

Submitted for recognition as an American National Standard

ELECTROLESS NICKEL-THALLIUM-BORON PLATING

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electroless deposition of a nickel-thallium-boron coating on various substrates and properties of the deposit.

1.2 Application: Primarily to provide hard, ductile, wear-resistant surfaces for operation in service up to 1000°F (540°C) and to provide uniform build up on complex shapes.

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

AMS 4928 - Titanium Alloy Bars, Forgings, and Rings, 6Al - 4V, Annealed, 120,000 psi (825 MPa) Yield Strength

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 B253 - Preparation of Aluminum Alloys for Electroplating

ASTM B487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section

ASTM B578 - Measurement of Microhardness of Electroplated Coatings

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2.2 (Continued):

ASTM D2714 - Calibration and Operation of the Alpha Model LFW-1 Friction and Wear Testing Machine

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 Welding, brazing, forming, and heat-treatment shall be completed before parts are plated.

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

3.1.3 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.

3.1.4 Surfaces required by drawing not to be plated shall be protected by suitable masking material.

3.1.5 Parts shall have chemically clean surfaces prepared with minimum abrasion, erosion, or pitting. Cleaning shall be performed immediately before plating as part of the plating cycle and neither storage nor handling without gloves will be permitted. This sequence shall not be interrupted; parts shall be suitably fixtured to avoid handling. Surfaces shall be free of visible residue and stains prior to plating.

3.1.5.1 For titanium and titanium alloys, cleaning solutions shall not contain methanol or halogenated hydrocarbons, and chloride content of processing solutions and rinse water shall not exceed 50 parts per million.

3.2 Procedure:

3.2.1 Plating shall be performed by chemical deposition of a homogeneous, amorphous nickel-thallium-boron metallic compound on a catalytic or catalyzed surface from a chemical nickel-thallium-boron bath utilizing sodium borohydride reducing agents. Plate shall be deposited directly on the basis metal without a prior flash coating of other metal, except that when required by drawing, the nickel-thallium-boron plate shall be deposited upon a prior coating of nickel or other metal.

3.2.1.1 Parts made of aluminum and aluminum alloys shall be zinc coated in accordance with ASTM B253, flash coated with electroless nickel, or both, immediately prior to nickel-thallium-boron deposition.

3.2.2 The plated parts shall be removed from the plating solution, thoroughly rinsed, and forced-air dried. Any maskant shall be removed prior to completion of this operation. Chloride content of rinse water used on titanium and titanium alloys shall not exceed 50 parts per million.

3.3 Post Treatment:

3.3.1 Parts shall be handled only with clean cotton gloves after plating and prior to heat treatment. If storage is necessary prior to heat treatment, parts shall be suitably protected.

3.3.2 Plated parts, except as specified in 3.3.2.1, shall be heat treated for 90 min. ± 10 at $675^{\circ}\text{F} \pm 15$ ($355^{\circ}\text{C} \pm 8$).

3.3.2.1 Cold worked or tempered parts, aluminum and aluminum alloy parts, and precipitation hardenable or other alloys requiring special handling shall be post-treated as agreed upon by purchaser and vendor.

3.3.3 When specified on the drawing, nickel-thallium-boron plated parts shall be impregnated after heat treatment with a suitable dry film lubricant or fluorotelomer to improve corrosion resistance, lower coefficient of friction, or both.

3.4 Properties: Plate shall conform to the following requirements:

3.4.1 Composition: Deposit shall contain 2.5 - 5.0% by weight boron, 2.5 - 6.0% by weight thallium, and the remainder essentially nickel, determined by any analytical method approved by purchaser.

3.4.2 Hardness: Shall be not lower than 1000 HV, or equivalent, determined in accordance with ASTM B578 or other microhardness test method agreed upon by purchaser and vendor, after heat treatment as in 3.3.2, using a standard 100 g load, except for aluminum alloys or other materials where other requirements are specified.

3.4.3 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 by other method agreed upon by purchaser and vendor.

- 3.4.4 Adhesion: Specimens shall show no separation of plating from the basis metal when examined at up to 6X magnification after being bent rapidly at room temperature in accordance with ASTM E290 through an angle of 180 deg around a mandrel having a diameter of twice the nominal thickness of the specimen, except that when a larger bend ratio is permitted by the applicable basis metal material specification, the requirement of the panel material specification shall apply. Formation of cracks which do not result in flaking or other separation of the plating is acceptable.
- 3.4.5 Wear Resistance: A standard test block with 0.001 in. (25 μm) plating thickness, heat treated as in 3.3.2 and subjected to a 600 lb (270 kg) load with filtered mineral spirits lubricant, shall exhibit a wear scar with an average width not greater than 0.032 in. (0.80 mm) after 25,000 test cycles, determined in accordance with ASTM D2714.
- 3.4.6 Corrosion Resistance: Parts or representative test panels having a specified minimum nickel-thallium-boron plating thickness of 0.0005 in. (12.5 μm) over prior flash coating of nickel or impregnated with suitable fluorotelomer, or both, shall 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, as received by purchaser, shall be smooth, continuous, adherent to basis metal, uniform in appearance, and essentially free of pinholes, porosity, blisters, pits, and other imperfections detrimental to usage of the plate. Standards for acceptance shall be as agreed upon by purchaser and vendor.
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 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 hardness (3.4.2), thickness (3.4.3), adhesion (3.4.4) 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 composition (3.4.1), wear resistance (3.4.5), and corrosion resistance (3.4.6), 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 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 and shall be performed prior to or on the initial shipment of plated parts to a purchaser, when a change in material, processing, or both requires approval 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 of the same part number or configuration plated to the same range of thickness in the same set of solutions in 24 consecutive hours of operation and presented for vendor's inspection at one time.
- 4.3.1 For Acceptance Tests:
- 4.3.1.1 Hardness, Thickness, and Adhesion: Sample size used for these requirements shall be as agreed upon by purchaser and vendor dependent upon lot or batch size and the criteria for determining acceptability.
- 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 and vendor.
- 4.3.3 When plated parts are of such configuration or size as to be not readily adaptable to the specified tests, separate test specimens, of the same or similar alloy to the part being plated, cleaned, plated, and post treated with the parts represented may be used. For adhesion tests, specimens shall be panels approximately 0.032 x 1 x 4 in. (1 x 25 x 100 mm). For salt spray 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. For thickness and quality tests, specimens shall be as specified above for adhesion tests or shall be bars approximately 0.5 in. (10 mm) in diameter and 4 in. (100 mm) long. Other test specimens shall be in accordance with the appropriate ASTM procedure or as agreed upon by purchaser and vendor.
- 4.4 Approval:
- 4.4.1 Sample plated parts shall be approved by 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.