

MIL-P-45209B
23 January 1981
SUPERSEDING
MIL-P-45209A
22 December 1967

MILITARY SPECIFICATION

PALLADIUM PLATING, ELECTRODEPOSITED

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers electrodeposited palladium plating on metal surfaces.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.

(Copies of specifications, standards, drawings and publications required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following document form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Director, US Army Materials and Mechanics Research Center, ATTN: DRXMR-LS, Watertown, MA 02172 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MIL-P-45209B

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARDS

- B 487 - Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
- B 567 - Measurement of Coating Thickness by the Beta Backscatter Method
- B 568 - Measurement of Coating Thickness by X-ray Spectrometry
- E 8 - Tension Testing of Metallic Materials

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 Materials. Manufacturers are given latitude in the selection of raw materials for formulating the plating bath provided the finish meets the requirements of this specification.

3.2 Preplating operations.

3.2.1 Unless otherwise specified in the contract or order, the plating shall be applied after all basis metal heat treatments and mechanical operations such as machining, brazing, welding, forming and perforating of the article have been completed.

3.2.2 All steel parts having a hardness greater than Rockwell C40 shall be given a suitable stress-relief heat treatment, prior to cleaning and plating, at a temperature which will produce maximum stress relief without reducing the hardness to less than the specified minimum.

3.3 Pretreatment. Articles shall be cleaned, pickled, or otherwise pretreated as necessary. Acid pickling on high strength steels shall be avoided.

3.4 Strikes. When palladium plating is preceded by a strike, or a strike and underplate, it shall be as specified (see 6.2).

3.5 Plating equipment and processes. Unless otherwise specified in the contract or order, the plating equipment and process used shall be at the option of the supplier.

3.6 Plating properties.

3.6.1 Thickness. The minimum thickness of deposited palladium on significant surfaces shall be as specified on the drawings or in the contract. Unless otherwise specified on the drawings or in the contract, the minimum thickness of palladium shall be 0.00005 in (1.3 μ m) on all surfaces on which palladium is functionally necessary (for example: appearance, wear, corrosion protection, conductivity). The plating on nonfunctional surfaces and areas shall be of sufficient thickness to ensure plating continuity and uniform utility, appearance and protection. The thickness of plating on nonsignificant surfaces, unless specifically exempted, shall be a minimum of 60 percent of that specified for significant surfaces.

3.6.2 Adhesion. The adhesion of the palladium plating shall be such that the coating, examined at a magnification of approximately four diameters shall not show separation from the basis metal at the interface when subjected to the tests specified in 4.5.2 or to any type of mechanical deformation. The formation of cracks in the basis metal or plate which do not result in flaking, peeling, or blistering of the plate shall not be considered as non-conformance to this requirement.

3.6.3 Smoothness. If a degree of surface smoothness of the finished article is required, the degree of smoothness required shall be specified in the contract or order. Methods for measuring surface smoothness shall be approved by the procuring activity (see 6.2).

3.7 Postplating procedures.

3.7.1 Removal of plating salts. Residual plating salts shall be removed from the plated articles. Articles difficult to clean, as spot-welded articles or other prefabricated articles with lap seams or joints, shall be soaked after plating for a minimum of 3 minutes in clean hot water maintained at a temperature of 200 to 212 F (94 to 100 C). If any blisters appear after cleaning, the plated article shall be considered defective.

3.7.2 Heating of hardened parts (embrillement relief). Steel springs and other steel parts subject to flexure or repeated impact and of hardness greater than Rockwell C40 shall be heated to 375 ± 25 F (191 ± 14 C) for 3 hours after all plating. Plated springs or other parts subject to flexure shall not be flexed prior to the baking operation. When specified by the procuring activity, the plated part shall be tested for embrittlement relief as specified in 4.5.3.

3.8 Workmanship.

3.8.1 Basis metal. The basis metal shall be free from visible defects that will be detrimental to the utility, appearance or protective value of the plating.

MIL-P-45209B

3.8.2 Plating. Palladium plating shall be smooth, fine grained, adherent and free from visible blisters, pits, nodules, porosity, indications of burning, excessive edge build-up and other detrimental defects. Superficial staining shall not be cause for rejection.

3.9 Identification marking. When specified, the plated articles shall be marked with a fluid which is not affected by water and which shall not rub off or smear during shipment or storage, or shall carry a tag giving the following information:

- (a) The basis metal
- (b) The number of this specification

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Inspection. All examination and testing shall be to determine conformance to the requirements of this specification to serve as a basis for acceptance.

4.2.1 Lot. A lot shall consist of plated articles of the same type and same basis metal and plated under similar conditions and of approximately the same size and shape, submitted for delivery at one time. In no case shall the lot exceed production for one week.

4.3 Sampling.

4.3.1 For visual examination and nondestructive tests. Representative samples from each lot shall be selected for examination of visual characteristics with lot acceptance based on the sampling inspection requirements in accordance with MIL-STD-105, inspection level III up to 90 pieces in the lot and inspection level II for 91 and over, with an AQL of 1.5 percent defective.

