SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2403L

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Superseding AMS 2403K

Plating, Nickel
General Purpose

1. SCOPE:

1.1 Purpose:

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

1.2 Application:

This process has been used typically to provide moderate corrosion and oxidation resistance to metal parts but without control of other characteristics, and for the buildup of surfaces, but usage is not limited to such applications. If a hard plate is required, AMS 2423 should be used; if a low-stressed plate is required, AMS 2424 should be used.

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 issues 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.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2423	Plating, Nickel, Hard Deposit
AMS 2424	Plating, Nickel, Low Stressed Deposit
AMS 2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Testing Apparatus
ASTM B 487	Measurement 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 of Magnetic Basis Metals
ASTM B 504	Measurement of Thickness of Metallic Coatings by the Coulometric 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 of Coating Thickness by Magnetic Field or Eddy Current (Electromagnetic) Test Methods
ASTM F 519	Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments

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 waterbreak, prior to immersion in the plating solution.

3.1.3 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 suitable plating solution containing no addition agents which may have a detrimental effect on the properties of the plate or the basis metal; stress-reducing agents shall not be used unless specifically authorized by purchaser. Except as specified in 3.2.1.1, nickel shall be deposited directly on the basis metal without a prior flash coating of metal other than nickel.

3.2.1.1 A preliminary chemical coating, immersion plate, and/or flash is permissible on aluminum, magnesium, beryllium, and their alloys.

3.3 Hydrogen Embrittlement Relief:

After plating, rinsing, and drying, ferrous parts shall be treated in accordance with AMS 2759/9. Parts, if plated as an aid to brazing, and if brazed within four hours after completion of plating, do not require hydrogen embrittlement relief.

3.4 Properties:

3.4.1 Thickness: Thickness shall be determined in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, ASTM E 376 or other method acceptable to purchaser.

3.4.1.1 Where "nickel flash" is specified, plate thickness shall be approximately 0.0001 inch (2.5 µm).

3.4.1.2 For surfaces that will not be machined after plating, the plate shall be substantially uniform in thickness on significant surfaces except that slight buildup on exterior corners or edges will be permitted provided finished drawing dimensions are met.

3.4.1.3 Unless otherwise specified on the drawing for specific areas, thickness shall apply to surfaces of parts that can be touched by a 0.75 inch (19.0 mm) sphere. Surfaces that cannot be touched by a 0.75 inch (19.0 mm) sphere, such as holes, recesses, internal threads, and other areas where a controlled deposit cannot be obtained under normal plating conditions shall not be masked during plating. This requirement will be satisfied for carbon and low-alloy steels if such surfaces show no film of copper after being immersed in a solution containing 4 grams copper sulphate $CuS0_4 \cdot 5H_20$, 10 grams sulfuric acid H_2SO_4 (sp. gr. 1.84), and 90 mL distilled water for not less than six minutes at room temperature. If internal surfaces are required to be plated to meet a thickness requirement, the drawing shall so specify.

3.4.2 Adhesion:

3.4.2.1 Specimens: 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 E 290, through an angle of 180 degrees around a diameter equal to the thickness of the specimen. Formation of cracks which do not result in flaking or blistering of the plating is acceptable.

3.4.2.2 Machined Plating: Adhesion of plating after finish machining of the plating will be considered acceptable evidence of plating adhesion.

3.4.2.3 Parts: When specified by purchaser, there shall be no blisters or other evidence of poor adhesion when parts are subjected to the heat-quench test of ASTM B 571.

3.4.3 Heat Resistance: Specimens as in 4.3.3, except aluminum and magnesium, shall show no cracks or blisters in the plate after being heated to 1000 °F ± 25 (538 °C ± 14), held at heat for not less than two hours, and cooled; heating shall be in a circulating-air furnace.

