



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

This standard is issued under the fixed designation B 634; 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.

<sup>ε1</sup> NOTE—Keywords were added editorially in April 2004.

## 1. Scope

1.1 This specification covers requirements for electrodeposited coatings of rhodium used for engineering purposes.

1.2 Coatings of rhodium covered by this specification are usually employed for their corrosion resistance, stable electrical contact resistance, wear resistance, reflectivity, and heat resistance.

1.3 Appendix X1 covers some typical applications for electrodeposited rhodium.

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 The following documents form a part of this document to the extent referenced herein.

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

- B 183 Practice for Preparation of Low-Carbon Steel for Electroplating
- B 242 Practice for Preparation of High-Carbon Steel for Electroplating
- B 252 Guide for Preparation of Zinc Alloy Die Castings for Electroplating and Conversion Coatings
- B 254 Practice for Preparation of and Electroplating on Stainless Steel
- B 281 Practice for Preparation of Copper and Copper-Base Alloys for Electroplating and Conversion Coatings
- B 322 Practice for Cleaning Metals Prior to Electroplating
- B 343 Practice for Preparation of Nickel for Electroplating with Nickel

- B 456 Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium
  - B 481 Practice for Preparation of Titanium and Titanium Alloys for Electroplating
  - B 482 Practice for Preparation of Tungsten and Tungsten Alloys for Electroplating
  - B 487 Test Method for Measurement of Metal and Oxide Coating Thicknesses by Microscopical Examination of a Cross Section
  - B 507 Practice for Design of Articles to Be Electroplated on Racks
  - B 567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method
  - B 568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry
  - B 571 Practice for Qualitative Adhesion Testing of Metallic Coatings
  - B 602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
  - B 697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings
  - B 762 Test Method of Variables Sampling of Metallic and Inorganic Coatings
  - E 8 Test Methods of Tension Testing of Metallic Materials
- ### 2.3 Military Standards:
- MIL-R-46085 Rhodium Plating, Electrodeposited<sup>3</sup>
  - QQ-N-290 Nickel Plating, Electrodeposited<sup>3</sup>

## 3. Classification

3.1 Electrodeposited coatings of rhodium on the basis of thickness are classified as follows:

Class	Minimum Thickness, μm
0.05	0.05
0.25	0.25
0.5	0.5
1	1
2.5	2.5

<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 B08.08.02 on Precious Metal Coatings.

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<sup>2</sup> 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.

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



#### 4. Ordering Information

4.1 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:

4.1.1 Name, designation, and year of issue of this standard,

4.1.2 Class including a maximum thickness, if appropriate (3.1),

4.1.3 Nature of substrate, for example, high strength steel, need for stress relief, undercoats, embrittlement relief (5.1, 5.2, 5.3),

4.1.4 Significant surfaces (6.2),

4.1.5 Appearance (6.3),

4.1.6 Requirements and methods of testing for one or more of the following requirements: need for and type of test specimens (8.1); thickness (8.2); adhesion (8.3); absence of embrittlement (8.4); reflectivity (8.5); and undercoats (S1.4), and

4.1.7 Sampling plans (Section 7) and quality assurance (S1.2).

#### 5. Process Requirements

5.1 *Preparatory Procedures*—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 1—For basis metal preparations, the following appropriate ASTM standards are recommended: Practices B 183, B 242, B 252, B 254, B 281, B 322, B 343, B 481, and B 482.

##### 5.2 *Preplating Operations*:

5.2.1 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.

5.2.2 *Stress Relief Treatment*—All steel parts having an ultimate tensile strength of 1050 MPa (approximately 35 HRC) and above and that have been machined, ground, cold formed, or cold straightened shall have heat treatment to  $190 \pm 15^\circ\text{C}$  for a minimum of 5 h before cleaning and electroplating.

##### 5.3 *Post-Plating Procedures*:

5.3.1 *Embrittlement Relief*—Steel parts having an ultimate tensile strength of 1200 MPa (approximately 38 HRC) or greater shall be baked at  $190 \pm 15^\circ\text{C}$  for a minimum of 8 h within 4 h after electroplating to provide hydrogen embrittlement relief. Steel parts having an ultimate tensile strength greater than 1300 MPa (approximately 40 HRC) shall be baked at  $190 \pm 15^\circ\text{C}$  for a minimum of 23 h within 4 h after electroplating.

