SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2438B

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Superseding AMS 2438A

Plating, Chromium
Thin, Hard, Dense Deposit

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for thin, hard, dense chromium plating on surfaces of ferrous and nonferrous alloys.

1.2 Application:

This plating has been used typically to provide improved lubricity, wear and/or corrosion resistance to selected materials 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 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 issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: custsvc@sae.org
SAE WEB ADDRESS: http://www.sae.org

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts
AMS 6330	Steel Bars, Forgings, and Tubing, 0.65Cr - 1.25Ni (0.33 - 0.38C)

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM B 117	Operating Salt Spray (Fog) Apparatus
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 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 748	Measurement of Thickness of Metallic Coatings by Measurement of Cross Section with a Scanning Electron Microscope
ASTM D 2625	Endurance (Wear) Life and Load-Carrying Capacity of Solid Film Lubricants (Falex Pin and Vice Method)
ASTM E 384	Microhardness of Materials
ASTM F 519	Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments

2.3 U.S. Government Publications:

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

FED-STD-141 Paint, Varnish, Lacquer, and Related Materials; Methods for Testing of

2.4 ANSI Publications:

Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002

ANSI B46.1 Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 Surface texture of functional surfaces shall be 16 microinches (0.40 µm) RHR or smoother determined in accordance with ANSI B46.1.

3.1.2 Steel 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. Unless otherwise specified, the stress relief shall be not less than 275 °F (135 °C) for five hours for parts 55 HRC or higher and not less than 375 °F (191 °C) for four hours for other parts.

3.1.3 Parts shall have clean surfaces, free of water break, prior to immersion in the pickling and plating solutions.

3.2 Procedure:

3.2.1 Chromium shall be plated directly on the basis metal without a coating of other metal underneath, except that a preliminary plating of nickel or copper 0.00005 inch (1 µm), maximum, is permissible on aluminum and titanium alloys. Aluminum alloys shall be prepared in accordance with ASTM B 253.

3.2.2 Spotting-in is not permitted.

3.3 Hydrogen Embrittlement Relief:

Shall be performed in accordance with AMS 2759/9.

3.4 Properties:

The plating shall conform to the following requirements:

3.4.1 Thickness: The finished thickness shall be as specified on the drawing, determined on representative parts or test panels in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, ASTM B 748, or other method acceptable to purchaser. Recommended plating thickness range is 0.00025 to 0.0006 inch (6.35 to 15 µm). When a single thickness value is specified, the applicable tolerance shall be in accordance with Table 1.

TABLE 1A - Thickness Tolerances, Inch/Pound Units

Thickness Range Inch		Tolerance, Inch plus and minus
Up	to 0.0001	0.00001
Over 0.0001	to 0.00025	0.000025
Over 0.00025	to 0.0006	0.00005

TABLE 1B - Thickness Tolerances, SI Units

Thickness Range Micrometers	Tolerance, Micrometers plus and minus
Up to 2.5	0.25
2.5 to 6.35	0.62
6.35 to 15.0	1.25

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

3.4.1.2 No requirements are established for minimum plate thickness on surfaces of holes, recesses, internal threads, contact areas of parts plated all over, and other areas where a controlled deposit cannot be obtained under normal plating conditions, but such surfaces shall not be masked to prevent plating. The resultant thickness shall be considered only when such surfaces can be touched by a sphere 0.75 inch (19.0 mm) in diameter.

3.4.2 Hardness: Shall be 900HV100 or higher (or equivalent), determined in accordance with ASTM E 384.

3.4.3 Adhesion: Adhesion shall meet the requirements of ASTM B 571. There shall be no evidence of internal delamination or loss of adhesion from basis metal.

3.4.4 Abrasion and wear resistance shall be such that the plating passes either one of the following tests:

3.4.4.1 A standard Taber specimen, cleaned, plated, and post-treated in the same manner as the parts represented shall, after 5000 cycles, show a wear index based on the weight-loss method of less than 1.2 average, or 6 milligrams, for three tests, determined in accordance with FED-STD-141, Method 6192, using the Taber abrasion tester with CS-10 wheels, each subjected to a 1000 gram load.

3.4.4.2 An AMS 6330 steel pin, cleaned, plated, and post-treated (See 3.3) with the parts represented shall show an average endurance life of 60 minutes minimum and an average weight loss of 2 milligrams/hour maximum for three tests, determined in accordance with ASTM D 2625, using the Falex lubricant tester and a 750 pound (340 kg) gage load in additive-free, white mineral oil, U.S.P. 18. The 96 degree V-blocks shall be 50 HRC minimum and shall not be coated or treated.

3.4.5 Corrosion Resistance of Steel: Test specimens (4.3.1.3) having a plating thickness of 0.0005 inch (13 µm) maximum, shall show no visible corrosion of the basis metal after being subjected for 50 hours to a continuous salt spray corrosion test in accordance with ASTM B 117.

