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AEROSPACE MATERIAL SPECIFICATION

**AMS 2406H**

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Superseding AMS 2406G

Submitted for recognition as an American National Standard

(R) PLATING, CHROMIUM Hard Deposit

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for electrodeposited hard chromium plate and processing requirements.

1.2 Application:

This plating has been used typically on parts for increasing abrasion resistance, increasing tool and die life, maintaining accuracy of gauges, and reconditioning worn or undersized parts, but usage is not limited to such applications.

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 purchase order.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

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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 499 Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
- ASTM B 504 Measurement of Thickness of Metallic Coatings by the Coulometric 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 F 519 Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals

2.2 U.S. Government Publications:

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

MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

- 3.1.1 All fabrication operations, such as forming, heat treating, shot preening, roll threading, welding, and brazing of areas to be plated, shall be completed before parts are plated.
- 3.1.2 Steel parts having hardness over 40 HRC and which have been ground, machined, cold formed, or cold straightened after heat treatment shall be cleaned to remove surface contamination and stress-relieved before preparation for plating. Unless otherwise specified, the stress relief shall be not less than 275 °F (135 °C) for five hours for parts with hardness of 55 HRC or greater and not less than 375 °F (191 °C) for four hours for other parts.
- 3.1.3 Parts shall have clean surfaces, free from water break, prior to immersion in the plating solution.
- 3.1.4 Electrical contacts between the parts and power source shall be made to prevent chemical or immersion deposition, electrical arcing, and overheating. 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.

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3.2 Procedure:

3.2.1 Deposition: The chromium shall be deposited directly on the basis metal without a coating of other metal underneath, except in the case of parts made of maraging steels, corrosion-resistant steels, or aluminum alloys, on which a preliminary deposit of nickel or other suitable metal 0.0002 inch (5 μ m) thickness maximum is permissible. Aluminum alloys may be zincate or stannate treated before plating.

3.2.2 Post Treatment: Unless otherwise specified, steel parts having a tensile strength of 160 ksi (1103 MPa) or 36 HRC, or greater, shall be heated after plating to $375^{\circ}\text{F} \pm 25$ ($191^{\circ}\text{C} \pm 14$) in air, preferably in a circulating-air oven, for not less than the time shown in Table 1. Carburized parts or other parts which may be deleteriously affected by heating to 375°F (191°C) shall be baked at $275^{\circ}\text{F} \pm 10$ ($135^{\circ}\text{C} \pm 6$) for not less than five hours. Post treatment shall start within four hours after removal from plating solution.

TABLE 1 - Minimum Post Treatment Times

Tensile Strength	Hardness, HRC	Hours
160 ksi, min (1103 MPa)	36 min	3
180 to 219 ksi (1241 to 1510 MPa)	40 to 45	8
220 ksi and over (1517 MPa)	46 and over	23

3.3 Properties:

The deposit shall conform to the following requirements:

3.3.1 Thickness: Shall be as specified on the part drawing, determined in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, or other method acceptable to purchaser.

3.3.1.1 The plate shall be substantially uniform in thickness on significant surfaces except that build-up at exterior corners or edges will be permitted provided finished drawing dimensions are met.

3.3.1.2 All surfaces of the part, except those which cannot be touched by a sphere 0.75 inch (19 mm) in diameter, shall be plated to the thickness specified. Unless otherwise specified, these surfaces, such as holes, recesses, threads, and other areas where a controlled deposit cannot be obtained under normal plating conditions, may be under specified limits provided they show coverage.

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- 3.3.2 Hardness: Shall be not lower than 700 HV, or equivalent, determined in accordance with ASTM B 578 except that a Vicker indenter and 100 gram load shall be used. Hardness shall be determined on test specimens in accordance with 4.3.4.
- 3.3.3 Adhesion: The deposited coating shall be tightly adherent to the substrate, determined in accordance with ASTM B 571.
- 3.3.4 Embrittlement: The chromium plating process, after baking, shall not cause hydrogen embrittlement in steel parts 40 HRC and over, determined using separate specimens in accordance with 4.3.4.3.
- 3.4 Quality:

Plating, as received by purchaser, shall be firmly bonded to the basis metal, and shall be smooth and uniform in appearance and, except as noted in 3.4.1, shall be bright, free from frosty areas, pinholes, nodules, blisters, and other imperfections detrimental to performance of the deposit. Visual inspection may be aided by not greater than 5X magnification. Different standards for acceptance may be agreed upon by purchaser and vendor, such as when post-plating polishing or grinding operations will remove visual deficiencies.

