

MIL-C-83488C
1 May 1985

SUPERSEDING
MIL-C-83488B(USAF)
1 December 1978

MILITARY SPECIFICATION
COATING, ALUMINUM, HIGH PURITY

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

1. SCOPE

1.1 Scope. This specification establishes the requirements for coating low alloy steel, stainless steel, aluminum alloy and titanium alloy parts with high purity aluminum (99 percent plus).

1.2 Classification.

1.2.1 Classes. High Purity aluminum coatings shall be of the following classes, as specified (See 3.5 and 6.2):

- Class 1 - 0.0010 inch thick (0.026 mm) (min)
- Class 2 - 0.0005 inch thick (0.013 mm) (min)
- Class 3 - 0.0003 inch thick (0.008 mm) (min).

1.2.2 Types. High purity aluminum coatings shall be of the following types as specified (See 6.2):

- Type I - as coated
- Type II - with supplementary chromate treatment (See 3.4).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: AFWAL/MLSE, Standardization Manager, WPAFB, OH 45433 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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2. APPLICABLE 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 specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-A-225/1	Aluminum Alloy Bar, Rods, and Wire, Rolled, Drawn, or Cold Finished, 1100
QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet

MILITARY

MIL-S-5002	Surface Treatments and Metallic Coatings for Metallic Surfaces of Weapon Systems
MIL-C-5541	Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys
MIL-T-9046	Titanium and Titanium Alloy, Sheet, Strip and Plate
MIL-S-18729	Steel Plate, Sheet and Strip, Alloy 4130 Aircraft Quality

STANDARDS

FEDERAL

FED-STD-151	Metals; Test Methods
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MILITARY

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attributes
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(Copies of specifications, standards, drawings, and publications required by manufacturers 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 documents form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DOD adopted shall be the issue listed in the current DODISS and the supplement thereto, if applicable.

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ASTM B117 Salt Spray (Fog) Testing
ASTM B499 Measuring Coating Thickness by the Magnetic Method
 Nonmagnetic Coatings on Magnetic Basis Metal

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

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups 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, the text of this specification shall take precedence.

3. REQUIREMENTS

3.1 Materials. The materials used shall be such as to produce aluminum coatings which conform to this specification.

3.1.1 Composition. The composition of the coating shall be not less than 99.0 percent aluminum.

3.2 Equipment and processes. The equipment and processes employed to produce high purity aluminum coatings shall be capable of providing a uniform coating in accordance with the detailed requirements of this specification.

3.2.1 Process. The process used to deposit the coating shall be such that a temperature rise in the parts shall not occur that will cause adverse action between the coating and the substrate, or adverse effects to the substrate.

3.2.1.1 Cleaning. All basis metals shall be cleaned in accordance with MIL-S-5002 prior to coating with high purity aluminum.

3.3 Areas of deposit. The coating shall completely cover all visible surfaces, including roots of threads, recesses, and sharp corners. The coating shall be deposited directly on the basis metal without a preliminary coating of other metal.

3.4 Supplementary chromate treatment (Type II). Unless otherwise specified, the high purity coating shall be Type II, which is a Type I coating with a supplementary chromate treatment in accordance with MIL-C-5541, Class 1A. Chromate treated parts, other than fasteners, should receive additional protective coatings. Applications requiring electrical conductivity (See 6.1) shall be chromate treated with a MIL-C-5541 solution which meets both Class 1A (Corrosion resistance and Class 3 (low electrical resistance) requirements.

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3.5 Thickness of coating. The thickness of high purity aluminum shall be as specified in 1.2.1 on all visible surfaces except as specified in 3.5.3.

3.5.1 Class 1 thickness. Class 1 thickness shall be used when no additional paint finish is required. Class 1 thickness is recommended for high temperature applications and exterior applications where tolerance will permit.

3.5.2 Class 2 thickness. Class 2 thickness is recommended for interior applications or where class 1 thickness is unacceptable for dimensional thickness reasons.

3.5.3 Exceptions to Class 1, Class 2 and Class 3 thicknesses. Holes, recesses, internal threads, and other areas where a controlled deposit cannot normally be obtained shall not be subject to a thickness requirement, but there shall be no bare areas.