3.4.4 Corrosion Resistance: Carbon and low-alloy steel parts (except as provided in 3.4.1.3) when required by purchaser, or test specimens, excluding those parts plated to aid in brazing or where plating is used for dimensional restoration, shall show no visual evidence of corrosion after being subjected for not less than 48 hours to a continuous salt spray corrosion test conducted in accordance with ASTM B 117 when plate is in the following conditions:

3.4.4.1 When specified minimum plate thickness is 0.002 inch (51 µm) or greater, parts or panels shall withstand the test either after embrittlement relief as in 3.3 or after the heat resistance test of 3.4.3 following embrittlement relief as in 3.3.

3.4.4.2 When specified minimum plate thickness is 0.0005 inch (12.7 µm) or greater but less than 0.002 inch (51 µm), parts or panels shall withstand the test only after the heat resistance test of 3.4.3 following embrittlement relief as in 3.3.

3.4.5 Hydrogen Embrittlement: The plating process shall not cause hydrogen embrittlement in ferrous metals. Testing 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, is required only when parts 40 HRC or higher are plated. For test purposes, plating thickness shall be not less than 0.002 inch (51 µm), measured on the smooth section of the specimen, but with visual plating at the root of the notch.

3.5 Quality:

Plating, as received by purchaser, shall be smooth, continuous, adherent to the basis metal, and uniform in appearance and shall be visually free from frosty areas, pin holes, porosity, blisters, nodules, pits, and other imperfections detrimental to usage of the plating. Slight staining or discoloration is permissible. There shall be no evidence of double plating or spotting-in after plating.

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 requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.4.1), adhesion (3.4.2.1, or 3.4.2.3 when specified), and quality (3.5) are acceptance tests and shall be performed to represent each lot.

4.2.1.1 If the nickel plate is used for braze preparation, acceptance test requirements for thickness and adhesion may be modified with the approval of the purchaser.

4.2.2 Periodic Tests: Heat resistance (3.4.3), corrosion resistance (3.4.4), and embrittlement (3.4.5) are periodic tests and shall be performed at a frequency selected by the processing vendor unless frequency of testing is specified by purchaser. Tests of cleaning and plating solutions (See 8.6) to ensure that the deposited metal will conform to this specification.

4.2.3 Preproduction Tests: All technical requirements are preproduction tests and shall be performed prior to or on the initial shipment of plated parts to a purchaser, when a change in material and/or processing requires reapproval by the cognizant engineering organization (see 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 the same part number, plated to the same range of plate thickness in the same set of solutions, in each consecutive 24 hour period of operation, and presented for processor's inspection at one time:

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

TABLE 1 - Sampling for Acceptance Tests

Number of Parts in Lot	Quality	Thickness and Adhesion
Up to 7	All	3
8 to 15	7	4
16 to 40	10	4
41 to 110	15	5
111 to 300	25	6
301 to 500	35	7
Over 500	50	8

4.3.2 Periodic Tests: Sample quantity and frequency of testing shall be at the discretion of the processor unless a test frequency is specified by the purchaser.

4.3.3 When plated parts are of such configuration or size as to be not adaptable to the specified tests, or for periodic tests as applicable, or when there is no nondestructive test adaptable to the parts, separate test specimens cleaned, pretreated, plated, and post-treated with the parts represented may be used. For adhesion tests, such specimens shall be panels of approximately 0.032 x 1 x 4 inches (0.81 x 25 x 102 mm); for thickness and quality tests, such specimens shall be panels of the same size and type or shall be bars approximately 0.5 inch (12.7 mm) in diameter and 4 inches (102 mm) long. For corrosion resistance and heat resistance tests, specimens shall be panels 0.062 to 0.125 inch (1.57 to 3.18 mm) in nominal thickness and not less than 4 inches (102 mm) long by 3 inches (76 mm) wide. Except for corrosion testing, specimens shall be made from material generically similar to the parts, such as low-alloy steel, age-hardenable nickel alloy, aluminum alloy, or corrosion-resistant steel. Corrosion test specimens shall be low-alloy steel.

4.4 Approval:

4.4.1 The process and control factors, a 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 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 parts.

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

Activation procedure(s)
Composition limits or the plating bath
Plating bath temperature
Plating current (or voltage) limits
Frequency of plating bath composition determination
Tooling and fixturing