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MILITARY STANDARD

CADMIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

NO DELIVERABLE DATA REQUIRED BY THIS DOCUMENT

AREA-MFFP

DEPARTMENT OF DEFENSE
WASHINGTON, DC 20402

Cadmium Plating, Low Embrittlement, Electrodeposition

1. This Military Standard is approved for use by Ogden ALC/MMEDO, Department of the Air Force, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Ogden ALC/MMEDO Hill AFB Utah 84056-5609 by using the self-addressed Standardization Document Improvement Proposal (Form DD1426) appearing at the end of this document or by letter.

CONTENTS

CADMIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

1. SCOPE

1.1 Scope. This standard covers the process and materials required for the electrodeposition of cadmium on high strength steel substrates. Subsequent heat treating techniques needed to insure low embrittlement of steel are also described. This process is not authorized for use on steel heat treated above 1.65×10^9 Pascals (Pa)[240,000 pounds per square inch (psi)] without the approval of the applicable Procuring Activity. Plating of steel heat treated above 1.65×10^9 Pascals (Pa) (240,000 psi) is authorized only on individual part evaluation.

1.2 Documentation. This standard meets and exceeds the requirements of QQ-P-416 and may be used whenever plating per QQ-P-416.

1.3 Classification.

1.3.1 Classes. Cadmium plating covered by this standard shall be of the following classes:

Class 1 0.013mm (0.0005 inch) thick minimum

Class 2 0.008mm (0.0003 inch) thick minimum

Class 3 0.005mm (0.0002 inch) thick minimum

2. REFERENCED DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

SPECIFICATIONS

Federal

O-S-598	Sodium Hydroxide, Technical
QQ-A-671	Anodes, Cadmium
QQ-P-416	Plating, Cadmium (Electrodeposited)

Military

MIL-S-5002	Surface Treatments and Inorganic Coatings for Metal Surfaces of weapons Systems

STANDARDS

Military

MIL-STD-871	Electro-chemical Stripping of Inorganic Finishes
MIL-STD-1504	Abrasive Blasting of Aircraft components

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

2.2 Other publications. The following document(s) form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
ASTM E8 - Metallic Materials, Tension Testing of

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

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS Standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supercede applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 High strength steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 1.24×10^9 Pa (1.26×10^2 kgf/mm^2) (1.8×10^5 psi).

3.2 Material batch. All items processed at one time through the plating bath.

4. GENERAL REQUIREMENTS

4.1 Materials and equipment.

4.1.1 Materials. The use of reclaimed materials shall be encouraged to the maximum extent possible. Materials used in cadmium plating are as follows:

Nondestructive Testing Methods of Composite Materials -

a. Sodium Hydroxide, flake or granulated (O-S-598).

b. Sodium Cyanide, Plating Grade, (96-98% NaCN).

c. Cadmium Ball Anodes, QQ-A-671.

4.1.2 Equipment. Equipment used in cadmium plating is as follows:

a. Either generated or rectified D.C. current may be used. Ripple value shall not exceed 10 percent as measured by dividing the Root Mean Square of the A.C. voltage component by the D.C. voltage.

b. Tanks shall be resistant to the operating temperature and the chemical environment. Tanks in which any electrolytic action takes place must be free of shorts.

c. Plating tanks to be operated at temperatures other than room temperature shall be equipped with automatic temperature indicating and regulating devices.

d. An ammeter shall be placed in series with the cadmium tank cathode. The ammeter shall have sufficient shunts and switches to provide a full-scale reading equal to the maximum capacity of the power source, and an accuracy of ± 10 percent of the current being measured.

e. A blast cabinet shall be located near the plating line. The size of the cabinet shall be adequate to enclose the parts to be plated. Air lines shall be suitably trapped and filtered to prevent in-process contamination of the parts to be cleaned.

f. An oven capable of baking parts at 190.5 ± 13.9 degrees C (375 ± 25 degrees F) shall be located near the plating line. The size of the oven shall be adequate to enclose parts to be plated. The oven shall be equipped with temperature indicating, recording and regulating devices.

4.2 Specification QQ-P-416. The requirements of QQ-P-416 shall be complied with on all parts, in conjunction with those specified in this standard. If there is a conflict between the two documents however, the requirements of this standard shall govern.