4.3.1.1 Visual examination. Samples selected in accordance with 4.3.1, shall be visually examined for compliance with the requirements for removal of plating salts (see 3.7.1), workmanship (see 3.8), and identification marking (see 3.9). The procuring activity may specify that the samples shall be examined at four diameter magnification. If any defect is noted on a finished item, the item is considered defective. If upon examination the number of defective items in any sample exceeds the acceptance number of the appropriate sampling plan of MIL-STD-105, the lot represented by the sample shall be rejected.

4.3.1.2 Thickness of plating (nondestructive tests). Samples selected in accordance with 4.3.1 shall be inspected and the plating thickness measured by the applicable tests detailed in 4.5.1. The part or article shall be considered nonconforming if one or more measurements fail to meet the specified minimum thickness. If the number of defective items in any sample exceeds the acceptance number for the specified sample the lot represented by the sample shall be rejected. Separate specimens (see 4.3.2.1) shall not be used for thickness measurements unless a need has been demonstrated.

4.3.2 Sampling for destructive tests (thickness, adhesion and embrittlement). A representative sample shall be prepared in accordance with 4.3.2.1 or selected in accordance with MIL-STD-105, inspection level S-3, with an acceptance number of zero.

4.3.2.1 Separate specimens. When the plated articles are not suitable for a test specified herein or in sampling small size lots for destructive tests, tests may be made on separate specimens plated concurrently with the articles represented unless otherwise specified, at least two (2) specimens shall be used for each test and specimens may be used for more than one test where applicable. The separate specimens shall be prepared as follows except as modified in 4.3.2.1.1. The separate specimens shall be of a basis metal of the same chemical composition, temper, and surface finish as the articles represented. For still rack or wire plating, the separate specimens shall be strips. Dimensions of the strip specimens shall be approximately 1 by 4 by 0.04 inch (25 X 102 X 1 mm). All specimens shall be introduced into normal production at regular intervals and be pretreated, cleaned, plated and processed with the articles comprising the lot. Conditions affecting plating of the specimens, such as spacing and positioning with respect to anodes and to other objects being plated, shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. For barrel plating, rod specimens shall be used approximating the dimensions of the parts, contained in the barrel, but of a nature that can be easily separated from the bulk of the items.

MIL-P-45209B

4.3.2.1.1 Separate specimens for embrittlement relief. Where separate specimens are to be subjected to the embrittlement test described in 4.5.3, separate test specimens shall be prepared of the same material, heat, and heat treated to the same strength level and finish as the materials of the articles they represent. The configuration shall be in accordance with figure 8 of ASTM E 8 for round specimens with the axis of the specimen perpendicular to the short transverse direction. Specimens shall have 60 degree V-notch with the area at the base of the Vee approximately equal to half the area of the full section of the specimen and 0.010 ± 0.0005 inch (0.254 ± 0.013 mm) radius of curvature at base of notch.

4.4 Testing. Unless otherwise specified sampling shall be in accordance with 4.3.1.2 and 4.3.2 and the items shall be tested in accordance with 4.5. If any item in the sample fails to pass any test, the lot which the sample represents shall be considered defective and shall be cause for rejection of the lot. Rejected lots may be resubmitted for acceptance tests provided the contractor has removed or reworked all nonconforming products.

4.5 Tests.

4.5.1 Thickness. Separate specimens (see 4.3.2.1) shall not be used for thickness measurements unless a need for such specimens has been shown. Thickness measurements may be made by any suitable method provided the specific method and equipment used shall be such that the coating thickness will be determined within plus or minus 10 percent of its true thickness. The following test methods for thickness may be used as applicable: ASTM B 487 (microscopical), ASTM B 567 (beta radiation backscatter), or ASTM B 568 (X-ray spectrometry). Measurements on threaded fasteners shall be made on the shank or other smooth surface as close to the threads as possible. The test method used for determining the coating thickness shall be of a type approved by the procuring activity.

4.5.1.1 Microscopical test method. Measurement of thickness shall be determined in accordance with ASTM B 487 with the procedural modifications indicated below (see 4.5.1.1.1, 4.5.1.1.2 and 4.5.1.1.3).

4.5.1.1.1 Preparation of specimens. Plate the articles with a coating at least 0.001 inch thick of copper, nickel or iron to protect the edges during grinding and polishing. The first layer of overplate shall be a copper strike from a cyanide solution followed by the relatively thick overplate.

4.5.1.1.2 Etching. Upon completion of the grinding and polishing operations involved in the section preparation the polished section shall be etched in a solution consisting of one part nitric acid (sp gr 1.42) to 19 parts ethyl alcohol (95 percent).

4.5.1.1.3 Use of microscope. Using the metallographic microscope with adequate resolving power and a magnification of at least 1000 diameters, take a minimum of five measurements at random locations on each specimen. Measurements shall be expressed to five decimal places. Better estimates can be made of thicknesses of less than 0.00010 inch (2.5 μ m) by expressing measurements to six decimal places using a magnification of 1500 diameters.

