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## Standard Specification for Electrodeposited Coatings of Tin-Lead Alloy (Solder Plate)<sup>1</sup>

This standard is issued under the fixed designation B579; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope

1.1 This specification covers the requirements for electrodeposited tin-lead coatings on fabricated articles of iron, steel, copper, and copper alloys, to protect them against corrosion (**Note 1**), to improve and preserve solderability over long periods of storage, and to improve anti-galling characteristics.

NOTE 1—Some corrosion of tin-lead coatings may be expected in outdoor exposure. In normal indoor exposure, tin-lead is protective on iron, copper, and copper alloys. Corrosion may be expected at discontinuities (pits or pores) in the coating. Porosity decreases as the thickness is increased. A primary use of the tin-lead coating (solder) is with the printed circuit industry as a solderable coating and as an etch mask material.

1.2 This specification applies to electrodeposited coatings containing a minimum of 50 % and a maximum of 70 % tin. The specification applies to mat, bright, and flow-brightened tin-lead coatings.

NOTE 2—Tin-lead plating baths are composed of tin and lead fluoborates and of addition agents to promote stability. The final appearance may be influenced by the addition of proprietary brighteners. Without brighteners, the coatings are mat; with brighteners, they are semibright or bright. Flow-brightened coatings are obtained by heating mat coatings to above the melting point of tin-lead for a few seconds and then quenching; palm oil, hydrogenated oils, or fats are used as a heat-transfer medium at a temperature of  $260 \pm 10^\circ\text{C}$  ( $500 \pm 20^\circ\text{F}$ ), but other methods of heating are also in use. The maximum thickness for flow-brightening is about  $7.5 \mu\text{m}$  (0.3 mil); thicker coatings tend to reflow unevenly. The shape of the part is also a factor; flat surfaces tend to reflow more unevenly than wires or rounded shapes (**Note 3**).

NOTE 3—Volatile impurities in tin-lead coatings will cause bubbling and foaming during flow-brightening resulting in voids and roughness. The impurities can arise from plating solution addition agents and from improper rinsing and processing.

1.3 This specification does not apply to sheet, strip, or wire in the unfabricated form or to threaded articles having basic major diameters up to and including ~~19 mm (0.75 in.)~~; 19 mm (0.75 in.).

1.4 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.5 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.06 on Soft Metals.

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## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- [B183 Practice for Preparation of Low-Carbon Steel for Electroplating](#)
- [B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)
- [B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings](#)
- [B322 Guide for Cleaning Metals Prior to Electroplating](#)
- [B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section](#)
- [B499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals](#)
- [B504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method](#)
- [B567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method](#)
- [B568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry](#)
- [B849 Specification for Pre-Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement](#)
- [B850 Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement](#)
- [E105 Guide for Probability Sampling of Materials](#)
- [E122 Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process](#)

### 2.2 Other Standards:<sup>3</sup>

- [MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes](#)
- [MIL-STD-414 Sampling Procedures and Tables for Inspection by Variables for Percent Defective](#)

## 3. Classification and Service Condition

3.1 Orders for articles to be plated in accordance with this specification shall specify, in addition to the ASTM designation number and year of issue, the classification notation indicating the basis metal and thickness of tin-lead coating required, or the service condition number indicating the severity of service required for the coating. In addition, when specifying a tin-lead coating composition, the first number shall refer to the tin content in percent.

### 3.1.1 Classification Notation:

Symbol	Classification
Fe/	Iron or steel basis metals
Cu/	Copper or copper alloy basis metals
/Sn-Pb	Tin-lead coating and its composition number, when required; for example, Sn60-Pb40
Number (5 to 50)	Minimum coating thickness in micrometres
Suffix Letter	
f	flow-brightened
b	bright
m	mat

An example of complete classification notation is as follows: Cu/Sn60-Pb40/5F

### 3.1.2 Service Condition Number:

No.	Service Condition
4	very severe exposure
3	severe exposure
2	moderate exposure
1	mild exposure

NOTE 4—See [Appendix X1](#) for additional description of exposure conditions and examples of typical end uses. The coating thicknesses given for each service condition are guidelines and are not intended to be absolute values.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

#### 4. Significant Surfaces

4.1 Significant surfaces are defined as those surfaces normally visible (directly or by reflection) that are essential to the appearance or serviceability of the article when assembled in normal position; or those surfaces that can be the source of corrosion products that will deface visible surfaces on the assembled article. When necessary, the significant surfaces shall be indicated on the drawing of the part, or by the provision of suitably marked samples.

NOTE 5—When significant surfaces include areas on which the specified thickness of deposit cannot readily be controlled, such as threads, holes, deep recesses, bases of angles, and similar areas, the purchaser and the manufacturer should recognize the necessity for either thicker deposits on the more accessible surfaces or for special racking. Special racks may involve the use of conforming, auxiliary bipolar electrodes, or nonconducting shields.

