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Standard Specification for Electrodeposited Coatings of Tin-Nickel Alloy¹

This standard is issued under the fixed designation B605; 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.

1. Scope

1.1 This specification covers the requirements for electrodeposited tin-nickel alloy coatings from aqueous solutions intended for the corrosion protection of fabricated articles of iron, steel, zinc-base alloys, copper, and copper alloys. The composition of the alloy remains constant at 65/35 tin-nickel in spite of wide fluctuations in both composition and operating conditions. The composition corresponds quite closely to an equiatomic ratio, and the process favors the co-deposition of tin and nickel atoms at identical rates.

1.2 This specification does not apply to sheet, strip, or wire in the fabricated form. It also may not be applicable to threaded articles having basic major diameters up to and including 19 mm because of the nonuniformity of thickness that can be expected on fine threads. However, a decision to use the coating on such components may be made by the purchaser.

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

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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

[B183 Practice for Preparation of Low-Carbon Steel for Electroplating](#)

[B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)

[B246 Specification for Tinned Hard-Drawn and Medium-Hard-Drawn Copper Wire for Electrical Purposes](#)

[B252 Guide for Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings](#)

[B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings](#)

[B322 Guide for Cleaning Metals Prior to Electroplating](#)

[B374 Terminology Relating 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](#)

[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 Test Method for Attribute Sampling of Metallic and Inorganic Coatings](#)

[B634 Specification for Electrodeposited Coatings of Rhodium for Engineering Use](#)

[B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings](#)

[B762 Test Method of Variables Sampling of Metallic and Inorganic Coatings](#)

[B765 Guide for Selection of Porosity and Gross Defect Tests for Electrodeposits and Related Metallic Coatings](#)

[B809 Test Method for Porosity in Metallic Coatings by Humid Sulfur Vapor \(“Flowers-of-Sulfur”\)](#)

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.

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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.

[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](#)
[D3951 Practice for Commercial Packaging](#)

3. Terminology

3.1 Definitions:

3.1.1 Many terms used in this standard are defined in Terminology [B374](#).

3.1.2 *significant surface*—that portion of a coated article’s surface where the coating is required to meet all the requirements of the coating specification for that article. Significant surfaces are those that are essential to the serviceability or function of the article, or which can be a source of corrosion products or tarnish films that interfere with the function or desirable appearance of the article. Significant surfaces are those surfaces that are identified by the purchaser by, for example, indicating them on an engineering drawing of the product or marking a sample item of the product.

3.1.3 *undercoating*—a metallic coating layer between the basis metal or substrate and the topmost metallic coating. The thickness of an undercoating is usually greater than 0.8 μm . This is in contrast to strikes or flashes, whose thicknesses are generally lower.

4. Classifications

4.1 *Coating Grades*—Six grades of coatings, designated by service condition numbers, are covered by this specification. For each coating grade a coating thickness grade is specified (see [Tables 1-3](#)).

4.2 *Service Condition Number*—The service condition number indicates the severity of exposure for which the grade of coating is intended.

SC5—extended severe service
 SC4—very severe service
 SC3—severe service
 SC2—moderate service
 SC1—mild service
 SC0—mild service (copper and copper alloys only)

NOTE 1—Typical service conditions for which the service condition numbers are appropriate are given in [Appendix X1](#).

4.3 *Coating Thickness Notation*—The coating thickness is specified for each service condition in the following manner: Basis metal/Undercoating (thickness)/Sn-Ni (thickness). For example, Fe/Cu4/Sn-Ni25 would indicate a 25 μm tin-nickel coating over an iron or steel article with a 4- μm thick copper undercoating. All thickness notations are minimum thicknesses.

5. Ordering Information

5.1 To make the application of this standard complete, the purchaser needs to supply the following information to the seller in the purchase order or other government documents.

- 5.1.1 The name, designation, and date of issue of this standard,
- 5.1.2 Location of significant surface(s) (see section [3.1.2](#)),
- 5.1.3 The service number or coating thickness notation (see [4.2](#) and [4.3](#)),
- 5.1.4 Undercoating, if required (see [6.2](#) and [Tables 1-3](#)),
- 5.1.5 Any requirement for submission of sample coated articles (see [7.2.1](#)),
- 5.1.6 Whether or not location of rack marks is to be defined (see [7.2.1](#)),
- 5.1.7 Any requirement for porosity testing and the criteria for acceptance (see [7.5.2](#)),
- 5.1.8 Heat treatment for stress relief, whether it has been performed by the purchaser, or is required (see [7.6](#)),
- 5.1.9 Heat treatment after electroplating, if required (see [7.7](#)),
- 5.1.10 Any packaging requirement (see section [7.8](#)),

TABLE 1 Tin-Nickel Coatings on Steel

Service Condition Number		Thickness Notation	Minimum Thickness, μm
5	Fe/Cu ^A /Sn-Ni	as specified ^B (above 45)	as specified ^B (above 45)
4	Fe/Cu ^A /Sn-Ni	45	45
3	Fe/Cu ^A /Sn-Ni	25	25
2	Fe/Sn-Ni	15	15
1	Fe/Sn-Ni	8	8

^A Copper undercoat shall be at least 4.0 μm .

