Designation: ~~B200 – 85 (Reapproved 2015)~~ B200 – 22

Standard Specification for Electrodeposited Coatings of Lead and Lead-Tin Alloys on Steel and Ferrous Alloys[1]

This standard is issued under the fixed designation B200; 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 reapproval. A superscript epsilon (ε) 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~~ Scope*

1.1 This specification covers the requirements for electrodeposited coatings of lead and lead-tin alloys on steel and ferrous alloys. The coatings of lead-tin alloys are those that range in tin content up to, but not exceeding, 15 mass %. The coatings ranging between 3 and 15 mass % in tin content are known also as "terne" metallic electrodeposits.

1.2 This specification does not apply to sheet, strip, or wire in the unfabricated form.

1.3 *Units*—The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 The following precautionary caveat pertains only to the test method portion, Section 11, of this specification: *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~~ safety, health, and ~~health~~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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

B117 Practice for Operating Salt Spray (Fog) Apparatus
B183 Practice for Preparation of Low-Carbon Steel for Electroplating
B242 Guide for Preparation of High-Carbon Steel for Electroplating
B320 Practice for Preparation of Iron Castings for Electroplating
B322 Guide for Cleaning Metals Prior to Electroplating
B339 Specification for Pig Tin
B374 Terminology Relating to Electroplating
B487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

[1] 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.

Current edition approved ~~March 1, 2015~~Nov. 15, 2022. Published ~~April 2015~~December 2022. Originally approved in 1970. Last previous edition approved in ~~2009~~2015 as B200 – 85~~ (2009).~~(2015). DOI: ~~10.1520/B0200-85R15.~~10.1520/B0200-22.

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

***A Summary of Changes section appears at the end of this standard**

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
B507 Practice for Design of Articles to Be Electroplated on Racks
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
B571 Practice for Qualitative Adhesion Testing of Metallic Coatings
B602 Guide for Attribute Sampling of Metallic and Inorganic Coatings
B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
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

3. Terminology

3.1 *Definitions*—Definitions of the terms used in this specification are in accordance with Terminology B374.

4. Classification

4.1 The coating designation shall comprise the following:

4.1.1 The chemical symbol for the basis metal.

4.1.2 The chemical symbol for the undercoating of copper or nickel, if used.

4.1.3 The chemical symbol Pb representing lead or the symbol Pb Sn for the lead-tin alloy. When tin is present, the tin content of the coating will appear before the symbol Sn. For example, Pb 5 Sn refers to a coating having the minimum composition 5 mass % tin, remainder lead.

4.1.4 A number indicating the minimum thickness of the coating in micrometres (μm). This minimum thickness shall be 6, 12, 25, or 40 μm, and shall apply to all significant surfaces specified in 8.2.2 and 8.3.1.

4.2 *Examples:*

4.2.1 Fe-Pb-5-Sn-40 represents a lead-tin alloy coating having 5 mass % tin content, remainder lead, on a ferrous basis metal. The thickness is ~~40 μm~~ 40 μm minimum.

4.2.2 Fe-Cu-Pb-6 represents a lead coating on a ferrous basis metal with a copper strike. The thickness is ~~6 μm~~ 6 μm minimum.

5. Sampling

5.1 *Lot*—An inspection lot is defined as a collection of finished articles that are of the same kind, that have been produced to the same specification, that have been coated by a single supplier at one time or at approximately the same time under essentially identical conditions, and that are submitted for acceptance or rejection as a group.

5.2 *Selection*—A random sample of the size required by Test Method B602 shall be selected from the inspection lot (see 5.1). The articles in the lot shall be inspected for conformance to the requirements of this specification and the lot shall be classified as conforming or nonconforming to each requirement according to the criteria of the sampling plans in Test Method B602.

NOTE 1—Test Method B602 contains three sampling plans that are to be used with nondestructive test methods and a fourth to be used with destructive test methods. The three methods for nondestructive tests differ in the quality level they require of the product. Test Method B602 requires use of the plan with the intermediate quality level unless the purchaser specifies otherwise. The purchaser should compare the plans with ~~his~~their needs and state which plan is to be used. If the plans in Test Method B602 do not serve the needs, additional ones are given in Guide B697.

NOTE 2—When both destructive and nondestructive tests exist for the measurement of a characteristic, the purchaser needs to state which is to be used so that the proper sampling plan is selected. Also, a test may destroy the coating in a noncritical area; or, although it destroys the coating, the tested article might be reclaimed by stripping and recoating. The purchaser needs to state whether the test is to be considered destructive or nondestructive.

5.3 *Separate Specimens*—If separate specimens are to be used to represent the finished articles in a test, the specimens shall be of the nature, size, number, and be processed as required in 6.1, 6.2, 6.3 and 6.4.