#### 5. Materials and Manufacture

5.1 Defects in the surface of the basis metal, such as scratches, porosity, nonconducting inclusions, roll and die marks, cold shuts, and cracks, may adversely affect the appearance and the performance of coatings applied thereto despite the observance of the best plating practices. Accordingly, the plater's responsibility for defects in the coating resulting from such conditions shall be waived, except when he is/they are also in the position of prime contractor supplying plated parts.

NOTE 6—In order to minimize problems of this sort, the specifications covering the basis material or the item to be plated should contain appropriate limitations on such basis metal conditions.

5.2 When required, the basis metal shall be subjected to such polishing or buffing operations as are necessary to yield deposits with the desired final appearance (Section 6).

5.3 Proper preparatory procedures and thorough cleaning of the basis metal surface are essential in order to assure satisfactory adhesion and corrosion performance of the coating. Accordingly, it is suggested that the following Practices for the preparation of various basis metals for electroplating be followed when appropriate: **B183**, **B281**, and **B322** and Guide **B242**.

5.4 When necessary, preliminary samples showing the finish shall be supplied to and approved by the purchaser. Where rack marks are inevitable, their location shall be the subject of agreement between supplier and purchaser.

#### 6. Physical Composition

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<https://standards.iteh.ai/catalog/standards/sist/e982ff70-3c1f-462b-acab-74eb9be1319f/astm-b579-22>

6.1 *Composition*—The tin-lead coating composition shall be as follows (Note 7):

Element	Weight, %
Tin (Sn)	50 to 70
Lead (Pb)	remainder

6.1.1 The tin percentage is calculated as follows:

$$\text{Tin, \%} = 134.1 \times (L/A - 1) \quad (1)$$

where:

$L$  = weight of lead coating,  $g$ , and  
 $A$  = weight of alloy coating,  $g$ .

NOTE 7—Only the tin content need be determined. Lead is usually determined by difference. A sample of the deposit can be obtained by plating on a stainless steel panel from which the coating can be peeled or by employing any recognized stripping method. The alloy composition of the deposit can be determined by methods such as gravimetric or volumetric analysis, density measurements, atomic absorption spectrophotometry, X-ray fluorescence, and beta backscatter.

In addition, the alloy composition produced by a plating solution may be obtained by comparing the weight of a tin-lead coating deposited by a given number of ampere-hours to the weight of lead coating produced in a lead fluoroborate coulometer in series with the plating bath.

6.2 *Appearance*—The tin-lead coating shall be smooth, fine grained, continuous, adherent, and shall be free of visible blisters, pits, nodules, indications of burning, excessive build-up, staining, and other defects. Flow-brightened coatings shall not have dewetted areas or beads, and shall be free of the oil used in the fusion process.

6.3 *Thickness*—The thickness of the coating on significant surfaces shall conform to the requirements in ~~Table 1~~ Tables 1 and 2

**TABLE 2 Tin-Lead Alloy Coatings on Copper, Copper Alloys<sup>A</sup>, and Nonmetals<sup>B</sup>**

Service Condition	Classification Number	Minimum Thickness	
		μm	mil
SC4	Cu/SnPb 30	30	1.2
SC3	Cu/SnPb 15	15	0.6
SC2	Cu/SnPb 8	8	0.3
SC1	Cu/SnPb 5	5	0.2
SC1	Cu/SnPb 5f <sup>C</sup>	5	0.2

<sup>A</sup> If the basis metal is a brass containing more than 15 % zinc, the tin-lead coating shall be preceded by an undercoat of at least ~~2.5 μm (0.1 mil)~~ 2.5 μm (0.1 mil) of copper and nickel to prevent the diffusion of zinc into the tin-lead. The same undercoating shall also be applied when the basis metal is beryllium copper to assure adhesion of tin-lead coating.

<sup>B</sup> Nonmetals shall be suitably sensitized and metalized prior to tin-lead coating.

<sup>C</sup> ~~f = flow brightened~~ f = flow brightened or

m = mat or  
b = bright

and ~~Table 2~~.

6.3.1 *Thickness Measurements*—Tin-lead alloy thickness measurements shall be made on those areas of the significant surfaces where the coating would be expected to be thinnest. The method of determining the thickness shall be agreed upon by the manufacturer and purchaser. Several methods are available depending upon the thickness of coating, the shape of the article, and the basis metal. They include beta backscatter, coulometric, magnetic, microscopical, and X-ray fluorescence test methods. The methods are outlined in 9.1.

NOTE 8—Thicknesses determined by beta backscatter, coulometry, and X-ray fluorescence are a function of the composition as well as the thickness of the coating.

6.4 *Adhesion*—The adhesion of the coating shall be adequate to pass the tests described in 9.2.

