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400 COMMONWEALTH DRIVE WARRENDALE PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 2424C
Superseding AMS 2424B
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NICKEL PLATING
Low-Stressed Deposit

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electrodeposition of a low-stressed nickel and the properties of the deposit.

1.2 Application: Primarily to provide moderate corrosion and oxidation resistance to parts which may operate in service up to 700°F (370°C), where low tensile stress in the deposit is required to avoid marked reduction of fatigue strength.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) 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 Specification:

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 B244 - Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals With Eddy-Current Instruments
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 Thickness of Metallic Coatings by the Coulometric Method
ASTM B530 - Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates
ASTM E92 - Vickers Hardness of Metallic Materials

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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 machining, forming, welding, and heat treating shall be completed before parts are plated, unless otherwise permitted by purchaser.

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

3.1.3 Parts having hardness of 40 HRC or higher and which have been ground after heat treatment, except those to be plated in preparation for brazing, 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.

3.1.4 Parts shall have chemically clean surfaces prepared with minimum abrasion, erosion, or pitting, prior to immersion in the plating solution. Treatments which may produce hydrogen embrittlement shall be avoided.

3.1.5 Electrical contacts between the parts and power source shall be made in such 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 Parts shall be plated by electrodeposition of nickel from a sulfamate solution containing no addition agents, including stress-reducing agents, which might have a detrimental effect on properties of the plate or of the basis metal. Except as permitted by 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 On aluminum, magnesium, and their alloys, a preliminary chemical coating, immersion plate, or metal flash is permissible.

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, parts, except those plated in preparation for brazing, shall be baked as in 3.3.1, 3.3.2, or 3.3.3, as applicable, to remove hydrogen embrittlement; heating shall be in air, preferably in a circulating-air furnace. Post heat treatment should be started as soon as practicable, preferably within 60 min., after plating.

3.3.1 Ferrous parts, including roll-threaded parts, cold worked after being heat treated by hardening and tempering, regardless of hardness, springs, and other parts having hardness of 33 HRC or higher shall be heated to 375°F ± 15 (190°C ± 8) and held at heat for not less than 3 hours.

3.3.1.1 Parts having hardness of 40 HRC or higher may require heating for up to 23 hours.

3.3.2 Parts and assemblies, including carburized parts, which will decrease in hardness or be otherwise deleteriously affected by heating as in 3.3.1 shall be heated to 275°F ± 15 (135°C ± 8) 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: The deposited nickel shall conform to the following requirements except that the requirements of 3.4.1.1, 3.4.3, and 3.4.6 shall not apply to parts plated in preparation for brazing:

3.4.1 Thickness: Shall be as specified on the drawing, determined on Ø representative parts or test panels in accordance with ASTM B244, ASTM B487, ASTM B499, ASTM B504, ASTM B530, or other method agreed upon by purchaser and vendor.

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 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. Unless otherwise specified, resultant 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 not show a film of copper after being immersed for 6 min. ± 0.5 at room temperature in a solution containing 4 g cupric sulfate, 10 g sulfuric acid (sp gr 1.84), and 90 mL distilled water.

3.4.1.2.1 If internal surfaces as specified in 3.4.1.2 are required to be plated, the drawing will so specify.

3.4.2 Hardness: Shall be not higher than 300 HV, or equivalent, determined in accordance with ASTM E92 on deposits 0.005 in. (0.12 mm) and over in thickness.

3.4.3 Stress: Shall be within the range 5000 psi (35 MPa) in compression to 15,000 psi (105 MPa) in tension, determined on specimens having plate Ø thickness of 0.0003 in. (7.5 µm) or greater; stress shall be calculated from spiral contractometer reading (Ref. 35th Annual Proceedings, American electroplaters Society, pp. 53 - 89) or other instrument agreed upon by purchaser and vendor.

3.4.4 Specimens as in 4.3.3 shall not show separation of the plate from the Ø basis metal, when examined at approximately 4X magnification, after being bent approximately 180 deg around a diameter equal to twice the thickness of the specimen. Formation of cracks which do not result in flaking or blistering of the plate is acceptable.

3.4.5 Heat Resistance: Plated ferrous parts or representative test panels shall withstand, without blistering or cracking, being heated in air, preferably in a circulating air furnace, to 700°F ± 15 (370°C ± 8) and held at heat for not less than 23 hr followed by heating to 1000°F ± 15 (540°C ± 8) and holding at heat for not less than 60 minutes.

3.4.6 Corrosion Resistance: Plated parts or representative test panels, plated to a thickness as follows and post treated as in 3.4.6.1 or 3.4.6.2, shall show no visual evidence of corrosion of significant surfaces after being subjected for 48 hr ± 1 to continuous salt spray corrosion test conducted in accordance with ASTM B117.

3.4.6.1 When specified minimum plate thickness is 0.002 in. (0.05 mm) or greater, parts or panels shall withstand the test either after embrittlement relief as in 3.3 or after the heat resistance test of 3.4.5 following embrittlement relief as in 3.3.

3.4.6.2 When the specified minimum plate thickness is 0.0005 in. (12.5 µm) or greater but less than 0.002 in. (0.05 mm), parts or panels shall withstand the test only after the heat resistance test of 3.4.5 following embrittlement relief as in 3.3.

3.5 Quality: Plated nickel shall be smooth, continuous, adherent to the basis metal, and uniform in appearance and shall be essentially free from pin holes, porosity, blisters, nodules, pits, and other imperfections detrimental to usage of parts. 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, unless otherwise specified.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The processing vendor shall supply all samples for vendor's tests and shall be responsible for performing all ø 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 on each lot.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for hardness (3.4.2), stress (3.4.3), adhesion (3.4.4), heat resistance ø (3.4.5), and corrosion resistance (3.4.6) and tests 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 vendor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests ø and shall be performed prior to or on the initial shipment of plated parts to a purchaser, when a change in processing 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 solutions in each consecutive 24-hr period of operation or fraction thereof, and presented for vendor's inspection at one time.

4.3.1 For Acceptance Tests:

4.3.1.1 Thickness: Three parts from each lot.

4.3.1.2 Quality: As agreed upon by purchaser and vendor.

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