4.3 Finish. The plated part will have a finish that is smooth, continuous, homogeneous, adherent and free from pits, blisters, nodules and any other indications of harmful defects. The appearance of a properly applied plate may vary from a dull gray to a frosty white. A bright, dense deposit indicates malfunction of the process which may produce embrittled parts (see MIL-S-5002).

4.4 Embrittlement. Qualification test specimens and process control test specimens shall be subjected to a sustained load test at 75 percent of the ultimate notched tensile strength. The specimens shall

endure this sustained load for 200 hours minimum without failing or cracking.

4.5 Reprocessing. Parts rejected for defective plating, requiring stripping and replating, shall include all of the preplating steps of this standard. Parts shall be stripped in accordance with MIL-STD-871.

5. DETAILED STATEMENTS OF REQUIREMENTS

5.1 Prior to plating. Prior to plating, all machining, forming, welding, and shot peening shall be completed.

5.1.1 Baking. Parts shall be baked for stress relief before plating for four hours minimum at 190.5 ± 13.9 degrees C (375 ± 25 degrees F). Shot peening, when required, shall be performed before plating and after stress relieving.

5.1.2 Plating sequence. If chromium and cadmium are used in combination, the chromium shall be deposited first. When chrome plating is to be followed by cadmium plating the 23 hour minimum bake period can be replaced by a four hour bake period at 190.5 ± 13.9 degrees C (375 ± 25 degrees F) provided the part is baked for 23 hours minimum after completion of the cadmium plating.

5.1.3 Storage of parts. Storage of parts between stress relief and cleaning shall be controlled to prevent contact with water or other corrosive materials. Parts shall be stored to permit free circulation of air around the parts.

5.1.4 Handling of parts. After the parts have been cleaned, they shall be handled in such a manner (white golves, etc) that will assure a minimum of contamination.

5.1.5 Masking. Sections or areas of a part that are not to be plated shall be masked off. Plug and masking materials which do not contaminate the plating bath shall be used. Masking should be performed at the most convenient step prior to plating.

5.1.6 Racking. Sufficient contact area and pressure shall be provided to carry the current without overheating. Racking should be performed at the most convenient step prior to plating.

5.2 Plating procedure. The cadmium plating procedure shall be as described below:

5.2.1 Step Number 1. Parts shall be vapor degreased. No minimum elapsed time requirement shall apply between this operation and the cleaning operation of 5.2.2.

5.2.2 Step Number 2. All parts shall be cleaned by dry blasting using 80-180 grit aluminum oxide (Al_2O_3), silicon dioxide (SiO_2) or garnet per MIL-STD-1504. Elapsed time between completion of cleaning

and Step Number 3 shall not exceed sixty minutes.

5.2.3 Step Number 3. Rinse parts in cold water. A cyanide holding tank can be used to hold parts if the plating tank is full.

5.2.4 Step+ Number 4. Cadmium plate at 5.4 to 7.5 amperes/sq decimeters (50 to 70 amperes/sq feet) in the following solution:

a. Cadmium metal 21-24 g/L (2.8 - 3.2 oz/gal)

b. Total cyanide 90-135 g/L (12 - 18 oz/gal)

c. Sodium hydroxide 11.25-30 g/L (1.5 - 4 oz/gal)

d. Sodium carbonate 0-37.5 g/L (0 - 5 oz/gal)

e. Ratio NaCN/Cd 4/1 to 6/1

f. Temperature 15.5-26.6 degrees C (60 - 80 degrees F)

g. Total permissible iron 300 parts/million

5.2.5 Step Number 5. Rinse parts in cold water.

5.2.6 Step Number 6. Rinse parts in hot water and blow dry with compressed air. Elapsed time between completion of plating and start of baking, Step Number 7, shall not exceed four hours.

5.2.7 Step Number 7. Bake all parts heat-treated above 1.24×10^9 Pa (180,000 psi) for twenty-three hours minimum, at 190.5 $\pm$ 13.9 degrees C (375 $\pm$ 25 degrees F).

NOTE: Refer to 5.3.1, 5.3.2 and 5.3.3 if post plating treatment is required. If post plating treatment is not required, refer to 5.4.

5.3 Post Plate Treatment.

5.3.1 Types of plating. Refer to applicable directives for type of plating. If the type of plating is not specified, the part shall be given the Type II treatment.

Type I - Nos post plate treatment required (see 5.4).

