SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS2425 | REV. F

Issued 1966-03
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Revised 2012-12

Superseding AMS2425E

Plating, Gold for Thermal Control

RATIONALE

AMS2425F results from a Five Year Review and update of this specification and adds ordering information consistent with other AMS plating specifications.

NOTICE

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

Purchase order shall specify not less than the following:

AMS2425F.

Plating thickness desired (3.4.2) and minimum thickness on internal surfaces, if required (3.4.2.4)

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

Periodic testing frequency and sample quantity, if different from 4.2.2 and 4.3.3.

Quantity of pieces to be plated

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2425F

1. SCOPE

1.1 Purpose

This specification covers the requirements for gold deposited on metal surfaces and the properties of the deposit.

1.2 Application

This process has been used typically for passive thermal control applications where high reflectance and low absorptance of solar radiation are required, but usage is not limited to such applications.

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.

2.1 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 117 Operating Salt Spray (Fog) Testing Apparatus

ASTM B 253 Preparation of Aluminum Alloys for Electrodeposition

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 Measurement of Coating Thickness by the Beta Backscatter Method

ASTM B 583 Porosity in Gold Coatings on Metal Substrates

2.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI B46.1 Surface Texture

3. TECHNICAL REQUIREMENTS

3.1 Preparation

3.1.1 Ferrous parts having a hardness higher than 40 HRC and which have been ground after heat treatment shall be cleaned to remove surface contamination and suitably 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 not less than 5 hours for parts having hardness of 55 HRC or higher or not less than 375 °F (191 °C) for not less than 4 hours for other parts.

3.1.2 Texture of surfaces to be plated, prior to cleaning, shall be not rougher than 32 microinches (0.8 µm), determined in accordance with ANSI B46.1. Light abrasive blasting and polishing are permitted to improve surface finish to produce a high luster.

3.1.3 Parts shall have clean surfaces free of waterbreak prior to immersion in the plating solution.

3.1.4 Except for barrel plating electrical contact points shall be as follows: For parts which are to be plated all over, locations shall be acceptable to purchaser; for parts which are not to be plated all over, locations shall be in areas on which plating is not required or is optional.

3.2 Procedure

Parts shall be plated in the following sequence using suitable plating solutions. A zincate immersion coating treatment in accordance with ASTM B 253 shall be applied to aluminum or aluminum alloys prior to plating.

Copper Flash or Strike
Nickel Plate
Gold Plate

3.2.1 Copper Flash or Copper Strike

A copper flash or copper strike shall be electrodeposited from a suitable copper plating bath except as exempted in 3.2.1.1, 3.2.1.2, and 3.2.1.3.

3.2.1.1 A nickel flash or nickel strike shall replace the copper strike when the basis metal is corrosion- resistant steel. The nickel flash or nickel strike shall be electrodeposited from a suitable nickel plating solution.

3.2.1.2 The copper strike may be omitted when the substrate is copper or a copper alloy containing less than 15% zinc.

3.2.1.3 Parts that have been zincated do not require a copper flash or strike.

3.2.2 Nickel Plate

The nickel plate shall be deposited directly onto the copper strike or flash or, when specified as in 3.2.1.1, onto the nickel strike or flash. Either electroplating or electroless nickel processing is permitted.

3.2.3 Gold Plate

Shall be electrodeposited from a suitable gold plating solution directly onto the nickel surface.

3.2.4 Rinsing

The plated part shall be removed from the plating solution and shall be thoroughly rinsed by immersion for not less than 15 minutes in water at not lower than 180 °F (82 °C) and dried.

3.2.4.1 Plated springs may be removed from the plating racks after rinsing provided they are not flexed prior to embrittlement relief.

3.3 Hydrogen Embrittlement Relief

After plating, rinsing, and drying and within 4 hours after removal from plating bath ferrous parts shall be treated as follows.

3.3.1 Parts having hardness of 33 HRC or higher shall be heated to 375 °F ± 25 (191 °C ± 14) and held at heat for not less than 3 hours.

3.3.2 Parts which will decrease in hardness or be otherwise deleteriously affected by heating to 375 °F ± 25 (191 °C ± 14) shall be heated to 275 °F ± 25 (135 °C ± 14) and held at heat for not less than 5 hours.

3.3.3 Polishing of plated metals is permitted to improve surface finish and luster.

3.4 Properties

Plated metals shall conform to the following requirements:

3.4.1 Composition

The gold, as plated, shall be not less than 98.0% pure, determined by a method acceptable to purchaser.

3.4.2 Thickness

Plating thicknesses shall be as follows, determined in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 567, or other method acceptable to purchaser.

3.4.2.1 Copper Flash or Copper Strike

Shall be not less than 0.0001 inch (2.5 µm).

3.4.2.2 Nickel Plate

Shall be 0.0004 to 0.0009 inch (10.0 to 23 µm).

3.4.2.3 Gold Plate

Shall be not less than 0.00008 inch (2.0 µm) on all surfaces on which gold is functionally necessary.

3.4.2.4 No requirements are established for minimum plate thickness on surfaces of holes, recesses, internal threads, contact areas of part plated all over, and other areas where a controlled deposit cannot be obtained under normal plating conditions but such areas 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 mm) in diameter.