6. Specimen Preparation

6.1 *Electroplated Parts or Separate Specimens*—When the electroplated parts are of such form, shape, size, and 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 incudes chemical composition, grade, condition, and finish of surface prior to electroplating. For example, a cold-rolled steel surface should not be used to represent a hot-rolled steel surface. Due to the impracticality of forging or casting separate test specimens, hot-rolled steel specimens may be used to represent forged and cast-steel articles. The separate specimens may also be cut from scrap castings when ferrous alloy castings are being electroplated. These separate specimens shall be introduced into a lot at regular intervals before the cleaning operations, preliminary to electroplating of specimens, including the spacing, plating media, bath agitation, and temperature, in respect to other objects being electroplated, shall correspond as nearly as possible to those affecting the significant surfaces of the articles represented. Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for nondestructive and visual examinations.

6.2 *Thickness and Adhesion Specimens*—If separate specimens for thickness and adhesion tests are required, they shall be strips approximately ~~25 mm~~ 25 mm wide, 100 ~~mm~~ mm long, and ~~1 mm~~ 1 mm thick.

6.3 *Corrosion Resistance Specimens*—If separate specimens for corrosion resistance tests are required, they shall be panels not less than ~~150 mm long, 100 mm~~ 150 mm long, 100 mm wide, and approximately ~~1 mm~~ 1 mm thick.

6.4 *Hydrogen Embrittlement Specimens*—If specimens are required, the configuration shall be that specified by the purchaser.

7. Significance and Use

7.1 Electrodeposits of lead and lead-tin alloys on steel and ferrous alloys are produced where it is desired to obtain atmospheric corrosion resistance. Deposits of lead and lead-tin alloys on steel have shown to have excellent corrosion protective qualities in atmospheric exposure, especially when under-coated by a thin deposit of copper (or nickel). Applications of lead and lead-tin alloy deposits include the following: protection from dilute sulfuric acid; lining of brine refrigeration tanks; chemical apparatus; and parts for storage batteries; and for coating bearing surfaces. In this last application, lead is electroplated alone, or as an alloy and coated with another metal, such as indium. The indium may be diffused into the lead or lead alloy by heat treatment. See Appendix X1.

8. Ordering Information

8.1 When ordering articles to be electroplated in accordance with this specification, the purchaser shall state the coating designation (see Section 4), the minimum thickness on significant surfaces, in addition to the ASTM designation number and year of issue.

8.2 If necessary, the purchaser shall include, on ~~his~~their part, drawings, or purchase order the following:

8.2.1 Electroplating application to high-strength steel, if specified (see 9.2.2).

8.2.2 Location of significant surfaces, to be shown on part drawing, or by the provision of a suitably marked sample.

8.2.3 Hydrogen embrittlement test, if required (see 6.4).

8.2.4 Sample size for inspection, if other than specified (see Section 5).

8.2.5 Supplementary requirements, if applicable (see Supplementary Requirements).

8.2.6 Separate test specimens, if permitted (see 6.1).

8.2.7 Certification, if required (see Section 13).

8.3 The manufacturer of the basis metal parts should provide the supplier of the coating facility, with the following data:

8.3.1 Hardness or tensile strength of steel parts (see 9.2.2 and ~~9.2.3~~9.2.4).

8.3.2 Heat treatment for stress relief, whether or not it has been performed or is required.

9. Coating Requirements

9.1 *Composition*—The coating compositions shall be as specified in Table 1.

9.2 *Process*—~~Process~~Lead~~—Lead~~ and lead-tin alloy coatings shall be produced by electrodeposition in aqueous solution of salts. For the preparation of ferrous metal surfaces necessary to assure good deposit, adhesion, and quality, see Practices B183, B242, B320, and B322.

9.2.1 A copper or nickel strike, 2.5 ~~μm~~ μm thick, may be employed and is desirable (see X1.1.2).

9.2.2 *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.

9.2.3 Steel parts ~~with ultimate tensile strengths greater than 1050 Mpa (approximately 32 HRC) and that have been machined, ground, cold-formed, or cold-straightened shall be stress relieved before processing by heat treating for 5 h at 190 ± 15°C. Steel parts~~ having an ultimate tensile strength greater than ~~2350 MPa (approximately 50 HRC)~~ 2350 MPa (approximately 50 HRC) shall not be coated with lead or lead-tin alloys by electrodeposition.

9.2.4 *Post Coating Treatments of Iron and Steel for the Purpose of Reducing the Risk of Hydrogen Embrittlement (Baking)*—~~Steel parts with ultimate tensile strengths greater than 1125 MPa (approximately 35 HRC) and greater, shall be heat treated within 4 h after plating to remove hydrogen embrittlement. The heat treatment shall be at least for 3 h at 190 ± 15°C.~~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 (39 HRC), or less, is not mandatory.

