



AEROSPACE MATERIAL SPECIFICATION

AMS2429™**REV. F**

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Superseding AMS2429E

Plating, Bronze
Nitriding Stop-off
90Cu - 10Sn

RATIONALE

AMS2429F results from a Five-Year Review and update of this specification with changes to Ordering Information, Definitions (see 2.3.1), Fixture/Electrical Contact Locations (see 3.1.4), Hydrogen Embrittlement Relief (see 3.3), Quality (see 3.5.3 and 3.5.4), Sample Configuration (see 4.3.3.2), and Notes (see 8.8 and 8.9).

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:

- AMS2429F
- Basis metal to be plated
- Tensile strength or hardness of the basis metal (steel alloys only)
- Plating thickness desired, if different from (see 3.4.1.1)
- If steel parts 40 HRC and above have been machined, ground, cold formed, or cold straightened after heat treatment (see 3.1.1.)
- If pre-plate stress relief is to be performed by the plating processor and, if different from 3.1.1, time and temperature to be specified
- Special features, geometry, or processing present on parts that requires special attention by the plating processor
- Optional: fixture/electrical contact locations, when not specified (see 3.1.4)
- If an alternative of the ferricyanide test method is to be used (see 4.3.4.1)
- Hydrogen embrittlement relief to be performed (time and temperature), if different from 3.3

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- Optional: periodic testing frequency (see 4.2.2) and sample quantity (see 4.3.2)
 - Quantity of pieces to be plated or to be stripped (post-nitriding)
 - Special processing, when required, to avoid or remove discoloration, post-plate (see 3.5.1) or post-strip (see 3.5.2)
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 the purchaser and is not controlled by this specification.
 3. The parts manufacturer shall ensure that surfaces of metal parts supplied to the processor are free from blemishes, pits, tool marks, and other irregularities that will affect the quality of the finished parts (see 3.5).

1. SCOPE

1.1 Purpose

This specification covers the requirements for electrodeposited bronze plate and its subsequent removal.

1.2 Application

This process has been used typically as a maskant to prevent nitriding of surfaces on which nitriding is neither required nor permitted, but usage is not limited to such applications.

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 that 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 +1 724-776-4970 (outside USA), www.sae.org.

AMS2451	Plating, Brush, General Requirements
AMS2750	Pyrometry
AMS 2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts
ARP4992	Periodic Test for Processing Solutions
AS2390	Chemical Process Test Specimen Material
AS7766	Terms Used in Aerospace Metals Specifications

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 B374	Terminology Relating to Electroplating
ASTM B487	Measurement of Metal and Oxide Coating Thickness 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 Thicknesses by the Beta Backscatter Method
ASTM B568	Measurement of Coating Thickness by X-Ray Spectrometry
ASTM B571	Qualitative Adhesion Testing of Metallic Coatings
ASTM E376	Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods
ASTM E478	Chemical Analysis of Copper Alloys
ASTM F519	Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

2.3 Definitions

Terms used in AMS are defined in AS7766.

ASTM B374 should be utilized as a reference and referee document when areas of design definition or technical interpretation arise.

2.3.1 NITRIDING

Nitriding is a heat-treating process that diffuses nitrogen into the surface of a metal to create a case-hardened surface. These processes are most commonly used on low-alloy steels.

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Stress-Relief Treatment

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 and Type D instrumentation. Parts having a hardness less than 55 HRC shall be stress relieved at 375 °F ± 25 °F (191 °C ± 14 °C) for a minimum of 4 hours. Nitrided parts fall into this category. Higher temperatures shall only be used when specified or approved by the cognizant engineering organization.

3.1.2 Substrate

Surfaces of metal parts to be plated shall be smooth and substantially free from blemishes, pits, tool marks, and other irregularities.

3.1.3 Cleaning

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 (see 8.3 and 8.4).

3.1.4 Fixture/Electrical Contact Locations

- 3.1.4.1 Except for barrel plating, for parts that are to be electroplated all over, and contact locations are not specified, contact locations shall be at the discretion of the processor.
- 3.1.4.2 For parts that are not to be electroplated all over, and contact locations are not specified, contact locations may be in areas on which plate is not required or may be in areas being plated provided the parts are moved to prevent contact marks/voids within the plating/coating.
- 3.1.4.3 Alternative methods for process completion of fixture contact points is permitted when approved by the cognizant engineering organization (see 8.9).

