The Engineering Society For Advancing Mobility Land Sea Air and Space®
INTERNATIONAL
400 Commonwealth Drive, Warrendale, PA 15096-0001

# AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2433B

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Submitted for recognition as an American National Standard

Superseding AMS 2433A

## (R) PLATING, NICKEL-THALLIUM-BORON OR NICKEL-BORON
## Electroless Deposition

1. SCOPE:

1.1 Form:

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

1.2 Application:

This process has been used typically to provide a hard, ductile, wear-resistant surface for operation in service up to 1000 °F (538 °C), to provide uniform build-up on complex shapes, and to enhance solderability of surfaces, but usage is not limited to such applications.

1.3 Classification:

The deposits covered by this specification are classified by composition as follows:

Type 1 - Nickel-Thallium-Boron
Type 2 - Nickel-Boron

1.3.1 Unless otherwise specified, Type 1 shall be supplied.

1.4 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 following publications form a part of this specification to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 4751 Solder, Tin-Lead, Eutectic, 63Sn-37Pb

2.2 ASTM Publications:

Available from ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

| | |
|---|---|
| ASTM B 117 | Salt Spray (Fog) Testing |
| ASTM B 253 | Preparation of Aluminum Alloys for Electroplating |
| ASTM B 487 | Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section |
| ASTM B 567 | Measurement of Coating Thickness by the Beta Backscatter Method |
| ASTM B 568 | Measurement of Coating Thickness by X-Ray Spectrometry |
| ASTM B 571 | Adhesion of Metallic Coatings |
| ASTM B 578 | Microhardness of Electroplated Coatings |
| ASTM D 2714 | Calibration and Operation of the Alpha Model LFW-1 Friction and Wear Testing Machine |
| ASTM E 1097 | Direct Current Plasma Emission Spectrometry Analysis |

2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-2073 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 All fabrication-type operations, such as machining, 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 cleaned to remove surface contamination and 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 five hours for parts 55 HRC or over, or 315 °F (191 °C) for four hours for other parts.

3.1.4 Surfaces required by drawing not to be plated shall be protected by suitable masking material or stripped back by a method acceptable to purchaser. Masking materials or strip back procedures shall not affect the basis metal or the plating.

3.1.5 Parts shall have clean surfaces, free of waterbreak, prior to immersion in the plating solution. Parts shall be suitably fixtured to avoid handling after cleaning.

3.1.5.1 Parts shall not be cleaned with acids which pit surfaces or induce hydrogen embrittlement in ferrous alloys. This includes, but is not limited to sulfuric and hydrochloric acids. However, a momentary dip in acid after alkaline cleaning is permissible.

3.1.5.2 For titanium and titanium alloys, cleaning solutions shall not contain methanol or halogenated hydrocarbons, and chloride content of final 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 or nickel-boron metallic compound on a catalytic or catalyzed surface from a chemical nickel-thallium-boron or nickel-boron bath utilizing sodium borohydride reducing agents. Plate shall be deposited directly on the basis metal, other than aluminum and aluminum alloys, without a prior flash of other metal, except that a flash or strike of nickel or copper may be used when plating corrosion resistant steel and nickel and cobalt alloys. A nickel or copper flash may be used on other basis metals when permitted by purchaser.

3.2.2 Aluminum and aluminum alloys shall be zinc immersion coated in accordance with ASTM B 253 followed by a flash of copper prior to plating.

3.2.3 The plated parts shall be removed from the plating solution, rinsed, and air dried. Any maskant shall be removed from parts.

3.3 Post Treatment:

3.3.1 Plated parts, except as specified in 3.3.1.1, shall be heat treated for 90 minutes ± 10 at 675 °F ± 15 (357 °C ± 8). Post thermal treatment shall start within four hours after completion of plating.

3.3.1.1 Cold worked or heat-treated parts, including carburized parts, and aluminum and aluminum alloy parts, precipitation-hardenable alloy parts which may decrease in hardness, and other parts requiring special handling shall be post-treated as agreed upon by purchaser and vendor.

3.3.2 When specified on the drawing, plated parts shall be impregnated after heat treatment with a suitable dry film lubricant or fluorotelomer to improve corrosion resistance and/or reduce coefficient of friction.

3.4 Properties:

Plate shall conform to the following requirements:

3.4.1 Composition: Deposit shall be homogeneous, conforming to one of the following compositions in percentage by weight, determined in accordance with ASTM E 1097 or other method acceptable to purchaser.

Type 1: Nickel plus 2.5 to 5.0% Boron and 2.5 to 6.0% Thallium
Type 2: Nickel plus 2.5 to 8.5% Boron

3.4.2 Hardness: Shall, after post treatment as in 3.3.1, be not lower than 1000 HV, or equivalent, determined in accordance with ASTM B 578 or other microhardness test method acceptable to purchaser using a load consistent with plating thickness, except for aluminum alloys or other materials for which different post treatments are specified.

3.4.3 Thickness: Shall be as specified on the part drawing, determined on representative parts or, when permitted by purchaser, on test panels (See 4.3.3), in accordance with ASTM B 487, ASTM B 567, ASTM B 568, or other method acceptable to purchaser.