#### 6. Coating Requirements

6.1 *Nature of Coating*—The coating shall be essentially pure rhodium produced by electrodeposition from aqueous electrolytes.

6.2 *Thickness*—The rhodium coating thickness on all significant surfaces shall conform to the requirements of the specified class as defined in Section 3.

6.3 *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 which 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 2—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. Therefore, the average coating thickness on an article will usually be greater than the specified value; how much greater is largely determined by the shape of the article (see Practice B 507) 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 of the articles in a production lot are to meet the thickness requirement, the average coating thickness of the production lot as a whole will be greater than the average necessary to ensure that a single article meets the requirements.

##### 6.4 *Appearance*:

6.4.1 Electroplated coatings shall completely cover all surfaces as specified in the manufacturing document and shall have a uniform appearance to the extent that the nature of the basis metal and good commercial practices permit.

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

NOTE 3—Applied 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 through special treatments such as grinding, polishing, abrasive blasting, chemical treatments, and electropolishing. However, these are not normal in the treatment steps preceding the application of the finish. When they are desired, they are the subject of special agreement between the purchaser and the supplier.

6.5 *Adhesion*—The rhodium coatings shall be free of blisters and peeled areas when tested in accordance with 8.3.

#### 7. Sampling

7.1 A random sample of the size required by Test Methods B 602 or B 762 shall be selected from the inspection lot (see 7.2). 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 B 602.

NOTE 4—Test Method B 602 contains four sampling plans, three for use with nondestructive test methods. The fourth is 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 B 602 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 B 602 do not serve the needs, additional ones are

given in Guide B 697 which provides a large number of plans and also gives guidance in the selection of a plan. When Guide B 697 is specified, the buyer and seller need to agree on the plan to be used.

NOTE 5—Test Method B 762 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 limit also such as thickness. Test Method B 762 contains several plans and gives instructions for calculating plans for special needs. Buyer and seller may agree on the plan or plans to be used; if not Test Method B 762 identifies the plan to be used.

NOTE 6—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. 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 at 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 accordance with 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 size, shape, or material that is not suitable for the test, or if it is preferred not to submit articles to a destructive test because, for example, the articles are expensive or few in number. The permission or the requirement to use special test specimens, their number, the material from which they are to be made, and their shape and size 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.

8.1.2.1 The special test specimens used to represent an article in an adhesion, corrosion resistance, 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.

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

NOTE 7—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 article 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 thickness on the specimen that corresponds to the required thickness on the article.

### 8.2 *Thickness:*

8.2.1 The coating thickness shall be measured at locations on the significant surfaces where it would be expected to be a minimum.

8.2.2 Use Test Method B 567 for beta backscatter or Test Method B 568 for X-ray fluorescence (as applicable) for nondestructive methods.

8.2.3 Rhodium thickness can be measured destructively by Method B 487 for microscopical cross sectioning. This method shall not be used for thicknesses less than 2.5  $\mu\text{m}$ .

8.3 *Adhesion*—Determine adhesion in accordance with one of the procedures given in Practice B 571, Bend Tests and Heat Quench Test.

### 8.4 *Hydrogen Embrittlement Relief:*

8.4.1 Steel products that are required by 5.3 to be heat treated to remove hydrogen embrittlement shall be subjected for  $200 \pm 8$  h to a sustained tensile load equal to  $75 \pm 2\%$  of the ultimate tensile notch strength of the material. If the product fractures during the test or is found, when examined after the test, to have cracks, it does not conform to the requirement for hydrogen embrittlement relief.