4.5.2 Adhesion tests. Adhesion of test specimens shall be performed at room temperature by means of the bend test (see 4.5.2.1) unless the plated articles are not readily adaptable. When the bend test is not suitable, adhesion of the plated articles shall be determined by means of the cutting test (see 4.5.2.2). At the option of the procuring activity, adhesion shall be determined by the baking test (see 4.5.2.3 and 6.2).

4.5.2.1 Bend test. Plated articles shall be bent repeatedly through an angle of 180 F on a diameter equal to the thickness of the specimen until fracture of the basis metal occurs. No detachment of the coating shall be possible by probing with a sharp instrument. Cracks in the basis metal or plating shall not be considered failure unless accompanied by flaking, peeling or blistering. Examination shall be at 4 diameter magnification.

4.5.2.2 Cutting test. The adhesion of plated articles shall be determined by cutting the plating from the basis metal at the interface(s) with a sharp instrument. The specimens shall be visually examined at four diameter magnification to determine whether removal has been caused by cutting away of an adherent plate or lifting of a non-adherent plate.

4.5.2.3 Baking test. The adhesion shall be determined by heating the plated articles at 250 to 300 F for one hour. After removal and cooling, the surface of the articles shall be examined at four diameter magnification for any evidence of flaking, peeling or blistering.

4.5.3 Embrittlement relief. Unless otherwise specified, samples of parts for determining compliance with 3.7.2 shall be taken as specified in 4.3.2. The article shall be subjected to a sustained tensile test, using loads applicable to the parts as contained herein. The articles or parts shall be held under the load for at least 200 hours, unless otherwise specified, and then examined for cracks. The lot shall be rejected if any plated part develops cracks or fails by fracture.

4.5.3.1 Fasteners. Parts such as steel fasteners, threaded or not threaded, which are used for mechanical joining of metals shall be subjected to a sustained tensile loading not less than 75 percent of the material specification minimum ultimate tensile strength.

4.5.3.2 Spring pins, lock rings, etc. Parts such as spring pins, lock rings, etc., which are installed in holes or on rods shall be similarly assembled using the applicable parts specification or drawing tolerances which impose the maximum sustained tensile stress on the plated parts.

MIL-P-45209B

4.5.3.3 Other parts. Other parts, that will be subjected to a sustained static tensile load in excess of 25 percent of the material specification minimum tensile yield strength in service use, shall be subjected to a sustained tensile load equal to 75 percent of the material notched tensile yield strength. Parts which require fixtures or extreme loads to comply with the above requirements shall be represented by four separate specimens prepared as specified in 4.3.2.1.1 to represent each lot.

4.6 Rejection.

4.6.1 Examination defects. Any sample unit having one or more defects shall be rejected. If the number of nonconforming sample units in the sample exceeds the acceptance number specified in 4.3.1, the entire lot shall be rejected subject to the provisions of the section on "Disposition of Non-Conforming Product" of MIL-STD-105.

4.6.2 Tests. A lot shall be rejected for failure to meet any of the test requirements when tested in accordance with 4.5.

5. PREPARATION FOR DELIVERY

5.1 There are no general packaging, packing and marking requirements applicable to this specification.

6. NOTES

6.1 Intended use. Palladium plating is intended for electrical applications requiring freedom from oxidation.

6.2 Ordering data. Purchasers should exercise any desired options offered herein and procurement documents should specify the following:

- (a) Title, number and date of this specification.
- (b) Thickness of palladium plating (see 3.6.1).
- (c) Strikes and underplating required (see 3.4 and 6.3).
- (d) Location of significant surfaces (see 3.6.1).
- (e) Degree of smoothness when required and method of determination (see 3.6.3).
- (f) When embrittlement relief and test is required and alternate temperature when applicable (see 3.7.2).
- (g) When identification marking is required on the articles (see 3.9).

MIL-P-45209B

(h) Visual examination at four diameter magnification, if required (see 4.3.1.1).

(i) Whether baking test for adhesion is required (see 4.5.2).

6.3 Strikes and underplating. Use of a palladium strike to obtain complete coverage and to avoid bath contamination is a good practice. Usually silver is the preferred base plate but sometimes depending on the type of bath, product application and the environment a substantial strike or underplate of one of the noble metals such as gold or platinum is used.

Custodians:

Army - MR
Navy - AS
Air Force - 11

Preparing activity:

Army - MR
Project No. MFFP-0159

Review interest:

Army - AR

User interest:

Army - CR, ER
Air Force - 99

EDITION OF 1 JAN 72 WILL BE USED UNTIL EXHAUSTED.

FOLD

DEPARTMENT OF THE ARMY



NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE \$300

BUSINESS REPLY CARD

FIRST CLASS

PERMIT NO. 12062

WASHINGTON D. C.

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE ARMY

Director
Army Materials & Mechanics Research Center
ATTN: DRXMR-LS
Watertown, MA 02172



FOLD