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MILITARY STANDARD

CADMIUM-TITANIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

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FSC MFFP

DEPARTMENT OF DEFENSE
WASHINGTON DC 20301

CADMIUM-TITANIUM PLATING, LOW EMBRITTLEMENT, ELECTRODEPOSITION

MIL-STD-1500A(USAF)

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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, Ogden, UT 84056, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1. SCOPE

1.1 General. This standard covers the process and materials required for the electrodeposition of cadmium-titanium on high strength steel substrates. Subsequent heat treating techniques needed to insure low hydrogen embrittlement of steel are also described. This process is not authorized for use on steel heat treated above 1654.7 megapascals (MPa) [240,000 pounds per square inch (psi)] without the approval of the applicable Procuring activity.

1.1.1 Alternate process. Any process of cadmium deposition should not be used when an alternate process meets the performance requirements of this standard, and is considered satisfactory for use on the item under consideration.

1.1.2 Government approval of alternate process. Information relative to an alternate process should be furnished to the cognizant Government activity for approval prior to use on the item under consideration.

1.2 Documentation. This standard meets and exceeds the requirements of QQ-P-416.

1.3 Classification.

1.3.1 Classes. Cadmium-titanium plating covered by this standard shall be of the following classes;

a. Class 1 - 0.013 millimeters(mm)(0.0005 inch) thick minimum.
b. Class 2 - 0.008mm (0.0003 inch) thick minimum.
c. Class 3 - 0.005mm (0.0002 inch) thick minimum.

1.3.2 Types. Cadmium-titanium plating covered by this standard shall be of the following types:

a. Type I - Without supplementary chromate or phosphate treatment.
b. Type II - With supplementary chromate treatment. Type II is the preferred type and will be used whenever applicable.
c. Type III - With supplementary phosphate treatment.

1.4 Approval. Plating in accordance with this standard must be performed by licensed vendors. American licensing arrangements for the Delta Processes are made through Delta Processes, Inc., Seattle, Washington.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents of the issue in effect on date of invitation for bids or request for proposal, 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	-	Surfaces Treatments and Inorganic Coatings for Metal Surfaces of Weapons Systems
MIL-C-6151	-	Cadmium Oxide

STANDARDS

MILITARY

MIL-STD-871	-	Electro-Chemical Stripping of Inorganic Finishes
MIL-STD-1504	-	Abrasive Blasting

(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 documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM E 8	Tension Testing of Metallic Materials
ASTM B 117	Salt Spray (fog) Testing

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

CODE OF FEDERAL REGULATIONS (CFR)
29 CFR 1910 Toxic and Hazardous Substances

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. DEFINITIONS

3.1 High Strength Steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 1241.1 MPa (180,000psi) and above.

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-titanium plating are as follows:

a. Cadmium Ball Anodes, QQ-A-671

b. Cadmium Oxide, MIL-C-6151

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

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

e. Titanium additive compound (license)

f. Hydrogen Peroxide - 35% Technical Grade

g. Filter Aid, Diatomaceous, Celite 501, Johns Manville or equal

4.1.2 Equipment. Equipment used in cadmium-titanium plating.

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 should be resistant to the operating temperature and the chemical environment. The cadmium plating tank must be of 300 series stainless steel, carbon steel with a rigid polyvinylchloride lining, or other suitable non-metallic material which has been determined to be compatible with ti-cad plating solutions.

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-titanium 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. If conventional ball anodes are used, carriers may be made of either titanium or stainless steel. Cadmium bar anodes may be used if they are cast with no central steel spline and titanium or stainless steel hooks are used. Auxiliary or internal anodes must be of cadmium or 300 series stainless steel.

f. This process requires a continuously filtered bath. The filter must be of a type that permits introduction of the titanium paste mixture on the filter cloth. The filter must have a plate area of 0.98 to 2.45 square meters per kiloliter (40 to 100 square feet per 1,000 gallons) of plating solution. The filtration equipment must be 300 series stainless steel or have an approved type of lining such as rigid polyvinylchloride or other unplasticized material. The filter cloth material should be of a high grade chemical resistant fabric. Cotton cannot be used in this system.

g. 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.

h. An oven capable of baking parts at 190.5 ± 13.9°C (375 ± 25°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 confliction 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, shiny deposit indicates malfunction of the process which may produce embrittled parts (see MIL-S-5002).

4.4 Corrosion. The test panel shall show no corrosion on the base metal after 500 hours exposure to salt spray per ASTM Standard B 117. Corrosion at the edges of the panel shall not constitute failure.

4.5 Titanium content of plating. The titanium content of the plate shall be between 0.07 and 0.5 percent titanium.

4.6 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. If hydrogen detection instrument testing is used for process control, the test must meet the requirements of the instrument manufacturer.

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

5. DETAILED 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°C(375 ± 25°F). Shot peening when required shall be performed before plating and after stress relieving.

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

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

5.1.4 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.

5.1.5 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-titanium plating procedure shall be performed as follows.