3.1.5 Auxiliary Anodes

Within the capability of the plating process and the configuration of the part(s) to be plated, auxiliary anodes shall be used as necessary to ensure proper plate thicknesses in holes, recesses, and closed-end deep bores on parts to be protected against nitriding.

3.2 Procedure

- 3.2.1 Parts shall be plated by electrodeposition of copper-tin alloy from a suitable bronze plating solution (see 3.4.2 and 8.2). A preliminary strike of copper or, for corrosion- and heat-resistant steels, a strike of nickel is permissible.
- 3.2.2 After plating, the parts shall be thoroughly rinsed and dried.
- 3.2.3 For parts that have been subsequently nitrided, unless otherwise specified or approved by the cognizant engineering organization, the bronze plate shall be stripped from parts using an alkaline copper stripper. The stripping method shall not roughen, pit, embrittle, or cause other damage to the basis metal (see 4.4.3).

3.3 Hydrogen Embrittlement Relief

After completion of plating, parts having hardness 40 HRC or higher shall be baked in accordance with AMS2759/9 except that the bake time shall be not less than 23 hours. If the nitriding cycle is started within 4 hours after completion of plating, the bake is not required to be performed.

3.4 Properties

The deposited copper-tin alloy shall conform to the following requirements:

3.4.1 Thickness

The bronze plate thickness shall be as follows, determined in accordance with any of the following methods: ASTM B487, ASTM B499, ASTM B504, ASTM B567, ASTM B568, ASTM E376, direct dimensional inspection provided the resolution of the measuring instrument is ten times more precise than the attribute being measured, or other method acceptable to the cognizant engineering organization.

- 3.4.1.1 Unless otherwise specified, thickness shall be not less than 0.0005 inch (13 µm) on all surfaces not to be nitrided.

3.4.2 Composition

The tin content of the bronze plate shall be 5 to 15% by weight, determined by wet chemical methods in accordance with ASTM E478, by spectrochemical methods, or by other analytical methods acceptable to the cognizant engineering organization.

3.4.3 Adhesion

Adhesion shall be tested on parts, or specimens representing parts, using the heat quench test for copper coatings in accordance with ASTM B571.

3.4.4 Porosity

The plate shall be sufficiently nonporous to not give a blue color when tested in accordance with 4.3.4.1. Contact marks that turn blue shall not be cause for rejection.

3.4.5 Hydrogen Embrittlement

The plating and/or stripping process shall not cause embrittlement in steel parts over 40 HRC, determined in accordance with 4.3.4.2.

3.5 Quality

3.5.1 Plating, as received by the purchaser, shall be continuous, adherent to basis metal, uniform in appearance, and essentially free from blisters, nodules, pits, and other surface imperfections. Slight staining or discoloration is permissible.

3.5.2 After nitriding and stripping, as received by the purchaser, the part surface shall be free from excessive roughness, pitting, or other damage to the basis metal. After stripping of the bronze plating, there shall be no residual plating, including any applied strike, remaining on surfaces that were plated. Slight staining or discoloration is permissible.

3.5.3 Imperfections in appearance that arise from surface conditions of the substrate, such as weld areas, variations in surface finish roughness, porosity, scratches, or inclusions, and that persist in the finished plating/coating despite observance of industry-accepted plating practices shall not be considered as cause for rejections (see 8.8).

3.5.4 If the plating is specified to be subsequently ground or machined, the above requirements are not required to be inspected for.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all samples for the processor's tests and shall be responsible for the performance of all required tests. When parts are specified to be tested, the 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 the specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (see 3.4.1), porosity (see 3.4.4), and quality (see 3.5) are acceptance tests and shall be performed on parts, or specimens representing parts when permitted herein, from each lot (see 4.3.3).

4.2.2 Periodic Tests

Composition (see 3.4.2) is a periodic test and shall be performed at least once each month that parts are processed, unless frequency of testing is specified by the cognizant engineering organization. Hydrogen embrittlement (see 3.4.5) is a periodic test and shall be performed at least once each month when steel parts HRC 40 or higher are processed, unless frequency of testing is specified by the cognizant engineering organization. Adhesion (see 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 4.4.3 and 8.7).