3.4.4 Adhesion: Plating shall be firmly adherent to the basis metal and shall show no loss of adhesion, determined in accordance with ASTM B 571. Adhesion testing is not required for parts which have been post treated in accordance with 3.3.1.

3.4.5 Wear Resistance: A standard test block with 0.001 inch (25 μM) plating thickness, post treated as in 3.3.1, and subjected to a 150 pound (68 kg) load with filtered mineral spirits lubricant, shall exhibit a wear scar with an average width not greater than 0.032 inch (0.81 mm) after 5000 test cycles, determined in accordance with ASTM D 2714.

3.4.6 Corrosion Resistance: Ferrous parts or representative test panels in accordance with 4.3.3, having a specified minimum plating thickness of 0.0005 inch (12.7 μm) over prior flash coating of nickel and/or impregnated with suitable fluorotelomer, shall show no visual evidence of corrosion of the basis metal after being subjected for not less than 48 hours to continuous salt spray corrosion test conducted in accordance with ASTM B 117.

3.4.7 Solderability: When specified, parts or specimens in accordance with 4.3.3, tested in accordance with 4.5.1, shall exhibit a bright uniform coating of solder free from dicontinuities, pinholes, or dewetted areas visible to the unaided eye.

3.5 Quality:

Plated surfaces, as received by purchaser, shall be smooth, continuous, adherent to basis metal, and essentially free of pinholes, porosity, blisters, pits, and other imperfections detrimental to usage of the plate. Slight staining or discoloration is acceptable.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor shall supply all samples for processor's tests and shall be responsible for performing all required tests. Where 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: Tests for thickness (3.4.3), adhesion (3.4.4), solderability (when specified (3.4.7)), and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Tests for composition (3.4.1), hardness (3.4.2), 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 specified requirements are 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 for 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 approval by the cognizant engineering organization (See 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, contracting officer, or request for procurement.

4.3 Sampling and Testing:

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 processor's inspection at one time.

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

TABLE I - Sampling for Acceptance Tests

| Number of Parts in Lot | Quality | Thickness And Adhesion | Solderability if Specified |
|---|---|---|---|
| 1 to 6 | All | 3 | 1 |
| 7 to 16 | 7 | 4 | 2 |
| 16 to 40 | 10 | 4 | 2 |
| 41 to 110 | 15 | 5 | 3 |
| 111 to 300 | 25 | 6 | 3 |
| 301 to 500 | 35 | 7 | 4 |
| 501 to 700 | 50 | 8 | 4 |
| 701 to 1200 | 75 | 10 | 5 |
| Over 1200 | 125 | 15 | 5 |

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 inches (0.81 x 25 x 102 mm). For salt spray 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. For thickness tests, specimens shall be as specified above for adhesion tests or shall be bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long. For solderability tests the specimen shall be approximately 0.062 x 1 x I inch (1.57 x 25 x 25 mm). 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 Process procedure and control factors, a preproduction sample, or both, whichever is specified by purchaser, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 Processor shall make no significant change to materials, processes, or controls from those on which the 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, could affect the properties or performance of the parts.

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

Pre-cleaning procedure
Composition limits for plating baths
Temperature limits for plating baths
Lubricant composition and application method, if required
Post treatment time and temperature
Test method for thickness determination
Periodic test plan

4.5 Test Methods:

4.5.1 Solderability: A part, if applicable, or specimen in accordance with 4.3.3 shall be cleaned to remove oils, dirt, and fingerprints. After cleaning, the specimens or parts shall be handled with tongs or by persons wearing clean cotton gloves. Immerse the part or specimen in mildly activated rosin flux (RMA) and immerse in a solder bath containing AMS 4751 tin/lead solder, or equivalent, heated to and held at 480 °F ± 10 (249 °C ± 6). Immediately prior to immersion of the part or specimen, the surface of the molten solder shall be skimed to remove dross.

4.5.1.1 If a specimen as in 4.3.3 is used for the test, immerse at a rate of 1 inch (2.5 mm) per second, hold in the bath for approximately five seconds, and withdraw at the same rate used for immersion. Hold the specimen above the bath until the solder solidifies; clean to remove residual flux and examine visually.

4.5.1.2 If an actual part is used, consideration must be given to extending the immersion time in the molten solder consistent with size or thickness of the part. Immersion time in the solder bath must ensure the part reaching the temperature of the molten solder.

4.6 Reports:

The processing vendor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with specified requirements and that they conform to the acceptance test requirements. This report shall include the type of plate, purchase order number, lot number, AMS 2433B, part number, and quantity.

4.7 Resampling and Retesting:

4.7.1 If the results of any acceptance test fail to meet specified test requirements, the parts in that lot may be stripped by a method acceptable to purchaser that does not roughen, pit, or embrittle the basis metal, pretreated, plated, post treated as defined herein, and tested. Alternatively, all parts in the lot may be inspected for the nonconforming attribute, and the nonconforming parts may be stripped by a method acceptable to purchaser that does not roughen, pit, or embrittle the basis metal, pretreated, plated, post treated as defined herein, and tested.