^B Thickness of Sn-Ni shall be stated in a Thickness Notation. A statement of Service Condition 5 is not sufficient.

TABLE 2 Tin-Nickel Coatings on Copper or Copper Alloys

Service Condition Number		Thickness Notation	Minimum Thickness, μm
5	Cu/Sn-Ni ^A	as specified ^B (above 45)	as specified ^B (above 45)
4	Cu/Sn-Ni ^A	45	45
3	Cu/Sn-Ni ^A	25	25
2	Cu/Sn-Ni ^A	15	15
0	Cu/Sn-Ni ^A	4	4

^A An undercoating of copper 4.0 μm thick shall be applied on copper-zinc alloys to serve as a zinc diffusion barrier.

^B Thickness of Sn-Ni shall be stated in a Thickness Notation. A statement of Service Condition 5 is not sufficient.

TABLE 3 Tin-Nickel Coatings on Zinc Alloys

Service Condition Number		Thickness Notation	Minimum Thickness, μm
4	Zn/Cu ^A /Sn-Ni	45	45
3	Zn/Cu ^A /Sn-Ni	25	25
2	Zn/Cu ^A /Sn-Ni	15	15
1	Zn/Cu ^A /Sn-Ni	8	8

^A An undercoating of copper 4.0 μm thick shall be applied to prevent zinc from contaminating the Sn-Ni plating bath and to serve as a diffusion barrier.

- 5.1.11 Inspection procedure to be used (see Section 9),
- 5.1.12 Any requirement for certification (see Section 11), and
- 5.1.13 Any requirement for test specimens (see 8.1.1).

6. Material and Process

6.1 *Composition of Coating*—Electrolytes that have been investigated for producing Sn-Ni alloy deposits include cyanide, fluoborate, pyrophosphate, and acetate, but the only one in general commercial use is the fluoride-chloride formulation.³ The deposit contains $35 \pm 5\%$ nickel with the remainder tin (see Note 2).

NOTE 2—The electrodeposited tin-nickel coating is a single-phase, metastable compound, corresponding approximately to the formula SnNi. It is stable at ordinary temperatures but starts to recrystallize at elevated temperatures. The safe working temperature of the coating is 300°C, although actual melting does not commence below 800°C. The coating is hard (700HV100). Like many such compounds, it is inherently somewhat brittle, but if it is free of internal stresses, the brittleness is not sufficient to impair its serviceability or to cause the coating to flake under impact. Because of the brittleness of the tin-nickel, however, it is not possible to fabricate parts by bending coated sheet material, because the compressive stresses in the coating on the inside of the bend usually cause some of the coating to flake off. To provide serviceability, the coating must be deposited in a stress-free condition. In addition, it is generally inadvisable to specify tin-nickel finish for parts subject to deformation in service.

6.2 *Basis Metal*—Tin-nickel can be deposited directly on steel, copper, and copper-base alloys. However, an undercoating of copper can improve performance in some systems and shall be used under the following conditions:

- 6.2.1 On steel, a copper undercoating with a minimum thickness of 4 μm , shall be used for Service Conditions 3, 4, and 5.
- 6.2.2 On copper-zinc alloys, a copper undercoating with a minimum thickness of 4 μm shall be used for all service conditions to prevent diffusion of the zinc.
- 6.2.3 Zinc-base alloys shall have an undercoating of a minimum of 4 μm of copper to prevent diffusion of the zinc into the deposit and to prevent contamination of the electrolyte with zinc.

NOTE 3—Tin-nickel-coated zinc-alloy diecastings shall never be returned for remelting to prevent contamination of the zinc alloy with tin.

7. Coating Requirements

7.1 *Composition of Coating*—The deposit shall contain $65 \pm 5\%$ tin, the balance nickel.

7.2 *Appearance*:

7.2.1 The coating on all readily visible surfaces shall be smooth, fine grained, continuous, adherent, free of visible blisters, pits, nodules, indications of burning, excessive buildup, staining, and other defects. All tin-nickel coated articles shall be clean and undamaged. When necessary, preliminary samples showing the finish shall be supplied for approval. Where a rack contact mark is unavoidable, its location shall be indicated on the article or its drawing.

³ Lowenheim, F. A., *Electroplating*, McGraw-Hill Inc., 1978.