Society of Automotive Engineers, Inc.
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AEROSPACE MATERIAL SPECIFICATION

AMS 2405A
Superseding AMS 2405

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ELECTROLESS NICKEL PLATING
Low Phosphorus

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electroless deposition of low-phosphorus nickel on various materials and the properties of the deposit.

1.2 Application: Primarily to provide hard, ductile, wear-resistant, and corrosion-resistant surfaces for operation up to 1000°F (540°C) and to provide uniform build-up on complex shapes. Maximum hardness and wear resistance are obtained by heating parts as in 3.3.2.

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 Society of Automotive Engineers, Inc., 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 E290 - Semi-Guided Bend Test for Ductility of Metallic Materials

2.3 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 Welding and brazing shall be completed before parts or assemblies are plated, unless surfaces are plated to aid in joining by brazing.

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

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3.1.3 Surfaces of nonmetallic parts shall show no marks other than those necessary to provide a freshly-abraded surface.

3.1.4 Parts having hardness higher than 40 HRC and which have been machined or 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.

3.2 Procedure:

3.2.1 Plating shall be performed by chemical deposition of an amorphous, high-nickel, low-phosphorus metallic compound on a catalytic or catalyzed surface from an aqueous bath containing nickel and hypophosphite ions and which bath may include a soluble compound to inhibit decomposition of the bath. The nickel-phosphorus plate shall, unless otherwise specified, be deposited directly on the basis metal without a deposit of other metal underneath except in the case of parts fabricated from corrosion-resistant steels or alloys on which a preliminary deposit of nickel or other suitable metal is permissible.

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

3.3 Post Treatment:

3.3.1 After plating, rinsing, and drying, parts shall be heat treated as in 3.3.1.1, 3.3.1.2, or 3.3.1.3 unless they are to be post treated as in 3.3.2 or unless otherwise permitted to remove hydrogen embrittlement; heating shall be in air, preferably in a circulating-air furnace.

3.3.1.1 Parts, including roll-threaded parts, cold worked after being heat treated by hardening and tempering, springs, and other parts having hardness of 33 HRC or over, shall be heated to 375°F ± 15 (191°C ± 8) and held at heat for not less than 3 hours.

3.3.1.2 Parts and assemblies, including carburized parts, which will decrease in hardness or be otherwise deleteriously affected by heating to 375°F (191°C) shall be heated to 275°F ± 15 (135°C ± 8) and held at heat for not less than 5 hours.

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

3.3.2 When specified on the drawing, parts, after plating, rinsing, and drying, shall be heated for 30 - 60 min., preferably in an inert atmosphere, at 750°F ± 15 (400°C ± 8) except that parts made of aluminum or aluminum alloy shall be heated to 450°F ± 15 (232°C ± 8) for not less than 4 hours.

3.4 Properties:

3.4.1 Composition: The phosphorus content of the deposited nickel-phosphorus alloy shall be held to a minimum and shall not exceed 8%.

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

3.4.3 Adhesion: Specimens shall show no separation of plating from the basis metal, when examined at magnification up to 6X, after being bent rapidly at room temperature, in accordance with ASTM E290, through an angle of 180 deg (3.14 rad) around a diameter equal to the nominal thickness of the specimen. Formation of cracks which do not result in flaking or blistering of the plating is acceptable.

3.4.3.1 As a referee test, plating shall show no blisters or cracks on representative steel parts or test panels after being heated in air, preferably in a circulating-air furnace, at 700°F ± 15 (370°C ± 8) for 23 hr ± 1 followed by heating at 1000°F ± 15 (540°C ± 8) for 60 min. ± 5.

3.4.4 Corrosion Resistance: Steel parts or representative test panels having specified minimum plating Ø thickness of 0.001 in. (0.03 mm) or more, shall, after plating and embrittlement-relieving, show no visual evidence of corrosion of the basis metal after being subjected for not less than 48 hr to continuous salt spray corrosion test conducted in accordance with ASTM B117.

3.5 Quality: Plated surfaces shall be smooth, continuous, and uniform in appearance and shall be free Ø from frosty areas, pinholes, blisters, and other imperfections detrimental to performance of parts.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The processing vendor shall supply all samples and shall be responsible Ø 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 perform such confirmatory testing as he deems 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 thickness (3.4.2) and quality (3.5) requirements Ø are classified as acceptance tests.

4.2.2 Periodic Tests: Tests to determine conformance to composition (3.4.1), adhesion (3.4.3), and Ø corrosion resistance (3.4.4) requirements 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.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification Ø are classified as preproduction tests.

4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction Ø 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:

4.3.1 Acceptance Tests:

4.3.1.1 Thickness: Three parts for each consecutive 8 hr of operation of the same set of solutions, except Ø as specified in 4.3.3.

Ø 4.3.1.2 Quality: As agreed upon by purchaser and vendor.

Ø 4.3.2 Periodic Tests 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 adaptable to the specified tests, Ø 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 1 x 4 in. or 1 x 25 x 100 mm and for thickness and quality tests shall be panels of the same size and type or shall be bars approximately 0.5 in. or 10 mm in diameter and 4 in. or 100 mm long. For corrosion resistance tests, specimens shall be panels 0.062 - 0.125 in. or 1.5 - 3 mm in nominal thickness and not less than 4 in. or 100 mm long by 3 in. or 75 mm wide.

4.4 Approval:

4.4.1 Plated parts shall be approved by purchaser before parts for production use are supplied, unless Ø such approval be waived. 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 Ø which are essentially the same as those used on the approved sample parts. If any change is necessary in type of equipment or in established composition limits and operating conditions of process solutions, 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 three copies of a report stating Ø 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, this specification number and its revision letter, part number, and quantity.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified require- Ø ments, 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.

4.6.1 If any part fails to meet the specified requirements, either on the original sampling as in 4.3 or Ø upon resampling as in 4.6, the parts in that lot may be stripped by a method approved by purchaser which does not roughen, pit, or embrittle the basis metal, replated, post treated, and retested.

5. PREPARATION FOR DELIVERY:

5.1 Parts shall be handled and packaged in such a manner as will ensure that the required physical Ø characteristics and properties of the plating are preserved.

5.2 Packages of parts shall be prepared for shipment in accordance with commercial practice to ensure Ø carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-794, Level A Ø or Level C, as specified in the request for procurement. Commercial packaging as in 5.2 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Parts on which plating does not conform to this specification or to authorized modifications will be subject to rejection.