SAE Aerospace
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AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2425E

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Superseding AMS 2425D

(R)

Plating, Gold For Thermal Control

RATIONALE

This document has been reaffirmed to comply with the SAE 5-year Review policy.

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 a combination of low solar absorptance, low infrared emittance, and corrosion resistance is 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 form 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.

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 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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 ANSI, 1430 Broadway, New York, NY 10018.

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 five hours for parts having hardness of 55 HRC or higher or not less than 375 °F (191 °C) for not less than four 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 and 3.2.1.2.

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.

3.2.2 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.

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 four 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 three 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 five 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 3.7.3.1, adhesion may be evaluated by heating the part to 350 °F ± 10 (177 °C ± 6) and holding at that temperature for not less than one 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, when permitted 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, $R\lambda$ is the normal spectral reflectance, λ is the wave length, and for $\bar{\alpha}$, a = 0.3 µm, b = 2.7 µm, and $S\lambda$ = Solar Spectrum and, for $\bar{\varepsilon}$, a = 2.0 µm, b = 27.0 µm, and $S\lambda$ = Black body spectrum (for temperature of interest), and $R\lambda$ 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.

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, when specified by purchaser (3.4.5) 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 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).

4.3.2 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.

4.4 Approval:

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

4.4.2.1 Control factors include, but are not limited to the following:

Surface preparation
Bath type and composition limits
Temperature limits and control of processing solutions
Method of thickness determination
Method of determining composition of gold deposit
Method of adhesion determination
Periodic test plan

4.5 Reports:

The processor of plated parts 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 test requirements. This report shall include the purchase order number, lot number, AMS 2425E, part number, and quantity.

4.6 Resampling and Retesting:

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

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