3.4.3 Adhesion

The gold deposit shall meet one of the following tests; the test in 3.4.3.1 shall be used where practicable.

3.4.3.1 The part, or representative test panels, shall be bent through an angle of 100 degrees around a 0.500 inch ± 0.005 (12.7-mm ± 0.12) diameter mandrel. It shall not be possible to detach any appreciable areas of deposited gold from the basis metal with a sharp instrument although fracture of the nickel plate or the basis metal is acceptable.

3.4.3.2 If the part is not readily adaptable to the test in 3.4.3.1, adhesion may be evaluated by heating the part to 350 °F ± 10 (177 °C ± 6) and holding at that temperature for not less than 1 hour. Following heating, no evidence of blistering of the plating shall be visible at 4X magnification.

3.4.4 Corrosion Resistance

Parts or representative test panels shall show no corrosion products to the unaided eye (corrected to 20/20 vision) at normal reading distance or any corroded areas greater than 1/32 inch (0.8 mm) in diameter after being subjected for 48 hours ± 1 to continuous salt spray corrosion test conducted in accordance with ASTM B 117.

3.4.4.1 The porosity test of ASTM B 583 may be used in lieu of the salt spray corrosion test, unless otherwise specified by purchaser.

3.4.5 Spectral Absorptance and Emittance

The normal spectral solar absorptance integrated over a wave length range 0.3 to 2.7 µm shall be 0.26 ± 0.04. The normal spectral emittance integrated over a wave length range of 2.0 to 27.0 µm shall be 0.04 ± 0.02.

3.4.5.1 The integrated normal spectral solar absorptance and integrated normal spectral emittance shall be determined using Equation 1:

$$\bar{\alpha}, \bar{\varepsilon} = 1 \frac{\int_a^b R\lambda S\lambda d\lambda}{\int_a^b S\lambda d\lambda} \quad \text{(Eq. 1)}$$

where $\bar{\alpha}$ and $\bar{\varepsilon}$ are the integrated normal spectral solar absorptance and the integrated normal spectral emittance respectively, Rλ is the normal spectral reflectance, λ is the wave length, and for $\bar{\alpha}$, a = 0.3 µm, b = 2.7 µm, and Sλ = Solar Spectrum and, for $\bar{\varepsilon}$, a = 2.0 µm, b = 27.0 µm, and Sλ = Black body spectrum (for temperature of interest), and Rλ is measured in an integrating-sphere reflectometer, preferably against a standard gold surface reference.

3.4.5.2 Total reflectance (specular and diffuse) shall be equal to or greater than 95% when measured at a wave length of 0.7 µm by an integrating-sphere reflectometer. (8.6)

3.5 Quality

Deposits of gold plate shall be smooth, fine grained, continuous, adherent to basis metal, and of a color normally associated with high quality 24-carat gold, and shall be free from blisters, pits, nodules, indications of burning, and other imperfections detrimental to performance of the gold plate. Slight discoloration does not deleteriously affect the thermal properties or corrosion resistance of the gold plate. There shall be no evidence of double plating and spotting-in after plating.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor of plated parts shall supply all samples for processor's tests and shall be responsible for the performance of all required tests, where parts are to be tested, the parts shall be supplied by the purchaser. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the processing conforms to the requirements of this specification.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (3.4.2), adhesion (3.4.3), reflectance (3.4.5.2), and quality (3.5) are acceptance tests and shall be performed on each lot as applicable.

4.2.2 Periodic Tests

Composition (3.4.1), corrosion resistance (3.4.4), spectral absorption and emittance (3.4.5.1), and tests of cleaning and plating solutions to ensure that deposits will conform to specified requirements (See 8.5) are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

All technical requirements of this specification 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, processing, or both requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling and Testing

Shall be not less than the following; a lot shall be all parts of the same part number, plated to the same plate thickness range in the same set of solutions, in each consecutive 24 hours of operation and presented for processor's inspection at one time.

4.3.1 Sample Configuration

Nondestructive testing shall be performed wherever practical and authorized herein. Except as noted actual parts shall be selected as samples for test.

4.3.1.1 Thickness and Adhesion Test

Separate test panels of the same generic class of alloy as the parts distributed throughout the lot, cleaned, plated and post treated with the parts represented shall 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 testing on actual parts.

4.3.1.2 Corrosion Tests

Panels for salt spray testing shall be low carbon steel approximately 0.032 x 4 x 6 inches (0.8 x 102 x 152 mm) or bars approximately 0.5 inches (13 mm) in diameter and 4 inches (102 mm) long, having surface roughness not exceeding 32 microinches (0.8 µm).

4.3.1.2.1 If the porosity test of ASTM B 583 is used in lieu of the salt spray corrosion test, either actual parts, or panels of the same alloy and condtion, plated with the actual parts, shall be used.

4.3.2 Acceptance Tests

Test samples shall be selected randomly from all parts in the lot. Unless purchaser 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	Reflectance
1 to 6	all	3	1
7 to 15	7	4	2
16 to 40	10	4	2
41 to 110	15	5	3
111 to 300	25	6	4
301 to 500	35	7	5
501 to 700	50	8	6
701 to 1200	75	10	7

4.3.3 Periodic Tests

Sample quantity and frequency of testing shall be selected at the discretion of the processor unless otherwise specified by the purchaser.