Type II - (see 5.3.2)

Type III - (see 5.3.3)

5.3.2 Type II.

a. Immerse in the Type II chromating solution (Iridite No 8P or equivalent) for fifteen to thirty seconds.

b. Rinse thoroughly in tap water. An additional rinse in warm

water [60 degrees C Maximum (140 degrees F)] may be used to facilitate drying.

c. See 5.4.

5.3.3 Type III.

a. Immerse parts in Type III (QQ-P-416) phosphating solution for fifteen to thirty seconds.

b. Rinse thoroughly in tap water. An additional rinse in warm water [60 degrees C Maximum (140 degrees F)] may be used to facilitate drying.

c. See 5.4.

5.4 Inspection. Inspection shall be in accordance with the production control inspection and tests in QQ-P-416 and this standard.

5.5 Process controls. Solutions and equipment used in the plating process shall be checked periodically and maintained in accordance with the requirements of this process standard.

5.6 Qualification embrittlement test. The processor shall demonstrate his ability to provide cadmium plate which meets the requirements of 4.4 of this standard as follows:

a. Four round notched 4340 steel specimens from four separate heats, heat-treated to a tensile strength of 1.79×10^9 to 1.03×10^9 Pa (260,000 to 280,000 psi) shall be prepared. The configuration shall be in accordance with Figure 8 of ASTM Standard E8 for round specimens. Specimens shall have a 60 degree V-notch located approximately at the center of the gauge length. The cross section area at the root of the V-notch shall be approximately equal to half the area of the full cross section area of the specimens reduced section. The V-notch shall have a 0.254 $\pm$ 0.0127 mm (0.010 $\pm$ 0.0005 inch) radius of curvature at the base of the notch.

b. During plating the specimens shall be mounted symmetrically on a rack by themselves. All areas of the rack except the contact area shall be coated with a suitable maskant. An ammeter having a sensitivity of 0.5 amperes or better shall be connected between the specimen rack and the cathode. The specimens shall be plated at 5.4 A/dm^2 (50 ampere/ft^2) to a thickness of .20mm (0.0008 inch). The specimens shall be baked for twenty-three hours at 190.5 $\pm$ 13.9 degrees C (375 $\pm$ 25 degrees F) within four hours of removal from the bath.

c. The specimens will be subjected to 200 hours of static loading at 75 percent of the ultimate notched tensile strength. The test

shall be considered passed if all four specimens meet the requirements of 4.4.

d. Upon successful completion of the static load test, one of the notched tensile specimens shall be sectioned across the notch parallel to the axis of the specimen. Photomicrographs shall be taken of the notched area and examined for complete coverage of the notch with plating (use 80-100X magnification).

e. A complete analysis report of the plating bath shall be submitted to the procuring activity with the qualification tests.

5.7 Process control embrittlement acceptance test. The process control embrittlement acceptance test shall be one of the following two methods.

5.7.1 Method I, hydrogen detection instrument testing.

a. Hydrogen detection instrument testing shall be performed within the processor's facility by a certified operator according to the instrument manufacturer's instructions.

b. Hydrogen detection instrument testing shall be conducted at least twice weekly.

5.7.2 Method II, notched tensile tests.

a. Two standard specimens of the type noted in 5.6 shall be processed in conjunction with the plating of items. The specimens shall be subjected to a sustained load test of 75 percent of the ultimate notched tensile strength of the material for 200 hours minimum and shall meet the requirements of 4.4. Failure of any one of the specimens shall constitute failure of the test and production shall cease until the cause of failure is determined and the bath is requalified. Acceptance of items completed after the last successfully completed acceptance test shall be withheld until the extent and cause of failure have been determined.

b. The test for embrittlement shall be conducted as often as deemed necessary with a maximum interval of every thirty (30) calendar days. If the embrittlement test has not been performed in the thirty days proceeding the processing of a material batch, the bath must be requalified in accordance with 5.6.

6. NOTES

6.1 Safety and health. This document specifies the use of certain materials which have been listed in Subpart Z, 29 CFR 1910 (OSHA Standards) as "Toxic and Hazardous Substances". Personnel exposure to these materials during this process must be limited to the values specified in applicable portions of OSHA Standard 1910.1000.

Custodian:
Air Force - 99

Preparing activity:
Air Force - 70

(Project MFFP-F370)

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