

AEROSPACE MATERIALS SPECIFICATION

Submitted for recognition as an American National Standard

SAE

AMS 2415G

Issued OCT 1945
Revised SEP 1996

Superseding AMS 2415F

PLATING, LEAD AND INDIUM

1. SCOPE:

1.1 Purpose:

This specification covers the engineering requirements for electrodeposition of lead and indium and diffusion of the indium into the lead, and the properties of the deposit.

1.2 Application:

This process has been used typically to improve the performance and prevent corrosion of bearings or of other 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 following publications form a part of this specification to the extent specified herein. The applicable issue of referenced publications shall be the issue in effect on the date of the purchase order.

2.1 ASTM Publications:

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

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

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 1996 Society of Automotive Engineers, Inc.
All rights reserved.

Printed in U.S.A.

2.1 (Continued):

- 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 E 376 Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods

3. TECHNICAL REQUIREMENTS:

3.1 Preparation:

- 3.1.1 All fabrication-type operations, such as forming, machining, heat treating, brazing, and welding, shall be completed before parts are plated.
- 3.1.2 When specified by purchaser, the surfaces to be plated shall be blasted lightly with fine grit to obtain a matte finish.
- 3.1.3 (R) Steel parts, having a hardness of 40 HRC or higher and which have been 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 $275^{\circ}\text{F} \pm 25$ ($135^{\circ}\text{C} \pm 14$) for not less than five hours for parts with hardness 55 HRC or higher and not less than $375^{\circ}\text{F} \pm 25$ ($191^{\circ}\text{C} \pm 14$) for not less than four hours for parts with lower hardness.
- 3.1.4 (R) Parts shall have clean surfaces, free from water-break, prior to immersion in the pickling or plating solutions.
- 3.1.5 (R) Care must be used if parts are cleaned with acids which may pit the surface or induce hydrogen embrittlement in ferrous alloys. This includes, but is not limited to, hydrochloric and sulfuric acids. In general, a momentary dip in such acids for surface activation or neutralization after alkaline cleaning is permissible, but immersion for extended time is prohibited.
- 3.1.6 Electrical contact between the parts and power source shall be made to prevent chemical or immersion deposition, electrical arcing, or overheating. If parts are to be plated all over, contact points shall be located where specified or where agreed upon by purchaser and processor. 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:

- 3.2.1 Lead Plating: Parts shall be plated by electrodeposition of lead from a suitable lead plating solution directly onto the cleaned basis metal.
 - 3.2.1.1 After completion of the lead plating operation, the plated parts shall be rinsed immediately in running water and, except as specified in 3.2.1.1.1, transferred directly to the indium plating solution.

- 3.2.1.1.1 If indium cyanide is used in the make up of the indium plating bath, the lead plated parts, after rinsing, shall be immersed in a suitable sodium cyanide solution to neutralize remaining traces of acid lead solution and again thoroughly rinsed in running water.
- 3.2.1.2 Parts shall not be permitted to dry between the time they are removed from the rinse after lead plating and the time they are immersed in the indium plating solution.
- 3.2.2 Indium Plating: The plating process shall consist of electrodeposition of indium from a suitable indium plating solution onto the rinsed, wet, lead plated surfaces of the part.
- 3.2.2.1 The plated parts shall be removed from the plating solution, thoroughly rinsed, and dried.
- 3.3 Post Treatment:
- Parts, after plating, rinsing, and drying, shall be heated in an oil bath to 340 to 350 °F (171 to 177 °C) and held at heat for not less than two hours to diffuse the indium into the lead. Heat treated parts, including carburized parts, which will decrease in hardness or be otherwise deleteriously affected if heated to 350 °F (177 °C) shall be post treated by a method acceptable to purchaser.
- 3.4 Properties:
- The deposited lead and indium shall conform to the following requirements:
- 3.4.1 Composition: The weight of indium deposited shall be within the range 5.5 to 8.0% of the weight of deposited lead, determined by a method acceptable to purchaser.
- 3.4.2 Thickness: The combined thickness of lead and indium shall be as specified on the drawing, (R) determined in accordance with ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 568, ASTM E 376, or other method acceptable to purchaser. A tolerance of ± 0.0001 inch ($\pm 2.5 \mu\text{m}$) on the combined thickness of lead and indium shall be allowed when the nominal thickness is 0.001 inch (25 μm) or under. A tolerance of ± 0.00025 inch ($\pm 6.4 \mu\text{m}$) in combined thickness of lead and indium shall be allowed when the nominal thickness is over 0.001 inch (25 μm). These tolerances apply unless other values are specified.
- 3.5 Quality:
- The lead-indium deposit, as received by purchaser, shall be smooth, continuous, dense, adherent to basis metal, and free from pin holes, blisters, and other imperfections detrimental to usage of the deposit. There shall be no evidence of double plating or spotting-in.
- 3.5.1 Staining or discoloration, which may appear on the deposits after the diffusion treatment or during storage, is not 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 the 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 the lead-indium deposit conforms to specified requirements.

4.2 Classification of Tests:

4.2.1 All technical requirements are acceptance tests and preproduction tests and shall be performed prior to or on the initial shipment of plated parts to a purchaser, on each lot, when a change in bath composition and/or processing requires approval by the cognizant engineering organization (See 4.4.2), and when purchaser deems confirmatory testing to be required.

4.2.2 Periodic Tests: Tests of cleaning and plating solutions to ensure that deposited metals will conform to specified requirements are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser.

4.2.2.1 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, contracting officer, or request for procurement.

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 range of plate thickness in the same solutions in each eight hours of continuous operation, and presented for processor's inspection at one time:

4.3.1 Samples shall be selected at random from all parts in the lot. Unless purchaser specifies a sampling plan, the minimum number of samples shall be as shown in Table 1.

TABLE 1 - Sampling for Acceptance Tests

Number of Parts in Lot	Quality	Thickness	Composition	Test	Panels
1 to 6	All	3	1		1
7 to 15	7	4	1		2
16 to 40	10	4	1		3
41 to 110	15	5	1		4
111 to 300	25	6	1		5
301 to 500	35	7	1		6
501 to 700	50	8	1		6
701 to 1200	75	10	1		7
1201 and Over	125	15	1		10

- 4.3.2 (R) Preproduction and Periodic Testing: Sample quantity and frequency of testing shall be at the discretion of the processor, unless other specified.
- 4.3.2.1 (R) Nondestructive testing shall be performed whenever practical. Except as noted in 4.3.2.2, actual parts shall be selected as samples for test.
- 4.3.2.2 (R) Separate test panels made 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 specified tests, when nondestructive testing is not practical on actual parts, and when it is not economically acceptable to purchaser to perform destructive tests on actual parts.
- 4.4 Approval:
- 4.4.1 (R) The process and control factors, a preproduction sample, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.
- 4.4.2 (R) 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.
- 4.4.3 Control factors shall include, but not be limited to, the following:
- Surface preparation
 - Bath types and composition limits
 - Bath temperatures and times
 - Diffusion temperature and time
 - Current and voltage limits for each plating bath
 - Method of determining composition
 - 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 specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2415G, part number, and quantity.
- 4.6 Resampling and Retesting:
- 4.6.1 (R) If results of any acceptance test fail to meet specified requirements, the parts in the lot may be stripped by a method acceptable to purchaser that does not roughen, pit, or embrittle the basis metal, pretreated, plated, post treated, 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 purchaser that does not roughen, pit, or embrittle the basis metal, pretreated, plated, post treated, and retested.