3.6 Stripping of aluminum coatings. Parts to be recoated shall be stripped by mechanical means or in a suitable caustic solution. If stripped with caustic solution, steel parts having hardness of Rockwell C-40 or greater shall be baked after stripping at $375^{\circ}\text{F} \pm 25^{\circ}\text{F}$ for three hours minimum to relieve any hydrogen embrittlement in the basic metal.

3.7 Corrosion resistance. Test specimens shall show no evidence of corrosion of the basis metal when exposed for the periods of time shown in Table I in accordance with the method specified in 4.5.3. The appearance of white corrosion products on the aluminum coating during the test period shall not be cause for rejection.

TABLE I. Salt spray test.

Class	Test period (hours)	
	Type I	Type II
1	504	672
2	336	504
3	168	336

3.8 Adhesion. The adhesion of the coating shall be such that when examined at a minimum magnification of approximately four diameters it does not show separation from the basis metal at the interface, when subjected to the test specified in 4.5.2. The interface between the aluminum and the basis metal is the surface of the basis metal before coating. The formation of cracks in the deposit caused by rupture of the basis metal which does not result in flaking, peeling, or blistering of the deposit shall not be considered as nonconformance to this requirement.

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3.9 Workmanship.

3.9.1 Basis metal. The basis metal shall be substantially free from defects that will be detrimental to the appearance or the protective value of the coating.

3.9.2 Coating. The high purity aluminum coating shall be smooth, fine grained, adherent, uniform in appearance, free from staining, pits, burning porosity and other defects. The coating shall show no indication of contamination or improper operation of equipment used to produce the deposit, such as excessively powdered or darkened coatings. All details of workmanship shall conform to the best practice for high quality coating. Type II parts processed in accordance with MIL-C-5541 requirements shall have a continuous, distinctly colored protective film ranging in color from yellow and iridescent bronze through olive drab and brown.

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 or purchase order, 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 Classification. All the tests required herein for the testing of high purity aluminum coatings are classified as quality conformance tests, for which necessary sampling techniques and the methods of testing are specified in this section.

4.3 Test specimens. When the coated articles are of such form or material as to be not readily adaptable to a test specified herein, or for destructive tests, or for the sampling of small lot sizes, the tests shall be made by the use of separate specimens coated concurrently with the articles represented. The separate specimens shall be of a basis metal, equivalent to that of the articles represented, (or per 4.3.2 thru 4.3.5) except that corrosion resistance (see 3.7) shall be determined by coating 4130 alloy steel specimens.

4.3.1 Separate specimens. The separate specimens shall be strips approximately 1 inch wide, 4 inches long, and 0.04 inch thick, for adhesion and thickness tests, but shall be at least 3 inches wide, 6 inches long, and any convenient thickness for corrosion tests. These specimens shall be introduced into a lot at regular intervals prior to the cleaning operation preliminary to coating and shall not be separated therefrom until after

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completion of the processing. Conditions affecting the coating of the specimens, including the spacing and positioning with respect to vapor source and to other objects being coated, shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Separate specimens shall not be used for thickness measurements unless the necessity for their use has been demonstrated.

4.3.2 Steel parts. Metal strips approximately 1 inch by 4 inches by .040 inch, AISI 4130, (MIL-S-18729) or equivalent for coating adhesion test for steel parts.

4.3.3 Titanium parts. Metal strips approximately 1 inch by 4 inches by .040 inch, Ti-6Al-4V, (MIL-T-9046) or equivalent for coating adhesion test for titanium parts.

4.3.4 Aluminum parts. Metal strips approximately 1 inch by 4 inches by 0.40 inch, 2024-T81, (QQ-A-250/4) or equivalent for coating adhesion tests for aluminum parts.

4.3.5 Corrosion tests. Steel panels approximately 3 inches by 6 inches, AISI 4130, (MIL-S-18729) or equivalent for corrosion tests.

4.4 Sampling.

4.4.1 Lot. A lot shall consist of coated articles of approximately the same size, shape, type, and class of coating, coated in the same production run. In the case of short production runs, a lot for inspection purposes may be made up a group of small lots covering several orders of parts similar in size and shape and coated under similar conditions.

4.4.2. Sampling for destructive tests of coating. Random samples for the 4.5 test methods shall be taken as follows:

4.4.2.1 For thickness and adhesion. A random sample of two articles shall be taken from any inspection lot or two separately plated specimens shall be prepared in accordance with 4.3 to represent each inspection lot.

