

MIL-T-81955(AS)
15 November 1973

SUPERSEDING
AS 1131 A
26 February 1968

MILITARY SPECIFICATION

TIN PLATING; IMMERSION FOR COPPER AND COPPER ALLOYS

This specification is approved for use by the Naval Air Systems Command, Department of the Navy.

1. SCOPE

1.1 Scope. This specification covers the requirements for tin plating deposited by immersion, without an external potential, on copper and copper alloys.

1.2 Classification.

1.2.1 Classes. Deposited tin plating shall be of the following classes as specified (see 6.2):

- Class 1 - 0.000076 to 0.0001 inch thick
- Class 2 - 0.000051 to 0.000075 inch thick
- Class 3 - 0.000026 to 0.000050 inch thick
- Class 4 - 0.000025 inch or less thick

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.

SPECIFICATIONS

Federal

O-T-634	Trichloroethylene, Technical
QQ-S-571	Solder, Tin-Alloy: Tin-Lead Alloy; and Lead Alloy

MFFP

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SPECIFICATIONS

Military

MIL-T-81533 1, 1, 1 Trichloroethane (Methyl Chloroform)
Inhibited, Vapor Degreasing

STANDARDS

Federal

Fed. Test Method Metals; Test Methods
Std. No. 151

Military

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

MIL-STD-1312 Fasteners, Test Methods

(Copies of specifications, standards, and publications required by suppliers 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 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.

American Society for Testing and Materials (ASTM) Standards

A 630	Determination of Tin Coating Weights for Hot-Dip and Electrolytic Tin Plate
B 487	Measuring Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section
B 499	Method for Measurement of Coating Thickness by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals
B 504	Measuring the Thickness of Metallic Coatings by the Coulometric Method

American Society for Testing and Materials (ASTM) Standards (Continued)

B 567 Test for Coating Thickness by the Beta Backscatter Principle

B 568 Test for Coating Thickness by X-Ray Spectrometry

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

3. REQUIREMENTS

3.1 Materials. The materials used shall be such as to produce tin plating which meets the requirements of this specification.

3.2 Composition. The composition of the plating, deposited on the basis metal surface, shall not be less than 99 percent tin.

3.3 Cleaning. The basis metal shall be cleaned, pickled or otherwise pretreated by methods which shall not damage the substrate and shall not interfere with the adhesion of the deposit (see 6.3).

3.4 Plating application. Unless otherwise specified (see 6.2), the plating shall be applied after all basis metal heat treatments and mechanical operations, such as machining, soldering, brazing, welding, forming and perforating of the article have been completed. The tin plating shall be deposited from a bath solution onto the copper or copper alloy surface under the influence of the potential that exists between the solution and the immersed basis metal.

3.5 Coverage. Unless otherwise specified, the plating shall cover all surfaces including roots of threads, corners and recesses (see 6.2).

3.6 Thickness. Unless otherwise specified (see 6.2), the thickness range of tin, as specified in the contract, purchase order or applicable drawing, on significant surfaces for each class of plating shall be as detailed in Table I. Significant surfaces shall be all surfaces of the article which can be touched by a sphere 0.75 inch (19 mm) in diameter plus additional functional surfaces specified (see 6.2). Surfaces on which the specified thickness cannot readily be controlled, such as holes, deep recesses, bases of angles, and internal threads from which the external environment is completely excluded and where a controlled deposit cannot be normally obtained, shall not be subjected to a thickness requirement. However, the plating on such surfaces shall be of sufficient thickness to ensure coating continuity and uniform appearance.

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TABLE I
THICKNESS

Class	Thickness Range		
	Inch	Microlnches (millionths of an inch)	Micrometres (approx.) equivalent thickness $\frac{1}{16}$
1	0.000076 to 0.000100	76 to 100	1.92 - 2.54
2	0.000051 to 0.000075	51 to 75	1.28 - 1.91
3	0.000026 to 0.000050	26 to 50	0.64 - 1.27
4	0.000025 or less	25 or less	0.63 or less

$\frac{1}{16}$ 0.0001 inch = 0.1 mil = 100 microinches = 2.54 μm

3.7 **Adhesion.** The adhesion of the plating shall be such that when examined at a magnification of approximately 10 diameters, the plating shall not show separation from the basis metal at the interface when subject to the tests described in 4.5.3. The interface between the tin plating and the basis metal is the surface of the basis metal before plating. The formation of cracks in the plating caused by rupture of the basis metal which does not result in flaking, peeling, or blistering of the coating shall not be considered as nonconformance to this requirement.

