



Designation: B700 – 20

# Standard Specification for Electrodeposited Coatings of Silver for Engineering Use<sup>1</sup>

This standard is issued under the fixed designation B700; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers requirements for electrodeposited coatings of silver used for engineering purposes that may be matt, bright, or semibright and are not less than 98 % silver purity.

1.2 Coatings of silver covered by this specification are usually employed for solderable surfaces, electrical contact characteristics, high electrical and thermal conductivity, thermocompression bonding, wear resistance of load-bearing surfaces, and spectral reflectivity.

1.3 In the Appendixes, important characteristics of electrodeposited silver coatings are briefly described which must be considered when used in engineering applications, namely electrical conductivity (see [Appendix X1](#)), silver migration (see [Appendix X2](#)), thickness (see [Appendix X3](#)), hardness (see [Appendix X4](#)), and atmospheric tarnish (see [Appendix X5](#)).

1.4 The following hazard caveat pertains only to the test methods section 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, 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.*

## 2. Referenced Documents

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

<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 B08.04 on Precious Metal Coatings.

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<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.

- [B183 Practice for Preparation of Low-Carbon Steel for Electroplating](#)
- [B242 Guide for Preparation of High-Carbon Steel for Electroplating](#)
- [B252 Guide for Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings](#)
- [B253 Guide for Preparation of Aluminum Alloys for Electroplating](#)
- [B254 Practice for Preparation of and Electroplating on Stainless Steel](#)
- [B281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings](#)
- [B322 Guide for Cleaning Metals Prior to Electroplating](#)
- [B343 Practice for Preparation of Nickel for Electroplating with Nickel](#)
- [B374 Terminology Relating to Electroplating](#)
- [B481 Practice for Preparation of Titanium and Titanium Alloys for Electroplating](#)
- [B482 Practice for Preparation of Tungsten and Tungsten Alloys for 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](#)
- [B542 Terminology Relating to Electrical Contacts and Their Use](#)
- [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](#)
- [B578 Test Method for Microhardness of Electroplated Coatings](#)
- [B579 Specification for Electrodeposited Coatings of Tin-Lead Alloy \(Solder Plate\)](#)
- [B602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings](#)

- [B678 Test Method for Solderability of Metallic-Coated Products](#)
- [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](#)
- [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](#)
- [E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic \(Eddy Current\) Method](#)
- [F519 Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments](#)

2.2 *ANSI/ASQ Standard*:<sup>3</sup>

[ANSI/ASQ Z1.4 Sampling Procedures And Tables For Inspection By Attributes](#)

### 3. Terminology

3.1 *Definitions*—Many of the terms used in this specification are defined in Terminologies [B374](#) or [B542](#).

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *rack-plating, n*—an electrodeposition process in which articles to be coated are mounted on racks or other fixtures during the process.

3.2.2 *significant surfaces, n*—surfaces that are normally visible, directly or by reflection, or that are essential to the serviceability or function of the article or which can be the source of corrosion products or tarnish films that interfere with the function or desirable appearances of the article.

3.2.2.1 *Discussion*—When necessary, the significant surfaces shall be indicated on the drawings of the parts, or by the provisions of suitably marked samples.

3.2.2.2 *Discussion*—Variation in the coating thickness from point-to-point on a coated article is an inherent characteristic of electroplating processes. Therefore, the coating thickness will have to exceed the specified value at some points on the significant surfaces to ensure that the thickness equals or exceeds the specified value at all points. The average coating thickness on the article usually will be greater than that specified; how much greater is largely determined by the shape of the article (see Practice [B507](#)) and the characteristics of the electroplating process. Additionally, the average coating thickness on an article will vary from article to article within a production lot. If all the articles in a production lot are to meet the thickness requirement, the average coating thickness of a production lot as a whole will be greater than the average necessary to ensure that a single article meets requirements.

3.2.3 *strike or flash, n*—a thin, typically less than 0.25 μm (10 μ-in.) metallic coating layer between metallic coatings to improve adhesion.

3.2.4 *underplating, v*—an application of a metallic coating layer between the basis metal or substrate and the topmost metallic coating or coatings (see [6.3.4](#)).

### 4. Classification

4.1 Electrodeposited coatings of silver shall be classified for *Type* based on minimum purity; *Grade*, whether bright, semibright, or matt; *Class*, if supplementary surface treatment is applied; and thickness in micrometers.