4.4.2.2 For corrosion resistance. A random sample of two articles shall be taken from any inspection lot at a minimum of one per month or two separately coated specimens shall be prepared in accordance with 4.3 to represent an inspection lot. Failure of any sample shall require random sampling as mentioned above for each inspection lot for five consecutive inspection lots without failure.

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4.5 Test procedures.

4.5.1 Thickness. Thickness determinations shall be made by eddy current test, beta back scatter test, micrometer measurements, microscopic test, or magnetic test. The magnetic test is applicable only to ferrous alloy substrates. The microscopic test shall be made per Method 521 of FED-STD-151. The magnetic test shall be made per Method 522 of FED-STD-151. For reference tests, the microscopic test shall be used. If the thickness of the plating on an aluminum alloy part cannot suitably be measured with any of these devices, companion metal strips approximately 1 inch by 4 inches by .040 inch, AISI 4130, MIL-S-18729 or equivalent can be used.

4.5.2 Adhesion. Adhesion shall be determined by scraping the surface of the plated article to expose the basis metal and examining at a minimum of four diameters magnification for evidence of nonadhesion. Alternatively, the test strip shall be clamped in a vise and bent back and forth until strip rupture occurs. If the edge of the ruptured coating can be peeled back or if separation between the coating and the basis metal can be seen at the point of rupture when examined at four diameters magnification, adhesion is not satisfactory.

4.5.3 Corrosion resistance. The corrosion resistance test shall be conducted in accordance with the procedure specified in ASTM B-117 to determine conformance with 3.7.

5. PACKAGING

5.1 Packaging. There are no packaging, packing, or marking requirements applicable to this specification.

6. NOTES

6.1 Intended uses. The high purity aluminum coatings covered by this specification are intended for use as corrosion protective coatings on ferrous and aluminum alloy parts. Coating may be applied by any process which produces a high purity (99 percent plus) aluminum coating. The process should not cause hydrogen embrittlement of the basis metal. Ion vapor deposited aluminum and aluminum electrodeposited using an organic electrolyte are processes which meet this criteria. It can also be applied to titanium and stainless steel alloys to provide corrosion compatibility with aluminum structure. Type II (Chromated per 3.4) high purity aluminum coating can also be used for applications which require an electrically conductive surface such as electrical bonding and grounding, and EMI compatibility.

6.1.1 Class 1 and Class 2 coatings. Class 1 and Class 2 coatings are intended as general purpose coatings for corrosion protection of structural and functional ferrous and non-ferrous alloy components.

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6.1.2 Class 3 coatings. Class 3 coatings are intended as special purpose coatings where dissimilar metal compatibility is required for close tolerance or threaded parts (such as bushings, pins, fasteners, etc).

6.2 Ordering data. Procurement documents should specify the following:

- a. Title, number, and date of this specification.
- b. Class and type of coating required (see 1.2).
- c. Method of determining compliance with 4.3.

6.2.1 Options. Any desired options offered herein may be utilized in procurement documents.

6.3 Reagent for microscopic determination. The following typical reagent is satisfactory for etching aluminum coatings on steel for microscopic determination of coating thickness:

10 percent weight NaOH.

6.4 Dimensional tolerance. The dimensional tolerance of most threaded articles, such as nuts, bolts, and similar fasteners with complementary threads do not permit the application of a coating thickness much greater than Class 3. If heavier coatings are required for satisfactory corrosion resistance, allowance must be made in the manufacture of the threaded fasteners for tolerance necessary for coating build-up.

6.5 Samples. It is believed that this specification adequately describes the characteristics necessary to secure the desired material, and that, normally, no samples will be necessary prior to award to determine compliance with this specification. If, for any particular purpose, samples with bids are necessary, they should be specifically asked for in the invitation for bids, and the particular purpose to be served by the bid sample should be definitely stated. The specification will apply in all other respects.

6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodian:
Air Force - 20
Navy - AS
Army - MR

Preparing Activity:
Air Force - 20

(Project No. MFFP-0309)

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

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1. DOCUMENT NUMBER MIL-C-83488C		2. DOCUMENT TITLE Coating, Aluminum High Purity	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION <i>(Mark one)</i> <input type="checkbox"/> VENDOR <input type="checkbox"/> USER <input type="checkbox"/> MANUFACTURER <input type="checkbox"/> OTHER <i>(Specify):</i> _____	
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