

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SELECTIVE (BRUSH) NICKEL PLATING Low-Stressed, Hard Deposit

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for selective (brush) electrodeposition of nickel and the properties of the deposit.

1.2 Application:

This process has been used typically to provide good wear resistance and dimensional build-up and restoration of parts, which may operate in service up to 450 °F (232 °C), and requiring low tensile stress in the deposit, but usage is not limited to such applications. Diffusion heat treatment of the deposit is not required.

1.3 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 applicable issue of referenced publications shall be the issue in effect on the date of the purchaser order.

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2.1 ASTM Publications:

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

- ASTM B 487 Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
- ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric Method
- ASTM B 530 Measurement of Coating Thicknesses by the Magnetic Method: Electrodeposited Nickel Coatings on Magnetic and Nonmagnetic Substrates
- 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 E 92 Vickers Hardness of Metallic Materials
- ASTM E 290 Semi-Guided Bend Test for Ductility of Metallic Materials

2.2 U.S. Government Publications:

Available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

- MIL-STD-865 Selective (Brush Plating), Electrodeposition
- MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

- 3.1.1 All forming, machining, heat treating, brazing, welding, and surface prestressing 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 free from blemishes, pits, tool marks, and other irregularities.
- 3.1.3 Steel parts having hardness of 40 HRC or higher and which have been ground after heat treatment, shall be stress-relieved before 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, prior to selective plating, shall have chemically clean surfaces prepared with minimum abrasion, erosion, or pitting. Treatments which may promote hydrogen embrittlement shall be avoided.
- 3.1.5 Parts shall be within drawing limits after plating, unless otherwise specified.

3.1.6 Electrical contacts between the parts and power source shall be made to ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur.

3.2 Procedure:

3.2.1 Parts shall be plated by selective (brush) electrodeposition of nickel from a sulfamate solution containing addition agents to produce the specified hardness. Addition agents which might have a detrimental effect on properties of the plate or of the basis metal are not permitted. Except as permitted by 3.2.1.1, nickel shall be deposited directly on the basis metal without a prior preplate coating of metal other than nickel.

3.2.1.1 A preliminary chemical coating, immersion plate, or metal preplate is permissible on aluminum and aluminum alloys.

3.2.2 Equipment used to process samples, specimens, and parts shall be in accordance with MIL-STD-865.

3.2.3 Samples, specimens, and parts shall only be processed by qualified operators who have been certified by purchaser's Quality Assurance activity as holding a valid manufacturer's certification for the specific plating solution/basis material combination being processed. Certification shall be provided only to those trained operators who have successfully demonstrated a general knowledge of the selective plating process, a knowledge of the process requirements of this specification, and have shown their ability to process parts by successfully processing suitable specimens. As a minimum, operators shall demonstrate their ability to plate to the thickness required, and provide specimens capable of meeting the hardness, stress, adhesion, and quality requirements. Operators shall be recertified at least annually.

3.2.4 The plated parts shall be rinsed thoroughly and dried immediately after plating.

3.3 Post Treatment:

After plating, rinsing, and drying, parts 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 one hour, 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 $\pm$ 15 (191 °C $\pm$ 8) and held at heat for not less than three hours.

3.3.2 Parts, 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 $\pm$ 15 (135 °C $\pm$ 8) and held at heat for not less than five 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:

- 3.4.1 Thickness: Shall be as specified on the drawing, determined on representative parts or test panels in accordance with ASTM B 487, ASTM B 504, ASTM B 530, ASTM B 567, ASTM B 568, or other method acceptable to purchaser.
- 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 Resultant thickness shall be considered only when such surfaces of parts can be touched by a sphere 0.75 inch (19 mm) in diameter.
- 3.4.2 Hardness: Shall be not lower than 400 HV, or equivalent, determined in accordance with ASTM B 578 or ASTM E 92, on deposits 0.004 inch (0.10 mm) and over in thickness (See 8.1).
- 3.4.3 Stress: Shall be within the range of 0 to 15.0 ksi (0 to 103 MPa) in compression, determined on specimens having plate thickness of 0.003 inch (7.6 μ m) or greater. Stress shall be calculated by a method or instrument acceptable to purchaser.
- 3.4.4 Adhesion: Specimens as in 4.3.1 shall show no separation of the plating from the basis metal, when examined at approximately 4X magnification, after being bent rapidly at room temperature, in accordance with ASTM E 290, through an angle of 180 degrees around a diameter equal to the nominal thickness of the specimen. Formation of cracks which do not result in flaking, peeling, or blistering of the plate is acceptable.
- 3.4.4.1 Other methods acceptable to purchaser may be used to ensure that plated metal is firmly and continuously bonded to the basis metal.

3.5 Quality:

Plating, as received by purchaser, shall be smooth, continuous, adherent to the basis metal, uniform in appearance, and not coarsely crystalline and shall be essentially free from pinholes, porosity, blisters, nodules, pits, and other imperfections detrimental to performance of plating. Slight staining or discoloration is permissible.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processing vendor shall be responsible for performing all required tests. Representative test panels 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 (3.4.1) and quality (3.5) are acceptance tests and shall be performed to represent each lot.

4.2.2 Periodic Tests: Tests for hardness (3.4.2), stress (3.4.3), and adhesion (3.4.4) and tests of preparatory and plating solutions to ensure that the deposited metal will conform to the requirements of this specification 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 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, contracting officer, or request for procurement.

4.3 Sampling and Testing:

Shall be as agreed upon by purchase and vendor.

4.3.1 When plated parts are of such configuration and size not readily adaptable to the specified test, separate specimens prepared, plated, and post-treated with the parts represented may be used. Specimens shall be provided by purchaser and shall be representative samples of the basis material being plated. Specimens shall be plated as necessary to produce the plate thickness required for hardness, stress, and adhesion tests. For hardness and adhesion tests, specimens shall be panels of low-carbon steel, approximately 0.032 x 1 x 4 inches (0.81 x 25 x 102 mm). For thickness and quality tests, panels of the same size or bars or tubes approximately 1 inch (25 mm) in diameter and 4 inches (102 mm) long shall be used.