4.2 *Purity*—Specify by *Type* as follows:

*Type 1*—99.9 % min

*Type 2*—99.0 % min

*Type 3*—98.0 % min

NOTE 1—Metallic or organic brighteners used for grain refinement may be present in the electrodeposit so long as they do not interfere with the stated function of the coating and are acceptable to the purchaser (see [Appendix X1](#)).

4.3 *Surface Appearance*—Specify by *Grade* in letter code as follows:

*Grade A, Matt*—Electrodeposits without luster, obtained from electroplating solutions operated without the use of brighteners.

*Grade B, Bright*—Electrodeposits obtained by the use of brighteners in the electroplating bath.

*Grade C, Bright*—Electrodeposits obtained by mechanical or chemical polishing of *Grade A* silver coatings.

*Grade D, Semibright*—Semi-lustrous electrodeposits obtained by the use of addition agents in the electroplating bath.

4.4 *Supplementary Surface Treatment*—Specify by *Class* in letter code as follows (see [Appendix X5](#)):

*Class N*—A silver finish that has had no supplementary tarnish resistant treatment.

*Class S*—A silver finish that has had a supplementary chromate treatment to resist tarnishing.

*Class T*—A silver finish that has had a supplementary non-chromate treatment to resist tarnishing.

### 5. Ordering Information

5.1 To make application of this standard complete, the purchaser needs to supply the following information to the seller in the purchase order or other governing document:

5.1.1 Name, designation, and year of issue of this standard.

5.1.2 Type (see [4.2](#)), Grade (see [4.3](#)), Class (see [4.4](#)) and Thickness (see [6.6](#) and [Appendix X3](#)).

5.1.3 *Nature of Substrate*—If, for example, it is high strength steel, the need for stress relief (see [6.3.2.1](#)) and embrittlement relief (see [6.3.5.1](#)). If it is copper, an undercoat is needed (see [S1.3](#)) for some applications.

5.1.4 *Significant Surfaces* (see section [3.2.2](#)).

5.1.5 *Appearance* (see [6.7](#)).

5.1.6 *Underplates* (see [6.3.4](#) and [S1.3](#)).

5.1.7 Requirements and methods of testing for one or more of the following: need for and type of test specimens (see [8.1](#)), thickness (see [6.6](#), [8.2](#), and [Appendix X3](#)), adhesion (see [6.8](#) and [8.3](#)), hardness (see [6.10.1](#) and [8.7](#)), absence of embrittlement (see [8.4](#)), solderability (see [6.9](#) and [8.5](#)), spectral reflectance (see [6.10.2](#) and [8.8](#)), or electrical conductivity (see [6.10.3](#) and [8.9](#)).

<sup>3</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

5.1.8 *Sampling Plans and Quality Assurance* (see Section 7 and S1.2).

## 6. Coating Requirements

6.1 *Nature of Coating*—The coating essentially shall be silver, considering the type specified, produced by electrodeposition from aqueous electrolytes.

6.2 *Purity of Coating*—The coating shall meet the chemical composition requirements of the specified type as defined in 4.2 and measured as described in 8.6.

### 6.3 *Process:*

6.3.1 The basis metal shall be subjected to such cleaning procedures as are necessary to ensure a surface satisfactory for subsequent electroplating. Materials used for cleaning shall have no damaging effects on the basis metal resulting in pits, intergranular attack, stress corrosion cracking, or hydrogen embrittlement.

NOTE 2—For basis metal preparations, the following appropriate ASTM standards are recommended: Practices B183, B254, B281, B343, B481, and B482, and Guides B242, B252, B253, and B322.

6.3.2 *Preplating Operations*—Electroplating shall be applied after all basis metal heat treatments and mechanical operations such as forming, machining, and joining of the article have been completed.

NOTE 3—Silver deposits may be used to facilitate mechanical operations such as forming and drawing. In these applications, silver is applied before such process steps.

6.3.2.1 *Stress Relief Treatment*—Parts that are made of steels with ultimate tensile strength of 1000 MPa or over (hardness of 31 HRC or greater) that have been machined, ground, cold-formed, or cold-straightened subsequent to heat treatment, may require stress relief heat treatment when specified by the purchaser, the tensile strength to be supplied by the purchaser. Specification B849 may be consulted for a list of pretreatments that are used widely.

6.3.3 *Strike*—The final silver coating shall be preceded by a silver or gold strike for optimum adhesion.

