SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

AMS 2406L

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Superseding AMS 2406K

Plating, Chromium Hard Deposit

RATIONALE

AMS 2406L results from a Five Year Review and update of this specification.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the plating processor by the purchaser.

1) Purchase order shall specify not less than the following:

- AMS 2406L
- Plating thickness desired (see 3.4.1)
- Basis metal to be plated
- Tensile strength or hardness of the basis metal
- Pre-plate stress relief to be performed by plating processor (time and temperature) if different from 3.1.1
- Special features, geometry or processing present on parts that requires special attention by the plating processor
- Hydrogen embrittlement relief to be performed by plating processor (parameters or reference document) if different from 3.3.
- Minimum thickness on internal surfaces, if required (see 3.4.1.1)
- Optional: Sample quantity and frequency of periodic testing (see 4.2.2 and 4.3.2)
- Whether approval is based on approval of process/control factors or sample part or both (see 4.4.1)
- Quantity of pieces to be plated

2) Parts manufacturing operations such as heat treating, forming, joining and media finishing can affect the condition of the substrate for plating, or if performed after plating, could adversely affect the plated part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification.

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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**

1. SCOPE

1.1 Purpose

This specification covers the requirements for electrodeposited hard chromium plate.

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 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AMS 2759/9 Hydrogen Embrittlement Relief (Baking) of Steel

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

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 567 Method for Measurement of Coating Thickness by the Beta Backscatter Method
ASTM B 568 Measurement of Coating Thickness by X-Ray Spectrometry
ASTM B 571 Qualitative Adhesion of Metallic Coatings
ASTM B 578 Microhardness of Electroplated Coatings
ASTM F 519 Mechanical Hydrogen Embrittlement Evaluation of Plating Processes and Service Environments
ASTM B 748 Measurement of Thickness of Metallic Coatings by Measurement of Cross Section with a Scanning Electron Microscope

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3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 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. 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, the stress relief shall be not less than 275 °F (135 °C) for five hours for parts with hardness of 55 HRC or higher or not less than 375 °F (191 °C) for four hours for other parts.

3.1.2 The plating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting or intergranular attack of the basis metal and shall preserve dimensional requirements.

3.1.3 Except for barrel plating, electrical contact points shall be as follows. For parts which are to be plated all over, location shall be acceptable to the cognizant engineering organization; for parts which are not to be plated all over, location shall be in areas where plating is optional.

3.1.4 Aluminum alloys shall be zincate treated in accordance with ASTM B 253 or other method acceptable to the cognizant engineering organization prior to plating.

3.2 Procedure

3.2.1 The chromium shall be deposited directly over a surface free from water breaks 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 µm) thickness maximum is permissible.

3.3 Hydrogen Embrittlement Relief

Treatment of steel parts 36 HRC and above shall be in accordance with AMS 2759/9.

3.4 Properties:

3.4.1 Thickness

Thickness of the plate shall be as specified on the drawing, determined in accordance with any of the following methods as applicable: ASTM B 487, ASTM B 499, ASTM B 567, ASTM B 568, ASTM B 748, or by other method acceptable to the cognizant engineering organization.

3.4.1.1 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.

3.4.1.2 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.

3.4.2 Hardness

The plate hardness shall be not lower than 700 HV, or equivalent, determined in accordance with ASTM B 578 except that a Vicker's indenter and 100 gram load shall be used.

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3.4.3 Adhesion

Adhesion shall meet the requirements of ASTM B 571 Bend Test method with no mandrel. When examined at a magnification of approximately 4X, neither the chromium plating nor any electrodeposited underplate(s) shall show separation from the basis metal or from each other. The formation of cracks in the plating or the basis metal which do not result in flaking, peeling or blistering of plated layers shall not be cause for rejection.

3.4.4 Hydrogen Embrittlement

The chromium plating process, after baking, shall not cause hydrogen embrittlement in steel parts 36 HRC and over, determined in accordance with the requirements of ASTM F 519. See 4.3.3.2.

3.5 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 3.5.1, 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.

3.5.1 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 processor shall supply all specimens for processor's tests and shall be responsible for the performance of all required tests. Where parts are to be tested, such parts shall be supplied by purchaser. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that processing conforms to 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) is a periodic test and shall be performed at least quarterly unless frequency of testing is specified by the cognizant engineering organization. Tests of cleaning and plating solutions are periodic tests and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization. See 4.4.3 and 8.4. Hydrogen embrittlement (3.4.4) is a periodic test and shall be determined at least once in each month that steel parts 36 HRC and over are plated.

4.2.3 Preproduction Tests

All property verification tests are preproduction tests and shall be performed when prior to initial shipment and when the cognizant engineering organization deems confirmatory testing to be required.

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.

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4.3.1 Acceptance Tests

Test samples shall be selected randomly from all parts in the lot. Unless the cognizant engineering organization supplies a sampling plan, the minimum number of samples shall be as shown in Table 1.

TABLE 1 - Sampling for Acceptance Testing

Number of Parts in Lot	Quality	Thickness and Adhesion
Up to 7	All	All or 3*
8 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

*Whichever is less

4.3.2 Periodic and Preproduction Tests

Sample quantity shall be one for hardness and as specified in ASTM F 519 for hydrogen embrittlement unless otherwise specified by the cognizant engineering organization.

4.3.3 Sample Configuration

4.3.3.1 Separate test specimens may be used under any one of the following circumstances: the 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. When used, separate test specimens shall be of the same generic class of alloy as the parts, distributed within the lot, cleaned, plated, and post-treated with the parts.

4.3.3.2 Hydrogen embrittlement test specimens shall conform to ASTM F 519 Type 1a.1 using notched round bars, stressed in tension under constant load unless a different specimen is specified by the cognizant engineering organization. For test purposes, plating thickness shall be 0.002 inch ± 0.0002 (51 µm ± 5), measured on the smooth section of the specimen, but with visual evidence of plating in the root of 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 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the cognizant engineering organization for process reapproval, unless the change is approved by the cognizant engineering organization. A significant change is one which, in the judgment of the cognizant engineering organization, would affect properties or performance of the parts.

4.4.3 Control factors 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 temperature limits and controls
Current or voltage limits and controls
Method for testing plating thickness
Method for testing adhesion
Stripping procedure, if used

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