6.5 *Solderability*:

6.5.1 When specified by the purchaser, the coating shall be tested by one of the methods described in 9.2. The results shall be evaluated in accordance with each procedure described in that section.

6.5.2 When specified by the purchaser, the coating on copper and copper alloys shall, before solderability testing, be subjected to the preliminary artificial aging treatment described in 9.3.6 to determine if they may be expected to retain their solderability during periods of storage.

**TABLE 1 Tin-Lead Alloy Coatings on Steel**

Service Condition	Classification Number	Minimum Thickness	
		μm	mil
SC4 <sup>A</sup>	Fe/SnPb 30	30	1.2
SC3 <sup>A</sup>	Fe/SnPb 20	20	0.8
SC2	Fe/SnPb 10	10	0.4
SC1	Fe/SnPb 5	5	0.2
SC1	Fe/SnPb 5f <sup>B</sup>	5	0.2

<sup>A</sup> An undercoat of 2.5 μm (~~0.1 mil~~) (0.1 mil) copper is recommended for SC3 and SC4.

<sup>B</sup> ~~f = flow~~ f = flow brightened or

m = mat or  
b = bright

NOTE 9—See [Appendix X2](#) for design considerations that have an effect on the selection of thickness of the coating and, ultimately, on the solderability of the electrodeposits.

## 7. Hydrogen Embrittlement

7.1 Pretreatment of Iron or Steel for the Purpose of Reducing the Risk of Hydrogen Embrittlement—Steel parts having an ultimate tensile strength greater than 1000 MPa (31 HRC) that contain tensile stresses caused by cold forming or cold straightening which have not been heat treated after the cold forming process, shall be heat treated for stress relief to reduce the risk of hydrogen embrittlement in the part before clean and electroplate processes. If these heat treatments are not required, the purchaser shall specify in the ordering information their exception. If the purchaser does not specify an exception to heat treatment, then the plater shall use Table 1 in Specification [B849](#) to determine the appropriate heat treatment for the steel based on its tensile strength.

7.2 Post Coating Treatments of Iron and Steel for the Purpose of Reducing the Risk of Hydrogen Embrittlement (Baking)—High-tensile strength steels, and severely cold-worked steels, are susceptible to embrittlement by hydrogen in both cleaning and plating operations. The embrittling hydrogen shall be removed by heat treatment. Procedures for baking to minimize embrittlement before and after plating are covered in Sections 2 and 7 of Guide [Electroplated steel parts having a tensile strength greater than 1200 MPa \(39 HRC\) as well as surface hardened parts, shall be baked to reduce the risk of hydrogen embrittlement. Baking of electroplated steel parts with tensile strength 1200 MPa \[B242\]\(#\)-\(39 HRC\) or less is not mandatory.](#)

7.2.1 Steel parts having a tensile strength greater than 1200 MPa (39 HRC) as well as surface hardened parts, shall be baked to reduce the risk of hydrogen embrittlement. For such parts, purchasers shall specify the baking requirements in the ordering information. Purchasers are directed to the appropriate ER Class in Guide [B850](#) Table 1.

7.2.2 A purchaser wishing to specify baking requirements, irrespective of tensile strength, shall specify such requirements in the ordering information. Purchasers are directed to Guide [B850](#) Table 1.

7.2.3 Any baking treatment done under [7.1](#) shall begin within 4 h of removal from the electroplating process.

7.2.4 Electroplated springs and other parts subject to flexure shall not be flexed before the hydrogen embrittlement relief treatment.

## 8. Sampling

8.1 Test methods are time consuming and often destructive; therefore 100 % inspection is usually impractical. The purchaser should select a suitable sampling plan for the acceptance testing of lots of coated items. In order that the manufacturer (plater) may know the quality standard ~~he is~~they are expected to meet, the plan selected should be made part of the purchase contract.

8.2 General information on sampling procedures is given in Recommended Practices [E105](#) and [E122](#). Standard sampling plans are suggested in Military Standards MIL-STD-105 and MIL-STD-414.

## 9. Test Methods

### 9.1 Thickness:

9.1.1 To meet the thickness specifications of the coatings, the plater is advised to:

9.1.1.1 Maintain regular control of all solutions,

9.1.1.2 Inspect the equipment at regular intervals, and

9.1.1.3 Check thickness at periodic intervals.

9.1.2 The following ASTM methods are acceptable for measuring local thickness of the coating: [B487](#), [B499](#), [B504](#), [B567](#), and [B568](#).

### 9.2 Adhesion:

9.2.1 *Burnishing Test*—Rub an area of not more than ~~630 mm~~ $630 \text{ mm}^2$  (~~4 in.~~ $1 \text{ in.}^2$ ) of the coated surface, selected at the discretion of the inspector, rapidly and firmly for ~~15 s~~15 s with a smooth metal implement. A suitable burnishing implement is a copper or