6.3.4 *Underplating*—A nickel or nickel-alloy intermediate layer, at least 1  $\mu\text{m}$  (39  $\mu\text{-in.}$ ) thick, shall be applied before the silver electroplate when the product being plated is made from copper or copper alloy. Nickel underplatings are also applied for other reasons.

### 6.3.5 *Post-Plating Procedures:*

6.3.5.1 *Embrittlement Relief*—Parts that are made of steels with ultimate tensile strength of 100 MPa or over (hardness of 31 HRC or greater), as well as surface-hardened parts, may require post-coating hydrogen embrittlement relief baking when specified by the purchaser, the tensile strength to be supplied by the purchaser. Guide B850 may be consulted for a list of post-treatments that are used widely.

6.4 *Surface Appearance*—The coating's surface finish shall meet the requirements of the specified grade defined in 4.3.

6.5 *Supplementary Post Treatment*—The coating shall meet the requirements of the specified class defined in 4.4.

6.6 *Thickness*—The silver coating thickness on significant surfaces shall be at least that specified (see Appendix X3) when measured as described in 8.2.

6.7 *Appearance*—Silver electroplated coated articles shall be covered completely on all surfaces as specified in the manufacturing document and shall have a uniform appearance with no visible defects to the extent that the nature of the basis metal and good commercial practice permit. The requirement for uniform color or appearance need not apply for subsequent passivation or other treatments of the silver.

6.7.1 *Defects*—Defects in the surface of the basis metal such as scratches, pits, non-conducting inclusions, and roll and die marks may adversely affect the appearance and performance of applied coatings. Such defects that persists in the finish despite the observance of good metal finishing practices shall not be cause for rejection.

NOTE 4—Coated finishes generally perform better in service when the substrate over which they are applied is smooth and free from torn metal, inclusions, pores, and other defects. It is recommended that the specifications covering the unfinished product provide limits for those defects. A metal finisher often can remove defects by means of special treatments such as grinding, polishing, abrasive blasting, chemical treatments, and electropolishing. However, these are not normal for the treatment steps preceding application of the finish. When they are desired, they are the subject of special agreement between the purchaser and the supplier.

6.8 *Adhesion*—The silver coatings shall be free of blisters and peeled areas indicating poor adhesion when tested in accordance with 8.3.

NOTE 5—Some applications may require no separation by any mechanical means such as machining or milling through the interface.

6.9 *Solderability*—The silver plated surfaces shall produce solder coatings which shall be bright, smooth, and uniform. At least 95 % of the sample surface shall show good wetting when tested as described in 8.5.

### 6.10 *Supplementary Requirements:* astm-b700-20

6.10.1 *Hardness*—If a hardness requirement is specified, the hardness of the silver coatings shall conform to that specified as measured as described in 8.7.

6.10.2 *Spectral Reflectance*—The spectral reflectance of the silver coatings, if required, shall conform to that specified when measured as described in 8.8.

6.10.3 *Electrical Conductivity*—The electrical conductivity of the silver coatings, if required, shall conform to that specified when measured as described in 8.9.

## 7. Sampling

7.1 A random sample of the size required by Test Method B602 or Test Method B762 shall be selected from the inspection lot (see 7.2). The articles in the lot shall be classified as conforming or nonconforming to each requirement according to the criteria of the sampling plans in the chosen method.

NOTE 6—Test Method B602 contains four sampling plans, three for use with nondestructive test methods; the fourth is for use 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. It is recommended that the purchaser compare the plans with his 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



which provides a large number of plans and also gives guidance in the choice of a plan. When Guide **B697** is specified, the buyer and seller need to agree on the plan to be used.

**NOTE 7**—Test Method **B762** is a variables sampling plan. Such plans can only be used when a test yields a measured quantity, such as thickness, and when the requirements are stated as a numerical unit also such as thickness. Test Method **B762** contains several plans for special needs. Buyer and seller may agree on the plan or plans to be used; if not, Test Method **B762** identifies the plan to be used.

**NOTE 8**—When both destructive and nondestructive tests exist for the measurement of a characteristic, the purchaser needs to state which is to be used so the proper sampling plan is selected. Whether or not a test is destructive may not always be clear. A test may destroy the coating but in a noncritical area. The purchaser needs to state whether the test is to be considered destructive or nondestructive. The decision is important because the plans for destructive tests are significantly less able to discriminate between acceptable and unacceptable lots. This is because fewer parts are tested.