3.8 **Solderability.** Plated specimens or parts shall be easily and completely coated with solder when tested as specified in 4.5.4. The solder shall be deposited uniformly without lumps or peaks and shall be essentially free from evidence of bubbling, foaming, voids and other defects. The solder shall firmly adhere to the plating and the plating shall be firmly adherent to the basis metal. There shall be no separation at the solder-plating interface or at the plating-basis metal interface, so that they cannot be lifted when a sharp-edge instrument is applied.

3.9 **Workmanship.**

3.9.1 **Basis metal.** The basis metal shall be free from visible defects which will be detrimental to the appearance or protective value of the plating.

3.9.2 **Plating.** The tin plating shall be smooth, adherent, continuous, free from visible blisters, pits, nodules, porosity, excessive build-up, staining and other defects. The size and number of contact marks shall be at a minimum consistent with good practice. The location of contact marks shall be in areas of minimum exposure to service environmental conditions where important to the function of the part.

Superficial staining which has been demonstrated as resulting from any drying or baking operation shall not be cause for rejection. The plating shall show no indication of contamination or improper operation of equipment used to produce the plating. All details of workmanship shall conform to the best practice for high quality coating.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 Lot. A lot shall consist of plated articles of the same material, class, plated and treated under the same conditions and approximately of the same size and shape, submitted for inspection at one time. In no case shall the lot size exceed production for one normal work period, an 8-hour shift.

4.3 Quality conformance sampling.

4.3.1 For visual examination and nondestructive tests. Sampling for visual examination and nondestructive tests shall be conducted as directed by the procuring activity (see 6.2) in accordance with MIL-STD-105 or using Table II. A sample of coated parts or articles shall be drawn by taking at random from each lot the number of articles in accordance with MIL-STD-105, Level II, Acceptable Quality Level (AQL) 0.25-percent defective, or as indicated in Table II. The lot shall be accepted or rejected according to the procedures in 4.3.1.1 for visual examination and 4.3.1.2 for plating thickness (nondestructive tests).

4.3.1.1 Visual examination. Samples selected in accordance with 4.3.1 shall be examined for compliance with the requirements of 3.9.2 after plating. If the number of nonconforming articles exceeds the acceptance number for the sample, 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 4.5.2 at several locations on each article as defined in 3.6, as applicable, for compliance with the requirements. Measurements on fastener hardware shall be made at locations defined in MIL-STD-1312, Test 12. 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

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sample shall be rejected. Separate specimens (see 4.4.1) shall not be used for thickness measurements unless a need has been demonstrated.

TABLE II

SAMPLING FOR VISUAL EXAMINATION
AND NONDESTRUCTIVE TESTS

Numbers of items in lot inspections	Number of items in samples (randomly selected)	Acceptance number (maximum number of sample items nonconforming to any test)
15 or less	7 ^{1/}	0
16 to 40	10	0
41 to 110	15	0
111 to 300	25	1
301 to 500	35	1
501 and over	50	2

^{1/} If the number of items in the inspection lot is less than 7, the number of items in the sample shall equal the number of items in the inspection lot.

4.3.2 For destructive tests. A random sample of four plated parts or articles shall be taken from each lot for each destructive test or separately plated specimens shall be prepared in accordance with 4.4 and 4.4.1 to represent each lot. If the number of articles in the lot is four or less, the number of articles in the sample shall be specified by the procuring activity (see 6.2).

4.3.2.1 Composition. When specified in the contract or order, compliance with the requirements for composition shall be determined (see 6.2). Samples selected in accordance with 4.3.2 shall be tested in accordance with 4.5.1 to determine compliance with 3.2.

4.3.2.2 Thickness of plating (destructive tests). If sampling and testing for thickness of plating by nondestructive testing is not the option of the supplier, samples selected in accordance with 4.3.2 shall be measured for plating thickness by the applicable tests detailed in 4.5.2 at several locations as defined in 3.6 for compliance with the requirements. Measurements on fastener hardware shall be made at locations defined in MIL-STD-1312, Test 12. If the plating thickness on any place on any article or specimen is less than the specified minimum thickness, the lot shall be rejected. Separate specimens (see 4.4.1) shall not be used for thickness measurements unless a need has been demonstrated.

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4.3.2.3 Adhesion (destructive tests). The articles or specimens used for the destructive thickness test (see 4.5.2), if of suitable size and form, may be used as the test pieces for the adhesion tests to determine compliance with the requirements of 3.7. Failure of one or more of the test pieces shall constitute failure of the lot.

4.3.2.4 Solderability (destructive tests). Unless otherwise specified (see 6.2), compliance with the requirements for solderability shall be determined. The articles or specimens used for the destructive thickness test (see 4.5.2) of suitable size and form, may be used as the specimens for the solderability test (see 4.5.4) to determine compliance with the requirements of 3.8. Failure of one or more of the test specimens shall constitute failure of the lot.