4.2.2.1 Periodic testing may be suspended in any test period when parts are not processed but shall be performed before or at time such processing is resumed. Preproduction testing may be required by the cognizant engineering organization upon resumption of processing.

4.2.3 Preproduction Tests

All property verification tests (see 3.4) are preproduction tests and shall be performed prior to production or on the initial shipment of plated parts to a purchaser, when a change in material and/or processing requires approval by the cognizant engineering organization (see 4.4.2), and when the cognizant engineering organization requires confirmatory testing.

4.3 Sampling and Testing

Sampling for testing shall be not less than the following; a lot is a group of parts, all of the same part number, processed through the same chemical solutions in the same tanks under the same conditions, which have completed the chemical processing within a period of 24 hours of each other and are presented to inspection at the same time:

4.3.1 Acceptance Tests

Test samples shall be randomly selected from all parts in the lot unless the cognizant engineering organization provides a sampling plan. The minimum number of samples shall be as shown in Table 1. Examination shall be made with the unaided eye.

Table 1 - Sampling for acceptance tests

Lot Size	Quality	Thickness Porosity	Destructive Test (when required)
Up to 7	All	All or 3 ⁽¹⁾	0
7 to 15	7	4	0
16 to 40	10	4	1
41 to 110	15	5	2
111 to 300	25	6	3
301 to 500	35	7	4
501 to 700	50	8	5
701 to 1200	75	10	6

⁽¹⁾ Whichever is less.

4.3.2 Periodic Tests

Sample quantity for composition shall be at the discretion of the processor unless otherwise specified by the cognizant engineering organization. For hydrogen embrittlement, sample size is specified in ASTM F519 unless otherwise specified by the cognizant engineering organization (see 4.3.4.2). For adhesion tests, four test specimens, of each generic class of alloy, as defined by AS2390, that have been 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 Sample Configuration

Nondestructive testing shall be performed wherever practical. Except as noted, actual parts shall be selected as samples for tests. When representative specimens are used for acceptance testing, values so obtained shall be correlated with those of parts since properties, such as thickness, may differ between parts and representative test specimens.

4.3.3.1 Representative test specimens may be used in lieu of parts under any one of the following circumstances: the plated parts are of such configuration or size as to be not readily adaptable to specified tests, nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts or for the porosity tests where residual ferricyanide-salt is not desired on actual parts. Except as specified below, representative test specimens shall be made of the same generic class of alloy as the parts, established in accordance with AS2390, distributed within the lot, cleaned, plated, and post-treated with the parts represented.

4.3.3.2 For thickness, adhesion, and porosity tests, specimens shall be either: bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long or strips or panels approximately 1 x 4 inches (25 x 102 mm) with a minimum thickness of 0.025 inch (0.62 mm).

4.3.4 Testing

4.3.4.1 Porosity Test

Bronze-plated panels shall be immersed for not less than 5 minutes in potassium ferricyanide solution made up in accordance with Table 2. Another test method shall only be used when approved by the cognizant engineering organization (see 8.5).

Table 2 - Ferricyanide test solution

Ingredient	Amount ⁽¹⁾
Potassium ferricyanide	10 g
Sodium chloride	5 g
Reagent water	100 mL

⁽¹⁾ Quantities are approximate.

4.3.4.2 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F519 Type 1a.1 using round, notched specimens stressed in tension under constant load. For test purposes, the plate thickness shall be not less than 0.0005 inch (13 µm) or a thickness not less than twice the maximum specified thickness, measured on the smooth section of the specimen, but with visual plate at 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, a preproduction sample part, and/or both, 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 cognizant engineering organization 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:

Fixture/electrical contact locations when approval is required by the cognizant engineering organization

Surface preparation method(s), including strike plating, if used

Plating bath composition and composition control limits

Plating bath temperature limits and controls

Current/voltage limits and controls

Thermal post-treatment times and temperatures (when required)

Testing methods for plate, thickness, adhesion, and porosity

Stripping or selective removal procedure of the plated coating, when applicable

Periodic test plan for cleaning and processing solutions (see 8.7)

4.5 Reports

The processor of plated parts or stripped parts (post-nitriding) shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS2429F, part number, and quantity.