7.2 An inspection lot shall be defined as a collection of coated articles that are of the same kind, that have been produced to the same specifications, that have been coated by a single supplier at one time or approximately the same time under essentially identical conditions, and that are submitted for acceptance or rejection as a group.

7.3 If special test specimens are used to represent the coated articles in a test, the specimens shall be of the nature, size, and number and shall be processed as required in **8.1**.

## 8. Test Methods

### 8.1 *Special Test Specimens:*

8.1.1 Special test specimens are used to represent the coated articles in a test if the articles are of a shape, size, or material that is not suitable for the test, or if it is preferred not to submit samples to a destructive test because, for example, they are expensive or few in number. The permission or requirement to use special test specimens, their number, the material they are to be made of, and their size and shape shall be stated by the purchaser.

8.1.2 The special test specimen shall duplicate those characteristics of the article that influence the property being tested; and it shall be processed with the article through those process steps that influence the property.

8.1.3 The special test specimens used to represent an article in an adhesion, solderability, or appearance test shall be made of the same material, shall be in the same metallurgical condition, and shall have the same surface condition as the articles they represent. They shall be placed in the production lot of, and be processed along with, the articles they represent.

8.1.4 Special test specimens used to represent an article in a coating thickness test shall be introduced into the process at the point where the coatings are applied and shall be carried through all the steps that have a bearing on the coating thickness.

**NOTE 9**—When special test specimens are used to represent a coated article in a thickness test, the specimens will not necessarily have the same thickness and thickness distribution as the article, unless the specimens and the articles are of the same general size and shape. Therefore, before coated articles may be accepted on the basis of a thickness test performed on test specimens, the relationship between the thickness on special test specimens and the thickness on the part needs to be established. The criterion of acceptance is that the thickness on the specimen corresponds to the required thickness on the articles.

8.2 *Thickness*—The coating thickness shall be measured at locations on significant surfaces where it would be expected to be a minimum either nondestructively or destructively:

8.2.1 *Nondestructive*—Measure thickness of silver coatings by beta backscatter (Test Method **B567**), by X-ray spectrometry (Test Method **B568**), or by the magnetic method (Test Method **B499**).

8.2.2 *Destructive*—Measure thickness of silver coatings by the coulometric technique (Test Method **B504**) or by microscopical cross-sectioning procedures (Test Method **B487**).

8.3 *Adhesion*—Determine adhesion qualitatively with one of the procedures given in Practice **B571**. Other procedures, such as machining milling or shot peening, may prove more appropriate in special cases.

8.4 *Hydrogen Embrittlement Relief*—Steel products that are required as described in **6.3.5.1** to be heat treated to remove hydrogen embrittlement shall be evaluated as directed by Test Method **F519** as a means of evaluating the process, using special test specimens (see **8.1**).

8.5 *Solderability*—Determine solderability qualitatively by Test Method **B678**.

**NOTE 10**—Other useful tests may be found in Specification **B579**.

8.6 *Purity of Coating*—Obtain the composition of the silver coating by determining the impurities (that is silver by difference) by emission spectroscopy, X-ray fluorescence, atomic absorption, or other methods capable of determining quantities of 0.01 mass % or less.

8.7 *Hardness*—Measure low load microhardness in accordance with Test Method **B578** (see **Appendix X4**).

8.8 *Specular Reflectance*—Measure reflectance in the spectral region of  $0.60 \pm 0.05 \mu\text{m}$  on a coated surface using a device suitable for determinations at an angle of  $45^\circ$  employing a narrow acceptance angle (suited for mirror finishes).

8.9 *Electrical Conductivity*—Measure electrical conductivity by Test Method **E1004** using separate test specimens.

## 9. Packaging

9.1 Some packaging materials may emit fumes that can be deleterious to the appearance or performance, or both, of electroplated silver surfaces. Useful guidelines for commercial packaging can be found in Practice **D3951**.

## 10. Special Government Requirements

10.1 The following special requirements shall apply when the ultimate purchaser is the U.S. Government or an agent of the U.S. Government.

10.1.1 *Sampling*—For government acceptance the sampling plan is to be in accordance with ANSI/ASQC Z1.4.

10.1.2 *Quality Assurance:*

10.1.2.1 *Inspection Responsibility*—The producer or supplier shall be responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract or order, the producer or supplier may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the