4.4 Quality conformance specimen preparation. When the plated articles are of such form, shape, size or value as to prohibit use thereof, or are not readily adaptable to a test specified herein, or when destructive tests of small lot sizes are required the test shall be made by the use of separate specimens plated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. Equivalent basis metal includes chemical composition, grade, condition and finish of surface prior to plating. For example, a cold-worked copper surface should not be used to represent an annealed surface. Due to the impracticality of forging or casting separate test specimens, hot-worked specimens may be used to represent forged and cast articles. The separate specimens may be also cut from scrap castings when castings are being plated. These separate specimens shall be introduced into a lot at regular intervals prior to the cleaning operations, preliminary to plating, and shall not be separated therefrom until after completion of plating. Conditions affecting the plating of specimens including the spacing, plating media, residual air pressure, temperature, etc. in respect to other objects being plated 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, however, unless the necessity for their use has been demonstrated.

4.4.1 Specimens for composition, thickness, adhesion, and solderability tests. If separate specimens for composition, thickness, adhesion, and solderability tests are required, they shall be strips approximately 1 inch wide, 4 inches long and 0.04 inch thick.

4.5 Tests.

4.5.1 Composition. Either Method 513 of Fed. Test Method Std. No. 151 or ASTM A 630 may be used for determining composition of the tin plating employing any recognized stripping method. Either Method 111 or Method 112 of Fed. Test Method Std. No. 151 may be used for determining composition of the tin plating. The plating composition may also be determined by X-ray fluorescence techniques and by atomic absorption spectrophotometry.

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4.5.2 Thickness. For nondestructive measuring of plating thickness, procedures in accordance with ASTM B 499 (magnetic test), ASTM B 567 (Beta radiation backscatter) or ASTM B 568 (X-ray spectrometry) may be used. For destructive measuring of plating thickness, procedures in accordance with ASTM B 487 (microscopic) or ASTM B 504 (coulometric) may be used. In addition to the above, the other procedures embodied in MIL-STD-1312, Test 12, may be used for thickness of plated fastener hardware.

4.5.3 Adhesion. Adhesion may be determined by scraping the surface of the plating or shearing with a sharp edge, knife or razor through the plating down to the basis metal and examining at ten diameters magnification for evidence of non-adhesion. Alternately the article or specimen may be clamped in a vise and the projecting portion bent back and forth until rupture occurs. If the edge of the rupture plating can be peeled back or if separation between the plating and the basis metal can be seen at the point of rupture when examined at ten diameters magnification, adhesion is not satisfactory.

4.5.4 Solderability. The surface of the article or the specimen to be tested shall be cleaned with a suitable solvent such as trichloroethylene, conforming to O-T-634, or stabilized 1, 1, 1 trichloroethane, conforming to MIL-T-81533, to remove dirt, grease, oil films, etc. The area to be tested shall be heated to a temperature of $420 \pm 25^\circ\text{F}$ ($216 \pm 14^\circ\text{C}$), above the flow temperature of the solder. The application of heat shall be carefully controlled during the soldering operation to prevent damage to the printed circuitry card material when used for testing. Flux cored solder, type Sn 60 WRP, conforming to QQ-S-571, shall be applied to the heated area. The solder shall flow evenly to form an integral coat on the test area and feather out to a thin edge. After cooling in air and examination, the article or the specimen shall be tested for adhesion of the solder as detailed in 4.5.3.

5. PREPARATION FOR DELIVERY

5.1 Packaging and packing. Unless otherwise specified, preservation, packaging and packing methods for immersion plated tin parts or articles employed by a supplier shall be such as to preclude any physical damage during shipment and handling and surface deterioration during shipment and storage which would interfere with solderability.

6. NOTES

6.1 Intended use. The tin plating covered in this specification is intended for use as a base for soldering printed circuitry and microwave parts and components. The thin plating, ranging up to 100 millionths of an inch (2.54 μm) in thickness offers some corrosion protection but should not be used as a substitute for tin plating, electro deposited or hot dipped, in accordance with MIL-T-10727. The tin plating should not be used on parts which in service reach a temperature of 330°F (166°C) or higher or come in contact with other parts which reach those temperatures.

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. Class required (see 1.2.1).
- c. When plating is to be applied, if other than specified (see 3.4).
- d. Coverage, if other than specified (see 3.5).
- e. Thickness of plating, if other than specified (see 3.6).
- f. Sampling plan (see 4.3.1).
- g. Number of samples for destructive testing (see 4.3.2).
- h. Whether composition test is required (see 4.3.2.1).
- i. Whether solderability test is not required (see 4.3.2.4).
- j. Special delivery preparation (see 5.1).

6.3 Cleaning. Copper and copper-based alloys may be cleaned as detailed in ASTM B 281, Recommended Practice for the Preparation of Copper and Copper-Base Alloys for Electroplating (see 3.3).

Preparing activity - AS

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