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.

Designation: B999 – 15 (Reapproved 2022)

Standard Specification for Titanium and Titanium Alloys Plating, Electrodeposited Coatings of Titanium and Titanium Alloys on Conductive and Non-Conductive Substrate[1]

This standard is issued under the fixed designation B999; 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 coatings of titanium and titanium-zirconium alloys on conductive and non-conductive substrates for engineering (functional) uses. The coatings of titanium-zirconium alloys are those that range in zirconium between 10wt% and 14wt% zirconium and are known as "terne" metallic electrodeposits.

1.2 This specification applies for both conductive (metallic) substrates and non-conductive (plastics, fibers, carbon foam, etc.)

1.3 Electrodeposits of titanium and titanium-zirconium alloys on aluminum and conductive substrate and nonconductive substrate are produced where it is desired to obtain atmospheric corrosion resistance. Deposits of titanium and titanium-zirconium alloys particularly on aluminum have shown to have excellent corrosion protective qualities in atmospheric exposure, especially when under-coated by electroless nickel. Titanium and titanium-zirconium alloy deposits provide corrosion protection from dilute sulfuric acid, are used for lining of brine refrigeration tanks, chemical equipment apparatus, storage batteries, and as a wear coating for bearing surfaces.

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

1.5 *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.*

1.6 *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
B253 Guide for Preparation of Aluminum Alloys for Electroplating
B320 Practice for Preparation of Iron Castings for Electroplating
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 Guide for Attribute Sampling of Metallic and Inorganic Coatings
B697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings

[1] This specification is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.03 on Engineering Coatings.

Current edition approved May 1, 2022. Published June 2022. Originally approved in 2015. Last previous edition approved in 2015 as B999 – 15. DOI: 10.1520/B0999-15R22.

[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.

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B727 Practice for Preparation of Plastics Materials for Electroplating
B733 Specification for Autocatalytic (Electroless) Nickel-Phosphorus Coatings on Metal
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
B851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Autocatalytic Nickel, or Chromium Plating, or as Final Finish
D2982 Test Methods for Detecting Glycol-Base Antifreeze in Used Lubricating Oils
D3359 Test Methods for Rating Adhesion by Tape Test
D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
E127 Practice for Fabrication and Control of Flat Bottomed Hole Ultrasonic Standard Reference Blocks
F519 Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

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 classification system provides for a scheme to select a titanium or titanium alloy coating to meet specific performance requirements based on alloy composition and thickness.

4.1.1 "Type" describes the general composition of the deposit with respect to zirconium alloying content and is divided into two categories which establish deposit properties (see Table 1).

4.2 *Service Condition Based on Thickness:*

4.2.1 Service condition numbers are based on the severity of the exposure in which the coating is intended to perform and minimum coating thickness to provide satisfactory performance (see Table 2).

4.2.2 *SC0 Minimum Service, 1 μm*—This is defined by a minimum coating thickness to provide specific material properties and extend the life of a part or its function. Applications include requirements for diffusion barrier, undercoat, electrical conductivity, and wear and corrosion protection in specialized environment.

4.2.3 *SC1 Light Service, 2.5 μm*—This is defined by a minimum coating thickness of 2.5 μm for extending the life of the parts. Typical environments include light-load lubricated wear and indoor corrosion protection to prevent rusting.

TABLE 1 Deposit Compositions by Type

Type	Zirconium % wt
Type I	0 %
Type II	10 to 14%

TABLE 2 Service Conditions and Coating Thickness Requirements

Service Conditions	Minimum Coating Thickness Specification	Coating Thickness, μm	cm
SC0	Minimum Thickness	1.0	0.000102
SC1	Light Service	2.50	0.000254
SC2	Mild/Moderate Service	3.75	0.000381
SC3	Severe Service	5.0	0.000508

4.2.4 *SC2 Mild/Moderate Service 3.75 μm*—This is defined by mild corrosion and wear environment and moderate environment such a non-marine outdoor exposure, alkali salts at elevated temperature, and moderate wear.

4.2.5 *SC3 Severe Service 5.0 μm*—This is defined by a very aggressive environment. Typical environments would include acid solution, elevated temperature and pressure hydrogen sulfide and carbon dioxide oil service, high temperature chloride systems, very severe wear, and marine immersion.

5. Ordering Information

5.1 The following information shall be supplied by the purchaser in either the purchase order or on the engineering drawing, or the part to be plated.

5.1.1 Title, ASTM designation number, and year of issue of this specification.

5.1.2 Classification of the deposit by type and service condition.

5.1.3 Maximum dimension and tolerance requirements, if any.

5.1.4 Peening, if required.

5.1.5 The tensile strength of ferrous base materials in MPa.

5.1.6 Stress relief heat treat requirements before plating, if any.

5.1.7 Hydrogen embrittlement relief baking requirements after plating, if any.

5.1.8 Significant surfaces for plating as well as drawing indications of surfaces not to be plated.

5.1.9 Requirements for sampling.

6. Materials and Manufacture

6.1 *Substrate*—Defects in the surface of the basis metal such as scratches, porosity, pits, inclusions, roll and die marks, laps, cracks, burrs, cold shuts, and roughness may adversely affect the appearance and performance of the deposit, despite the observance of the best plating practice. Any such defects on significant surfaces shall be brought to the attention of the purchaser before plating. The producer shall not be responsible for coating defects resulting from surface conditions of the metal, if these conditions have been brought to the attention of the purchaser.

6.2 *Pretreatment*—A suitable method shall activate the base material surface and remove oxide and foreign materials, which may cause poor adhesion. See Practices B183, B242, B253, B320, B322, and B727.

6.3 *Stress Relief:*

6.3.1 *Pretreatment of Iron and Steel for Reducing the Risk of Hydrogen Embrittlement*—Parts that are made of steel with ultimate tensile strength (UTS) of 1000 MPa or greater, that