

# AEROSPACE MATERIAL SPECIFICATION



AMS 2423D

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Superseding AMS 2423C

(R)

Plating, Nickel  
Hard Deposit

## RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

### 1. SCOPE:

#### 1.1 Purpose:

This specification covers the engineering requirements for electrodeposition of a hard nickel and the properties of the deposit.

#### 1.2 Application:

This process has been used typically to provide good wear resistance to metal parts which may operate in service up to 450 °F (232 °C), but usage is not limited to such applications. Diffusion heat treatment of the deposit is not required.

#### 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.

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## 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, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or [www.sae.org](http://www.sae.org).

AMS 2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

### 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or [www.astm.org](http://www.astm.org).

ASTM B 253 Preparation of Aluminum Alloys for Electroplating

ASTM B 487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric Method

ASTM B 530 Measurement of Coating Thicknesses by the 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 B 578 Microhardness of Electroplated Coatings

ASTM B 636 Measurement of Internal Stress of Plated Metallic Coatings with the Spiral Contractometer

ASTM E 92 Vickers Hardness of Metallic Materials

ASTM E 376 Measurement of Coating Thickness by Magnetic or Eddy Current (Electromagnetic) Test Method

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Preparation:

- 3.1.1 Steel parts having hardness higher than 40 HRC and which have been ground after heat treatment shall be cleaned to remove surface contamination and suitably 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 Parts shall have clean surfaces, free of water break, prior to immersion in the plating solution.
- 3.1.2.1 Alkaline cleaning of steel parts may be done with anodic current, but steel part shall not be cathodically cleaned.
- 3.1.3 Parts shall be within drawing limits after plating and machining.
- 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 purchaser; for parts which are not to be plated all over, locations shall be in areas on which plating is not required.
- 3.2 Procedure:
- 3.2.1 Nickel shall be electrodeposited from a chloride, sulfate/chloride, sulfamate or other suitable plating solution containing addition agents to produce the specified hardness. Nickel shall be deposited directly on the basis metal without a prior flash coating of metal other than nickel, except that a preliminary chemical coating, immersion plate, and/or metal flash is permissible on aluminum, magnesium, and their alloys.
- 3.2.1.1 Aluminum alloys may be zincate treated in accordance with ASTM B 253 before plating.
- 3.2.2 The plated parts shall be removed from the plating solution, thoroughly rinsed, and dried.
- 3.3 Post Treatment:
- Hydrogen embrittlement relief shall be in accordance with AMS 2759/9.
- 3.4 Properties:
- Plating shall conform to the following requirements:
- 3.4.1 Thickness: Shall be as specified, determined on representative parts or test panels in accordance with ASTM B 487, ASTM B 504, ASTM B 530, ASTM E 567, ASTM B 568, ASTM E 376, or other method acceptable to purchaser.
- 3.4.1.1 The plate shall be substantially uniform in thickness on significant surfaces except that slight build-up at exterior corners or edges will be permitted provided finished drawing dimensions are met.
- 3.4.1.2 Thickness requirements apply to surfaces that can be touched by a sphere 0.75 inch (19 mm) in diameter. Other areas such as surfaces of holes, recesses, internal threads, or contact areas of parts plated all over, where a controlled deposit cannot be obtained under normal plating conditions, shall show evidence of plating.
- 3.4.2 Hardness: Shall be not lower than 400 HV or equivalent, determined in accordance with ASTM E 92 or ASTM B 578, on deposits 0.004 inch (0.10 mm) and over in thickness.

