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 253	Preparation of Aluminum Alloys for Electroplating
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 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 Detail Specification

The requirements for a specific brush plating shall consist of all requirements specified herein in addition to requirements specified in the applicable detail specification. In case of conflict between requirements of this basic specification and the applicable detail specification, requirements of the detail specification shall govern.

3.2 Preparation

3.2.1 Steel parts having a hardness of 40 HRC or higher and which have been ground 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.

3.2.1.1 Assemblies shall be treated in a manner acceptable to purchaser.

3.2.2 The plating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.2.3 For parts which are to be plated all over, electrical contact locations shall be acceptable to purchaser. For parts which are not to be plated all over, locations shall be in areas on which plating is not required.

3.3 Procedure

3.3.1 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.

3.3.1.1 Aluminum alloys may be zincate treated in accordance with ASTM B 253 or other method acceptable to purchaser prior to plating.

3.3.2 Parts and test 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.

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

3.3.4 Hydrogen Embrittlement Relief

Treatment of steel parts shall be in accordance with AMS 2759/9 except as follows:

3.3.4.1 Baking is not required for parts plated with cadmium in accordance with AMS 2451/4 if plated specimens have passed the test of ASTM F 519 (see 3.4.2.6) without hydrogen embrittlement relief.

3.3.4.2 Assemblies shall be treated in a manner acceptable to purchaser.

3.4 Properties

3.4.1 The following requirements apply to all detail specifications:

3.4.1.1 Thickness

Plating thickness shall be as specified on the drawing/purchase order and shall be determined on representative specimens or parts in accordance with any of the following methods as applicable: 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 $\pm 20\%$, except within 1/8 inch (3.2 mm) of exterior edges and corners where thicker plating (buildup) is permissible.

3.4.1.2 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.

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

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

3.4.2.1 Adhesion to Specimens

Adhesion shall meet the requirements of ASTM B 571 by the Bend Test method. 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.

3.4.2.2 Hardness

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

3.4.2.3 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.

3.4.2.4 Heat Resistance

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

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

3.4.2.5 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.

3.4.2.6 Hydrogen Embrittlement

The plating process shall not cause hydrogen embrittlement in steel parts, heat treated to 180 ksi (40 HRC) or higher, when plated in accordance with AMS 2451/4. 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.

3.5 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 specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (3.4.1.1), adhesion to parts (3.4.1.2), and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests

Adhesion to specimens (3.4.2.1), hardness (3.4.2.2), stress (3.4.2.3), heat resistance (3.4.2.4), corrosion resistance (3.4.2.5), hydrogen embrittlement (3.4.2.6), 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

All property verification tests (section 3.4) are preproduction tests and shall be performed for each schedule of control factors prior to initial shipment of plated parts to a purchaser 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 (3.4.1.1) and adhesion (3.4.1.2) 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 For Periodic Tests

Sample quantity and frequency shall be selected at the discretion of the processor, unless otherwise specified.

4.3.3 Process Monitoring

Processing shall be monitored to verify conformance to 3.3.

4.3.4 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 × 1 × 4 inches (1 × 25 × 102 mm); round - 1-inch (25 mm) diameter by 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 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
- Preplate, if required
- 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