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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 2403H

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Superseding AMS 2403G

NICKEL PLATING
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: Primarily to provide moderate corrosion and oxidation resistance to metal parts but without control of other characteristics. If a hard plate is required, AMS 2423 should be used; if a low-stressed plate is required, AMS 2424 should be used.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM B487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
ASTM b499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM B504 - Measurement of the Thickness of Metallic Coatings by the Coulometric Method
ASTM E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 All forming, heat treating, and welding and all brazing, except on parts to be plated as an aid to brazing, shall be completed before parts or assemblies are plated.

3.1.2 Parts shall be within drawing dimension limits before plating.

3.1.3 Surface of parts to be plated shall be smooth and substantially free of blemishes, pits, tool marks, and other irregularities.

3.1.4 Steel parts, except those to be plated as an aid to brazing, having hardness higher than 40 HRC and which have been ground after heat treatment shall be suitably stress-relieved before cleaning 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.

3.1.5 Parts shall have chemically clean surfaces, prepared with minimum abrasion, erosion, or pitting, prior to immersion in the plating solution.

3.1.6 Parts having hardness of 33 HRC or higher and parts roll-threaded after heat treatment shall not be cleaned with hydrochloric or sulfuric acids, unless specifically approved. Cleaning of other parts with inorganic acids is not prohibited but permission to use such method on a particular part shall first be obtained from purchaser. In either case, a momentary dip in acid after alkaline cleaning is permissible.

3.1.7 Electrical contacts between the parts and power source shall be made in such a manner as will ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur. If parts are to be plated all over, contact points shall be located where specified or where agreed upon by purchaser and vendor. If parts are not required to be plated all over, contact points shall be located in areas on which plating is not required or is optional.

3.2 Procedure:

3.2.1 Nickel shall be electrodeposited from a chloride, sulfate-chloride, Ø fluoborate, or sulfamate solution containing no addition agents which might 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, and their alloys.

3.2.2 The plated parts shall be removed from the plating solution, thoroughly rinsed, and dried.

3.3 Post Treatment: After plating, rinsing, and drying, steel parts, except Ø those plated as an aid to brazing, shall be treated as in 3.3.1, 3.3.2, or 3.3.3, as applicable, unless otherwise permitted, to minimize the effects of hydrogen embrittlement; heating shall be in air, preferably in a circulating-air furnace. Treatment of other parts is not required.

3.3.1 Parts, including roll-threaded parts, cold worked after being heat treated Ø by hardening and tempering, other parts having hardness of 33 HRC or higher, and springs shall be heated to 375°F ± 25 (190°C ± 15) and held at heat for not less than 3 hours.

3.3.1.1 Some parts having hardness of 40 HRC and higher may require heating for up to 23 hours.

3.3.2 Parts and assemblies, including carburized parts, which will decrease in Ø hardness or be otherwise deleteriously affected if heated to 375°F (190°C) shall be heated to 275°F ± 25 (135°C ± 15) and held at heat for not less than 5 hours.

3.3.3 Parts requiring special handling shall be post treated as agreed upon by purchaser and vendor.

3.4 Properties:

3.4.1 Thickness: Shall be as specified on the drawing, determined on representative parts or test panels in accordance with ASTM B487, ASTM B499, ASTM B504, or other method agreed upon by purchaser and vendor.

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

3.4.1.2 The plate shall be substantially uniform in thickness on significant surfaces except that slight build-up on exterior corners or edges will be permitted provided finished drawing dimensions are met.

3.4.1.3 Except on parts plated to aid in brazing, no requirements are established for minimum plate thickness for surfaces of holes, recesses, internal threads, contact areas of parts plated all over, and other areas where a controlled deposit cannot be obtained under normal plating conditions but such areas shall not be masked to prevent plating. The resulting thickness shall be considered only when such surfaces of parts can be touched by a sphere 0.75 in. (19 mm) in diameter, but such surfaces shall show no film of copper after being immersed in a solution containing 4 g $CuSO_4 \cdot 5H_2$), 10g H_2SO_4 (sp gr 1.84), and 90 mL distilled water for not less than 6 min. at room temperature.