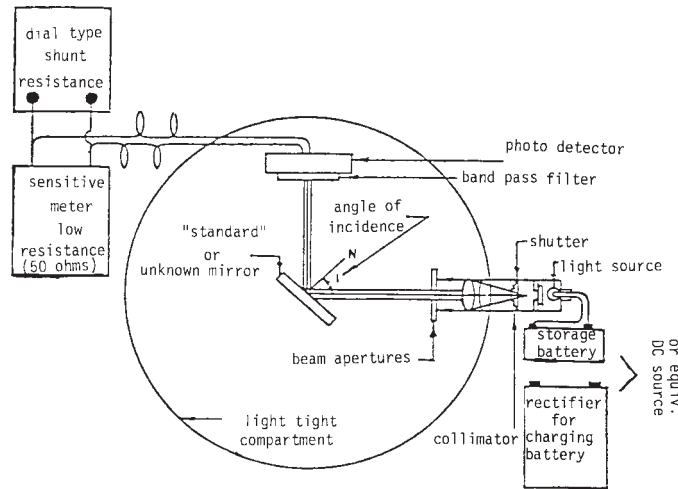
8.4.2 Separate specimens for embrittlement relief test may be used. If they are used, they shall be round notched specimens with the axis of the specimen (load direction) perpendicular to the short transverse grain flow direction. The configuration shall be in accordance with the appropriate figure for round specimens of Test Methods E 8. Specimens shall have a  $60^\circ \pm 10^\circ$  V-notch located approximately at the center of the gage length. The cross-sectional area at the root of the vee shall be approximately equal to half the area of the full cross-sectional area of the specimen's reduced section. The vee shall have a  $254 \pm 0.013$  mm radius of curvature at the base of the notch. The separate specimens shall be of the same basis metal as that of the articles represented.

NOTE 8—The manufacturer of the basis metal parts should provide the coating facility with notched tensile specimens when required for testing.

8.5 *Reflectivity*—Measure in the spectral region of  $0.45 \pm 0.05$   $\mu\text{m}$  on a coated surface using a device comparable to that in Fig. 1 with angles of incidence and reflectance at  $45 \pm 2^\circ$ . Standard for reflectance shall be specified by the purchaser. The light source shall provide uniform energy in the spectral region with beam collimation and detector size and position to collect all the reflected energy for measurement.

## 9. Keywords

9.1 connectors; contacts; electrical connectors; electrical contacts; engineering coatings; reflectors; relays; relay switches; rhodium; rhodium coatings; rhodium electrodeposits; rhodium platings



NOTE 1—The load resistance of the photocell is reduced by meter adjustment shunt.

FIG. 1 Reflectivity Test

**SUPPLEMENTARY REQUIREMENTS**

S1.1 The following supplementary requirements shall apply only when specified by the purchaser in the contract or order and for all agencies of the U.S. Government.

S1.2 *Quality Assurance:*

S1.2.1 *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 right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to assure that material conforms to the prescribed requirements.

S1.3 *Reflectivity*—Reflectivity shall be a minimum of 75 % when measured in accordance with 8.5.

S1.4 *Undercoats*—Surfaces other than gold, platinum, or silver shall be electroplated with nickel or with copper fol-

lowed by nickel in accordance with B 456 except for the thickness requirement. Corrosion or heat resistant steels shall have a minimum of 2.5 μm of nickel or as otherwise specified by the purchaser.

NOTE S1.1—Military Standard QQ-N-290 may be consulted for reference.

S1.5 *Thickness Cross Reference Table:*


B 634 (rev.) Class (μm)	B 634 (3/31/78) Class (μm)	MIL-R-46085 Class (μm) (μin.)
0.05	...	1 (0.051) 2
...	0.2	...
0.25	...	2 (0.254) 10
0.50	0.5	3 (0.51) 20
1	1	...
...	2	...
2.5	...	4 (2.54) 100
...	4	...
6.25	5	5 (6.35) 250

**APPENDIX**

**(Nonmandatory Information)**

**X1. TYPICAL APPLICATIONS FOR ELECTRODEPOSITED RHODIUM**

Application	Thickness Requirement, μm
Reflectors, Tarnish Resistance	0.05 to 0.25
Light duty electrical contacts	0.25 to 0.80
Corrosion protection (mild)	0.25
Severe corrosion conditions	2.5
Severe wear electrical contacts	1 to 2.5
Special applications	to 6.25

 **B 634 – 88 (2004)<sup>e1</sup>**

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