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AEROSPACE MATERIAL SPECIFICATION

AMS 2425C
Superseding AMS 2425B

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GOLD PLATING
For Thermal Control

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for electrodeposition of gold on metals and the properties of the deposit.

1.2 Application: Primarily for use in passive thermal control applications where a combination of low solar absorptance, low infrared emittance, and corrosion resistance is required.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM B487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
ASTM B499 - Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
ASTM B504 - Measurement of Thickness of Metallic Coatings by the Coulometric Method
ASTM B567 - Measurement of Coating Thickness by the Beta Backscatter Method
ASTM B583 - Porosity in Gold Coatings on Metal Substrates

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

2.4 ANSI Publications: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

3.1.1 All machining, brazing, welding, forming, and heat treating shall be completed before parts are plated.

3.1.2 Texture of surfaces to be plated, prior to cleaning, shall be not rougher than 32 microin. (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 chemically clean surfaces prepared with minimum abrasion, Ø erosion, or pitting, prior to immersion in the plating solution. Treatments which may produce hydrogen embrittlement shall be avoided.

3.1.4 Electrical contacts between the parts and power source shall be made in such a manner as will ensure that neither chemical or immersion deposition nor electrical arcing or overheating will occur. If parts are to be plated all over, contact points shall be located as specified on the part drawing or as 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.

3.2 Procedure: Unless otherwise specified, parts shall be plated in the following sequence using the solution specified. A zincate immersion coating treatment shall be applied to aluminum alloy substrates prior to the following cycle:

Ø

1. Copper Flash or Strike
2. Nickel Plate
3. Gold Plate

3.2.1 Copper Flash or Copper Strike: A copper flash or copper strike shall be Ø electrodeposited from a copper cyanide bath except as exempted in 3.2.1.1 and 3.2.1.2.

3.2.1.1 When specified, a nickel flash or nickel strike shall replace copper strike when the basis metal is corrosion-resistant steel or alloy. The nickel flash or nickel strike shall be electrodeposited from a Watt's type nickel solution or from a nickel chloride solution, unless otherwise agreed upon by purchaser and vendor.

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

3.2.2 Nickel Plate: Unless otherwise specified, 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. Alternatively, a nickel strike from a nickel chloride solution followed by nickel plating from a nickel chloride, Watt's nickel, or sulfamate nickel solution may be used. Proper procedure shall be adopted by the plating processor to ensure good adhesion of nickel plate to the substrate.

3.2.3 Gold Plate: Shall be electrodeposited from a gold cyanide solution or neutral (acid) gold solution directly onto the nickel surface.

3.2.4 Rinsing: The plated part shall be removed from the plating solution and, unless otherwise specified, shall be thoroughly rinsed by immersion for not less than 15 min. in water at not lower than 180°F (80°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 Post Treatment: After plating, rinsing, and drying and within 30 min. after completion of the hot water rinse, all parts shall be treated as follows, unless otherwise permitted by purchaser. All parts shall be handled carefully prior to completion of the relief treatment.

3.3.1 Steel Parts:

3.3.1.1 Parts having hardness of 33 HRC or higher, except as specified in 3.3.1.2 and 3.3.2 shall be heated to 375°F ± 10 (190°C ± 5) and held at heat for not less than 3 hours.

3.3.1.2 Parts which will decrease in hardness or be otherwise deleteriously affected by heating to 375°F ± 10 (190°C ± 5) shall be heated to 275°F ± 10 (135°C ± 5) and held at heat for not less than 5 hours.

3.3.1.3 Parts requiring special handling shall be post treated as agreed upon by purchaser and vendor.

3.3.2 When permitted or specified by purchaser, other methods of embrittlement relief may be employed.

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 but actual determination of purity shall not be required as a routine inspection procedure; the process of plating shall be controlled to produce this purity.

3.4.2 Thickness: Unless otherwise specified, plating thicknesses shall be as Ø follows, determined in accordance with ASTM B487, ASTM B499, ASTM B504, ASTM B567, or other method approved by purchaser:

3.4.2.1 Copper Flash or Copper Strike: Shall be not less than 0.0001 in. Ø (2.5 μm).

3.4.2.2 Nickel Plate: Shall be 0.0004 - 0.0009 in. (10.0 to 22.5 μm). Ø

3.4.2.3 Gold Plate: Shall be not less than 0.0008 in. (2.00 μm) on all Ø surfaces on which gold is functionally necessary.

3.4.2.4 No requirements are established for minimum plate thickness on Ø 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. Unless otherwise specified, the resultant thickness shall be considered only when such surfaces can be touched by a sphere 0.75 in. (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 deg around a 0.500-in. ± 0.005 (12.50-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 Ø may be evaluated by heating the part to 350°F ± 10 (175°C ± 5) 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 in. (0.8 mm) in diameter after being subjected for 48 hr ± 1 to continuous salt spray corrosion test conducted in accordance with ASTM B117.

3.4.4.1 The porosity test of ASTM B583 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 wavelength range 0.3 - 2.7 μm shall be 0.26 ± 0.04. The normal spectral emittance integrated over a wavelength range of 2.0 - 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 from the equation:

$$\bar{\alpha}, \bar{\varepsilon} = 1 - \frac{\int_a^b R\lambda\, S\lambda\, d\lambda}{\int_a^b S\lambda\, d\lambda}$$

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 wavelength, and

for $\bar{\alpha}$, a = 0.3 μm
b = 2.7 μm
$S\lambda$ = Solar Spectrum

and, for $\bar{\varepsilon}$, a = 2.0 μm
b = 27.0 μm
$S\lambda$ = 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 wavelength of 0.7 μm by an integrating-sphere reflectometer.

3.5 Quality: Deposits of gold plate shall be smooth, fine grained, continuous, Ø 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 resulting from rinsing or heating will be permitted provided that such discoloration does not deleteriously affect the thermal properties or corrosion resistance of the gold plate. Standards for acceptance shall be as agreed upon by purchaser and vendor.

3.5.1 Double plating and spotting-in after plating are not permitted, unless Ø otherwise authorized by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of plated parts shall supply all Ø samples for vendor's tests and shall be responsible for performing all required tests except as specified in 4.2.2.1. Results of such tests shall be reported to the purchaser as required by 4.5. 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 to determine conformance to requirements for Ø thickness (3.4.2), adhesion (3.4.3), corrosion resistance (3.4.4), reflectance (3.4.5.2), and quality (3.5) are classified as acceptance tests and shall be performed to represent each consecutive 24 hr of operation of the same set of solutions.

4.2.2 Periodic Tests: Tests to determine conformance to requirements for Ø composition (3.4.1) and spectral absorption and emittance (3.4.5) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

4.2.2.1 The plating processor will not be required to perform the spectral absorptance and emittance test (3.4.5), unless otherwise agreed upon by purchaser and vendor.

4.2.3 Preproduction Tests: Tests to determine conformance to all technical Ø requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of plated parts to a purchaser, when a change in material or processing, or both, requires reapproval as in 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, the contracting officer, or the request for procurement.