- 3.4.3 Stress: Shall be within the range 0 to 15.0 ksi (0 to 103 MPa) in compression, determined on a plate thickness of 0.0003 inch (7.5  $\mu$ m) by calculation from spiral contractometer reading in accordance with ASTM B 636 or other instrument acceptable to purchaser.
- 3.4.4 Adhesion: Specimens as in 4.3.3 shall not show separation of the plating from the basis metal, when examined at approximately 4X magnification, after being bent rapidly, in accordance with ASTM B 571. Formation of cracks which do not result in flaking or blistering of the plating is acceptable.
- 3.4.4.1 When acceptable to purchaser, adhesion of plating after final machining of the plating will be considered acceptable evidence of plating adhesion.
- 3.4.5 Hydrogen Embrittlement: The plating process shall not cause hydrogen embrittlement in ferrous metals. Testing shall be in accordance with the requirements of ASTM F 519 Type 1A using notched round specimens, unless a different specimen type is specified by the purchaser, stressed in tension under constant load. For test purposes, plating thickness shall be 0.005 inch (0.13 mm) minimum measured on the smooth section of the specimen, but with visual plating at the root of the notch.
- 3.5 Quality:
- Plated surfaces, as received by purchaser, shall be smooth, continuous, uniform in appearance, and essentially free from frosty areas, pin holes, porosity, blisters, nodules, pits, and other imperfections detrimental to usage of nickel plate. Slight staining or discoloration is acceptable. Double plating and spotting-in after plating are not permitted.
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. Where actual parts are to be tested, such parts shall be supplied by purchaser. Purchaser 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 (3.4.1), hardness (3.4.2), adhesion (3.4.4), and quality (3.5) are acceptance tests and shall be performed on each lot.
- 4.2.2 Periodic Tests: Stress (3.4.3), hydrogen embrittlement (3.4.5) and tests of cleaning and plating solutions (see 8.8) to ensure that the deposited metal will conform to the requirements of this specification are periodic tests and shall be performed at a frequency selected by the plating processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the first-article shipment of plated parts to a purchaser, when a change in bath composition and/or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing:

Shall be not less than the following; a lot shall be all parts of one size and shape plated in one bath to the same specified plating thickness range within one 24 hour period and presented for processor's inspection at one time:

4.3.1 For Acceptance Tests: Shall be as shown in Table 1. Test samples shall be randomly selected from all parts in the lot.

TABLE 1 - Sampling for Acceptance Tests

Number of Parts in Lot	Quality	Thickness and Adhesion
1 to 6	All	3
7 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

4.3.2 For Periodic Tests: Frequency of testing shall be at the discretion of the processor unless a test frequency is specified by purchaser. Tests for hydrogen embrittlement are applicable only when parts having a hardness of 36 HRC or higher are plated.

4.3.3 Sample Configuration: Nondestructive testing shall be performed wherever practical and authorized herein. Except as noted, actual parts shall be selected as samples for tests.

4.3.3.1 Thickness and Adhesion Test: Separate test panels of the same generic class of alloy as the parts, distributed throughout the lot, cleaned, plated, and post treated with the parts represented shall be used when plated parts are of such configuration or size as to be not readily adaptable to the specified tests or when nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive test on actual parts.

4.4 Approval:

4.4.1 The process and control factors, a preproduction sample plated part, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

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

4.4.3 Control factors shall include, but not be limited to, the following:

- Surface preparation and cleaning procedures
- Surface activation procedures
- Plating bath composition and composition control limits
- Plating bath temperature limits and controls
- Current/voltage limits and controls
- Method for testing plating thickness
- Method for checking adhesion
- Stripping procedure, when applicable
- Periodic test plan.

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 the specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2423D, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If the results of any acceptance test fail to meet specified test requirements, the parts in that lot may be stripped by a method acceptable to purchaser that does not roughen, pit, adversely affect part dimensions, pretreated, plated, post treated as defined herein, and tested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped by a method acceptable to purchaser that does not roughen, pit, or adversely affect part dimensions, pretreated, plated, post treated as defined herein, and tested.

4.6.2 If the results of any periodic test fail to meet the specified test requirements, the process is nonconforming. No additional parts shall be plated until the process is corrected and new specimens are plated and tested. Results of all tests shall be recorded and, when requested, reported. Purchaser shall be notified of all parts plated since the last acceptable test.

5. PREPARATION FOR DELIVERY:

5.1 Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plating are preserved.

5.2 Packages of plated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.