3.4.6 Hydrogen Embrittlement: The process shall not cause hydrogen embrittlement in ferrous metals. Testing in accordance with ASTM F 519, Type 1a, using notched round specimens, unless a different specimen type is specified by the purchaser, stressed in tension under constant load, is required when parts 40 HRC or higher are plated. For test purposes, plating thickness shall be 0.0003 to 0.0005 inch (8 to 13 µm) thick measured on the smooth section of the specimen. When parts to be plated are fabricated from an alloy for which AMS 2759/9 requires a baking temperature lower than 375 °F (191 °C), test specimens shall be baked at the same temperature for 96 hours.

3.5 Quality:

Plating, as received by purchaser, shall be smooth, continuous, free from delamination within the plating, uniform in appearance and, except as noted in 3.5.1, shall be free from imperfections detrimental to usage of the plating. Plating shall be visually free from frosty areas, pin holes, porosity, blisters, nodules, and pits. Slight staining or discoloration shall be acceptable.

3.5.1 Pinholes and other imperfections which can be shown to be the result of failure of the plating to bridge or fill imperfections, such as would be due to porosity in a casting, in the surface of the basis metal are 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 performance of all required tests. Parts, if required for tests, 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 specified requirements.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.4.1), adhesion (3.4.3), and quality (3.5) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests: Hardness (3.4.2), corrosion resistance (3.4.5), hydrogen embrittlement (3.4.6), and tests of cleaning and plating solutions to ensure that the plated metal will conform to this specification (See 8.7) are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser except corrosion testing shall be performed a minimum of once each month.

4.2.3 Preproduction Tests: All technical requirements of this specification are preproduction tests and shall be performed prior to production or on the initial shipment of plated parts 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.

4.3 Sampling and Testing:

Shall not be less than the following; a lot shall be all parts of the same part number, plated to the same range of plate thickness in the same solutions in each eight hours of continuous production, and presented for processor's inspection at one time.

4.3.1 Test samples shall be selected randomly from all parts in the lot. The minimum number of samples shall be as shown in Table 2.

TABLE 2 - Sampling for Acceptance Tests

Number of Parts in Lot	Quality	Thickness/ Adhesion	Test Panels (if required)
up to 7	All	3	1
8 to 15	7	4	2
16 to 40	10	4	3
41 to 110	15	5	4
111 to 300	25	6	5
301 to 500	35	7	6
501 to 700	50	8	6
701 to 1200	75	10	7
over 1200	125	15	10

4.3.2 Periodic Tests: Frequency of testing and sample size shall be at the discretion of the processor unless test frequency is specified by the purchaser.

4.3.3 Sample Configuration:

4.3.3.1 Nondestructive testing shall be performed wherever practical and where authorized herein. Except as noted below, actual parts shall be selected as samples for tests. Correlation of results on panels to parts for characteristics that differ from parts, such as thickness, must be established.

4.3.3.2 Thickness, Adhesion, and Hardness Tests: Separate test specimens, made of the same generic class of alloy as the parts, cleaned, plated, and post treated with the parts represented may be used when plated parts are of such configuration or size as to be not readily adaptable to the specified tests, or when nondestructive testing is not practical on actual parts, or it is not economically acceptable to perform destructive tests on actual parts. A greater plating thickness on microhardness test panels is permissible when required to obtain a valid test result.

4.3.3.3 Corrosion Tests: Corrosion testing shall be performed on separate panels of 40 HRC, minimum, steel approximately 0.032 x 4 x 1 inch (0.8 x 102 x 25 mm) or bars approximately 0.5 inch (13 mm) in diameter and 4 inches (102 mm) long. Surface texture shall be not rougher than 16 microinches (0.40 µm) RHR, determined in accordance with ANSI B46.1.

4.4 Approval:

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

4.4.2 The 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:

Surface preparation
Plating bath composition and composition control limits
Plating bath temperature limits and controls
Thermal post treatment times and temperatures
Method for determining plating thickness
Method of adhesion test
Pretreatment, plating voltage/current
Method of stripping (if required)
Periodic test plan

4.5 Reports:

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that they conform to the acceptance tests requirements. This report shall include the purchase order number, lot number, AMS 2438B, part number, and quantity.

4.6 Resampling and Retesting:

4.6.1 If the result of any acceptance test fails to meet specified test requirements, the parts in that lot may be stripped by a method acceptable to the purchaser that does not roughen, pit or embrittle the basis metal, pretreated, plated, and 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 the purchaser that does not roughen, pit or embrittle the basis metal, pretreated, plated, post treated as defined herein, and tested.

4.6.2 If the result of any periodic test fails to meet specified test requirements, the process is nonconforming. No additional parts shall be plated until the process is corrected and new specimens are plated and tested. Results of all tests shall be recorded and, when requested, reported. Purchasers shall be notified of all parts plated since the last acceptable test.

5. PREPARATION FOR DELIVERY:

5.1 Plated parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plating and parts are preserved.