9.2.4.1 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.

9.2.4.2 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.

9.2.4.3 Any baking treatment done under this section (9.2.4) shall begin within 4 h of removal from the electroplating process.

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

9.2.5 Defects and variations in appearance in the finish that arise from surface conditions of the substrate (for example, scratches, pores, roll marks, inclusions, etc.) and that persist in the finish despite the observance of good metal-finishing practices shall not be cause for rejection.

TABLE 1 Lead-Tin Alloy Coating Composition

Element	Mass %
Tin (Sn)	Up to 15 max
Lead (Pb)	Remainder
Other metals and nonmetallics	1.0 max
Lead Coating Composition	
Lead	99.0
Other metals and nonmetallics	1.0 max

NOTE 3—Applied finishes generally perform better in service when the substrate over which they are applied is smooth and free of torn metal, inclusions, pores, and other defects. It is recommended that the specifications covering the unfinished products provide limits for these defects. A metal finisher can often remove defects through special treatments such as grinding, polishing, abrasive blasting, chemical etching, and electropolishing. However, these are not normal in the treatment steps preceding the application of the finish. When they are desired, they shall be the subject of agreement between the buyer and the seller.

9.3 *Thickness*—~~Thickness~~The ~~—The~~ minimum thickness on significant surfaces shall be 6, 12, 25, or ~~40 µm,~~ 40 µm, as designated by the purchaser (see 8.1).

9.4 *Significant Surfaces*—Significant ~~Surfaces—Significant~~ surfaces are defined as those normally visible (directly or by reflection) or are essential to the serviceability or function of the article; or can be the source of corrosion products or tarnish films that interfere with the function or desirable appearance of the article. When necessary, the significant surfaces shall be indicated on the drawings of the parts, or by the provision of suitably marked samples.

NOTE 4—When significant surfaces are involved on which the specified thickness of finish cannot be readily controlled, it will be necessary to apply greater thickness on the more accessible surfaces, to use special racking, or both. The thickness requirements of this specification are ~~minimum,~~minimum (see Table 2). Variation in the finish thickness from point to point on a coated article is inherent in electroplating. Therefore, the finish thickness will have to exceed the specified value at some points on the significant surfaces to ensure that it equals or exceeds the specified value at all points. In most cases, the average finish thickness on an article will be greater than the specified value; how much greater is largely determined by the shape of the article (see Practice B507) and the characteristics of the plating process. In addition, the average finish thickness on articles will vary from article to article within a production ~~lot,~~lot. Therefore, if all of the articles in a production lot are to meet the thickness requirement, the average finish thickness for the production lot as a whole will be greater than the average necessary to assure that a single article meets the requirement.

9.5 *Corrosion Resistance*—~~Corrosion Resistance~~Lead ~~—Lead~~ and lead-tin coatings shall show neither corrosion products of lead (or lead-tin) nor basis metal corrosion products at the end of the test period, (see Table 2), when tested by continuous exposure to salt spray in accordance with 11.4. The appearance of corrosion products visible to the unaided eye at normal reading distance shall be cause for rejection except that corrosion products at the edges of specimens shall not constitute failure.

NOTE 5—Corrosion is defined as the presence of more than 66 rust spots per square metre, or more than two rust spots in an area less than 3 square decimetres, or rust spots larger than ~~1.6 mm~~ 1.6 mm in diameter.

10. Workmanship, Finish, and Appearance

10.1 The surface of the electroplated article shall be uniform in appearance and free of visible coating defects, such as blisters, pits, roughness, nodules, burning, cracks, or unplated areas, and other defects that will affect the function of the coating. However, superficial staining that results from rinsing or slight discoloration from any drying or baking operation to relieve hydrogen embrittlement, shall not be cause for rejection. On articles where a visible contact mark is unavoidable, its position shall be that chosen by the purchaser. The electroplated articles shall be clean and free of damage.

11. Test Methods

11.1 *Composition*—The lead-tin alloy coating deposit may be weighed and then analyzed for one of the metals. Lead content may be determined and the tin calculated by difference, for 1 g sample:

$$\text{Tin } \% = \frac{(1 - L)}{A} \times 100 \tag{1}$$

$$\text{Mass } \% \text{ Tin} = \left(W - \frac{L}{W} \right) \times 100 \tag{2}$$

where:

L = weight of lead in sample, and

TABLE 2 Lead and Lead-Tin Alloy Coatings on Ferrous Alloys

Thickness, min µm	Salt Spray Resistance, h
40	200
25	96
12	48
6	24