- 3.4.1 Pinholes and other imperfections which can be shown to be the result of failure of the deposit to bridge or fill imperfections, such as porosity, in the surface of the basis metal are acceptable.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processing vendor shall supply all specimens 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 (3.3.1), adhesion (3.3.3), and quality (3.4) are acceptance tests and shall be performed on each lot.
- 4.2.2 Periodic Tests: Tests for hardness (3.3.2), embrittlement (3.3.4), and tests of cleaning and plating solutions to ensure that deposited metal will conform to specified requirements are periodic tests and shall be performed at a frequency selected by the processing vendor unless frequency of testing is specified by purchaser.

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4.2.3 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed when preproduction tests are specified on the initial shipment of a plated part to a purchaser, when a change in material and/or processing requires reapproval 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 as follows; a lot shall be all parts of the same part number processed in a continuous operation, to the same thickness range, in the same set of solutions, in not longer than 24 consecutive hours, and presented for processor's inspection at one time. No fewer parts, or test specimens when authorized below, shall be tested than the following:

4.3.1 Quality: As shown in Table 2.

4.3.2 Thickness: As shown in Table 2.

TABLE 2 - Sampling for Acceptance Testing

Number of Parts in Lot		Quality	Thickness
Up to	6	all	3
7 to	15	7	4
16 to	40	10	4
41 to	110	15	5
111 to	300	25	6
301 to	500	35	7
501 to	700	50	8
701 to	1200	75	10
Over	1200	125	15

4.3.3 Adhesion: One part or a test specimen.

4.3.4 Test Specimens: When authorized by this specification, test specimens cleaned and plated with the parts they represent may be used. Specimens for ferrous parts, except stainless steels, shall be panels of annealed, low-carbon steel. For other alloys, test panels shall be of an alloy of the same generic type as the parts.

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4.3.4.1 Thickness shall be determined on parts except when part damage may occur, when part configuration or size is such that accurate results cannot be obtained, or unless otherwise agreed upon by purchaser and vendor. Representative parts are next in the order of preference for thickness testing. Test specimens as in 4.3.4 may be used if that is the only means for obtaining accurate and representative results.

4.3.4.2 Adhesion shall be determined on actual parts except when part damage may occur or unless otherwise agreed upon by purchaser and vendor. Representative parts are next in the order of preference for testing. Tests panels as in 4.3.4 may be used if that is the only means for obtaining accurate and representative results.

4.3.4.3 Embrittlement Relief: Three specimens conforming to ASTM F 519, Type 1, shall be prepared, plated, and post plate baked in accordance with this specification and tested in accordance with ASTM F 519. Plating thickness shall be $0.002 \text{ inch} \pm 0.0002$ ($0.05 \text{ mm} \pm 0.005$) measured on the smooth section of the specimen, but with visual evidence of plating in the notch.

4.4 Approval:

4.4.1 The process and control procedures, a preproduction sample part, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 The processor of plated parts shall make no significant change in bath type, plating conditions, or control factors from those on which approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgement of the cognizant engineering organization, would affect properties or performance of the parts.

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

- Surface preparation and cleaning procedures
- Surface activation procedure(s)
- Plating bath composition and composition control limits
- Plating bath temperatures limits and controls
- Current or voltage limits and controls
- Method for testing plating thickness
- Method for testing adhesion
- Stripping procedure if used
- Periodic test plan(s)

4.5 Reports:

The processing vendor shall furnish with each shipment a report stating that the parts have been processed and tested in conformance with specified requirements and that they conform to the technical requirements. This report shall include the results of the acceptance tests, purchase order number, lot number, AMS 2406H, part number, and quantity.

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4.6 Resampling and Retesting:

- 4.6.1 If results of any acceptance test fail to meet the specified requirements, the parts in that lot may be stripped by a method acceptable to purchaser which does not roughen, pit, or embrittle the basis metal, pretreated, replated, and post treated as defined herein and retested. 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 pit, roughen, or embrittle the basis metal, pretreated, replated, post treated as defined herein, and retested.
- 4.6.2 If results of any periodic test fail to meet specified requirements, the process will be declared nonconforming. No additional parts shall be plated until the process is corrected and new parts or specimens are plated and retested. Results of all tests shall be recorded and, when requested, reported. Purchaser shall be notified of all parts plated since the last acceptable test.

5. PREPARATION FOR DELIVERY:

5.1 Packaging:

- 5.1.1 Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plating and parts are preserved.
- 5.1.2 Packages of plated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.
- 5.1.3 For direct U.S. Military procurement, packaging shall be in accordance with MIL-STD-2073-1, Level C, unless Level A is specified in the request for procurement.

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 the plating does not conform to this specification, or to modifications authorized by purchaser, will be subject to rejection.

8. NOTES:

- 8.1 The (R) symbol is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this specification. If the symbol is next to the specification title, it indicates a complete revision of the specification.