3.4.2 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 E290, through an angle of 180 deg 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.

3.4.3 Heat Resistance: Specimens as in 4.3.3 shall show no cracks or blisters in the plate after being heated to 700°F + 25 (370°C + 15), held at heat for 23 hr ± 0.5, heated to 1000°F ± 25 (440°C ± 15), held at heat for 1 hr ± 0.25, and cooled; heating shall be in air, preferably in a circulating-air furnace.

3.4.4 Corrosion Resistance: Steel parts, except those plated to aid in brazing, or specimens as in 4.3.3 shall show no visual evidence of corrosion of significant surfaces after being subjected for not less than 48 hr to continuous salt spray corrosion test conducted in accordance with ASTM B117 when plate is in the following conditions:

3.4.4.1 When specified minimum plate thickness is 0.002 in. (50 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 in. (12.5 μm) or greater but less than 0.002 in. (50 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.

3.5 Quality: Plated nickel shall be smooth, continuous, adherent to the basis Ø metal, and uniform in appearance and shall be essentially 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. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.1 Double plating and spotting-in after plating are not permitted.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The processing vendor shall supply all Ø samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. 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: Tests to determine conformance to requirements for Ø thickness (3.4.1) and quality (3.5) are classified as acceptance tests and shall be performed to represent each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø adhesion (3.4.2), heat resistance (3.4.3), and corrosion resistance (3.4.4) and of cleaning and plating solutions to ensure that the deposited metal will conform to the requirements of this specification are classified as periodic tests and shall be performed at a frequency selected by the processing vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical Ø requirements of this specification are classified as preproduction tests and shall be performed prior to or on the first-article shipment of plated parts to a purchaser, when a change in material, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be not less than the following; a lot shall be all parts Ø made of the same alloy, plated to the same range of plate thickness in the same set of solutions, in each consecutive 24-hr period of operation, and presented for vendor's inspection at one time:

4.3.1 For Acceptance Tests:

4.3.1.1 Thickness: Three parts, except as specified in 4.3.3, from each lot.
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4.3.1.2 Quality: As agreed upon by purchaser and vendor.

4.3.2 Periodic and Preproduction Tests: As agreed upon by purchaser and vendor.

4.3.3 When plated parts are of such configuration or size as to be not readily
Ø adaptable to the specified tests, separate test specimens cleaned, plated, and post-treated with the parts represented may be used. For adhesion tests, such specimens shall be panels of annealed low-carbon steel approximately 0.032 x 4 x 1 in. (1 x 100 x 25 mm) and for thickness and quality tests shall be panels of the same size and type or shall be bars approximately 0.5 in. (10 mm) in diameter and 4 in. (100 mm) long. For corrosion resistance and heat resistance tests, specimens shall be panels 0.062 - 0.125 in. (1.5 - 3 mm) in nominal thickness and not less than 4 in. (100 mm) long by 3 in. (75 mm) wide.

4.4 Approval:

4.4.1 Plated parts and, when specified, plating fixtures shall be approved by
Ø purchaser before parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production parts shall be essentially equivalent to those on the approved sample parts.

4.4.2 Vendor shall use manufacturing procedures, processes, and methods of inspection on production parts which are essentially the same as those used on the approved sample parts. If necessary to make any change in type of equipment or in established composition limits and operating conditions of process solution, vendor shall submit for reapproval of the process a statement of the proposed changes in processing and, when requested, sample plated parts, test panels, or both. Production parts plated by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Reports: The vendor of plated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the requirements of this specification and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS 2403H, part number, and quantity.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the parts may be based on the results of testing three additional specimens for each original nonconforming specimen. Except as specified in 4.6.1, failure of any retest specimen to meet the specified requirements shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.