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.

WARNING

PROVIDE ADEQUATE VENTILATION DURING DEGREASING OPERATIONS. AVOID SKIN AND EYE CONTACT WITH SOLVENT SOLUTIONS.

5.2.2 Step Number 2. All parts shall be cleaned by dry blasting using 80-180 grit aluminum oxide (Al_2O_3) or silicon dioxide (SiO_2) per MIL-STD-1504. Elapsed time between completion of cleaning and Step Number 3 shall not exceed two hours.

5.2.3 Step Number 3. Rinse parts in cold water (Optional 1). A cyanide holding tank can be used to hold parts if the plating tank is full.

5.2.4 Step Number 4 (optional). All parts can be dipped in a 2-4 percent by volume hydrochloric acid (HCl) solution, (60 seconds maximum at ambient temperature) followed by a cold water rinse.

5.2.5 Step Number 5. Cadmium plate in the solution listed below. Apply voltages so that the current will flow upon immersion of parts. Strike the parts at 40-50 amps per 929.0 square centimeters (sq cm)[40-50 amps per square foot (asf)] for 15 seconds, then reduce the current to 15-30 amps per 929.0 sq cm (15-30 asf). Plating should be continued until the required thickness of cadmium-titanium has been deposited.

a.	Cadmium metal	20.970-23.965 kilograms per cubic meter (kg/m^3)(2.8-3.2 oz/gal)
b.	Total cyanide	89.869-127.315 kg/m^3 (12-17 oz/gal)
c.	Sodium hydroxide	14.978-22.467 kg/m^3 (2-3 oz/gal)
d.	Titanium	40-100 milligrams/liter (mg/L) (40-100 ppm)
e.	Sodium carbonate	37.445 kg/m^3(5 oz/gal) maximum
f.	Ratio NaCN/Cd	4/1 to 6/1
g.	Total permissible Iron content	300 mg/L (300 ppm)
h.	Temperature	15.5-29.4°C (60-85°F)

WARNING

PROVIDE ADEQUATE VENTILATION WHEN USING CADMIUM PLATING SOLUTIONS CONTAINING SODIUM HYDROXIDE AND SODIUM CYANIDE. WEAR PROTECTIVE RUBBER GLOVES AND CHEMICAL GOGGLES TO PREVENT SKIN AND EYE EXPOSURE.

5.2.6 Step Number 6. Rinse parts in cold water.

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

5.2.8 Step Number 8. Bake all parts heat-treated above 1241.1 MPa (180,000 psi) for twelve hours minimum at 190.5 ± 13.9°C (375 ± 25°F).

NOTE: Refer to 5.3 if post plate treatment is required, If post plate 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 - No post plate treatment required (see 5.4)
Type II - (see 5.3.1.1)
Type III - (see 5.3.1.2)

WARNING

PROVIDE ADEQUATE VENTILATION WHEN USING IRIDITE AND/OR PHOSPHATING SOLUTIONS. AVOID SKIN AND EYE CONTACT.

5.3.1.1 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 [71.1°C Maximum (160°F)] may be used to facilitate drying.

c. See 5.4

5.3.1.2 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°C Maximum (140°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-titanium plating which meets the requirements of 4.6 of this standard as follows:

a. Four round notched 4340 steel specimens from four separate heats, heat-treated to a tensile strength of 1792.6 to 1930.5 MPa (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 guage 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 specimen's reduced section. The V-notch shall have a 0.254 ± 0.0127 mm (0.010 ± 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 $amperes/ft^2$) to a thickness of 0.020 mm (0.0008 inch). The specimens shall be baked for twelve hours at 190.5 ± 13.9°C (375 ± 25°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 4.6.

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 on 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 test.

5.7 Process control embrittlement acceptance test. The process 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 test.

a. The 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 4.6. 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 embrittlement tests have not been performed in the thirty days proceeding the processing of a material batch, the bath must be requalified in accordance with 5.6.

5.8 Titanium content of plating. The titanium content of the plate shall be determined in accordance with the following steps:

a. Plate the cadmium-titanium deposit at normal current density onto passive stainless steel, nickel, or a chrome plated base, so as to produce a non-adherent deposit.

WARNING

PROVIDE ADEQUATE VENTILATION WHEN USING SULFURIC ACID. WEAR PROTECTIVE RUBBER GLOVES AND CHEMICAL GOGGLES TO PREVENT SKIN AND EYE EXPOSURE.

b. Dissolve the weighed deposit in 50 milliliters (ml) of 15-20 percent sulfuric acid (H_2SO_4).

c. Analyze the sulfuric acid for titanium and compute the titanium content of the plating.

5.9 Safety and health. This document specifies the use of certain materials which have been listed in 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.

5.9.1 Environmental precaution. Because of the toxicity of cadmium vapors, adequate ventilation must be assured before cadmium plated items can be welded, soldered, or heated.

Custodian:
Air Force -99

Preparing activity:
Air Force -70

(Project MFFP F175)

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