Designation: B 734 – 97

Standard Specification for Electrodeposited Copper for Engineering Uses[1]

This standard is issued under the fixed designation B 734; 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 requirements for electrodeposited coatings of copper used for engineering purposes. Examples include surface hardening, heat treatment stop-off, as an underplate for other engineering coatings, for electromagnetic interferences (EMI) shielding in electronic circuitry, and in certain joining operations.

1.2 This specification is not intended for electrodeposited copper when used as a decorative finish, or as an undercoat for other decorative finishes.

1.3 This specification is not intended for electrodeposited copper when used for electroforming.

2. Referenced Documents

2.1 *ASTM Standards:*

B 183 Practice for Preparation of Low-Carbon Steel for Electroplating[2]
B 242 Practice for Preparation of High-Carbon Steel for Electroplating[2]
B 254 Practice for Preparation of and Electroplating on Stainless Steel[2]
B 320 Practice for Preparation of Iron Castings for Electroplating[2]
B 322 Practice for Cleaning Metals Prior to Electroplating[2]
B 374 Terminology Relating to Electroplating[2]
B 487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section[2]
B 499 Test Method for Measurement of Coating Thicknesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals[2]
B 504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method[2]
B 507 Practice for Design of Articles to Be Electroplated on Racks[2]
B 555 Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test[2]
B 567 Test Method for Measurement of Coating Thickness by the Beta Backscatter Method[2]
B 568 Test Method for Measurement of Coating Thickness by X-Ray Spectrometry[2]
B 571 Test Methods for Adhesion of Metallic Coatings[2]
B 588 Test Method for Measurement of Thickness of Transparent or Opaque Coatings by Double-Beam Interference Microscope Technique[2]
B 602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings[2]
B 659 Guide for Measuring Thickness of Metallic and Inorganic Coatings[2]
B 678 Test Method for Solderability of Metallic-Coated Products[2]
B 697 Guide for Selection of Sampling Plans for Inspection of Electrodeposited Metallic and Inorganic Coatings[2]
B 762 Method of Variables Sampling of Metallic and Inorganic Coatings[2]
B 765 Guide for Selection of Porosity Tests for Electrodeposits and Related Metallic Coatings[2]
B 832 Guide for Electroforming with Nickel and Copper[2]
B 849 Specification for Pre-treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement[2]
B 850 Specification for Post-Coating Treatments of Iron or Steel for Reducing Risk of Hydrogen Embrittlement[2]
B 851 Specification for Automated Controlled Shot Peening of Metallic Articles Prior to Nickel, Auto Catalytic Nickel, or Chromium Plating, or as a Final Finish[2]
D 3951 Practice for Commercial Packaging[3]
F 519 Method for Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals[2]

2.2 *Military Standard:*

MIL-R-81841 Rotary Flap Peening of Metal Parts[4]
MIL-S-13165 Shot Peening of Metal Parts[4]
MIL-W-81840 Rotary Flap Peening Wheels[4]

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *significant surfaces*—those surfaces normally visible (directly or by reflection) that are essential to the appearance or serviceability of the article when assembled in a normal position; or which can be the source of corrosion products that

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[2] *Annual Book of ASTM Standards*, Vol 02.05.

[3] *Annual Book of ASTM Standards*, Vol 15.09.

[4] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094. Attn: NPODS.

deface visible surfaces on the assembled article. When necessary, the significant surface shall be indicated on the drawing of the article, or by the provision of suitably marked samples.

NOTE 1—When significant surfaces are involved on which the specified thickness of coating cannot readily be controlled, such as threads, holes, deep recesses, and bases of angles, it will be necessary to apply thicker coatings on the more accessible surfaces, or to use special racking or both.

3.1.2 *inspection lot*—a collection of coated articles that; are of the same type; have been produced to the same specifications; have been coated by a single supplier at one time, or at approximately the same time, under essentially identical conditions; and are submitted for acceptance or rejection as a group.

3.2 *Definitions*—For definitions of the technical terms used in this specification see Terminology B 374.

4. Classification

4.1 The electrodeposited copper is classified according to thickness of the electrodeposit in the following table:

Class	Minimum Thickness, µm
25	25
20	20
12	12
5	5
x	Thickness specified

NOTE 2—For electroforming applications, that require much thicker applications, see Guide B 832.

5. Ordering Information

5.1 The buyer shall supply to the producer in the purchase order or engineering drawings; marked samples or other governing documents the following information:

5.1.1 Title, ASTM designation number (Specification B 734), and date of issue.

5.1.2 Classification or thickness of electrodeposited copper (see 4.1),

5.1.3 Significant surfaces if other than defined in 3.1.1,

5.1.4 Sampling plan (Section 7),

5.1.5 Number of test specimens for destructive testing (Section 8), and

5.1.6 Thickness, adhesion, solderability, porosity and number of pores acceptable, or hydrogen embrittlement tests and methods required (Section 8).

5.2 Where required, dimensional tolerances allowed for the specified electroplated copper thickness shall be specified.

5.3 In addition to the requirements of 5.1 and when the parts to be electroplated are supplied to the electroplater by the buyer, the buyer shall also supply the following information as required.

5.3.1 Identity of the base material by alloy identification such as ASTM, AISI, or SAE numbers, or equivalent composition information,

5.3.2 Hardness of the parts, and

5.3.3 Heat treatment for stress relief, whether it has been performed or is required.

5.4 If required by either party, the manufacturer of the parts to be electroplated shall provide the electroplating facility with separate test specimens (see section 8.1).

6. Coating Requirements

6.1 *Appearance*—The coating on the significant surfaces of the product shall be smooth and free of visual defects such as blisters, pits, roughness, cracks, flaking, burned deposits, and uncoated areas. The boundaries of electroplating that cover only a portion of the surface shall, after finishing as indicated in the drawing, be free of beads, nodules, jagged edges and other detrimental irregularities. Imperfections and variations in appearance in the coating that arise from surface conditions of the basis metal (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.

NOTE 3—Electroplated finishes generally perform better when the substrate over which they are applied is smooth and free of deep scratches, torn metal, pores, inclusions, and other defects. It is recommended that the specifications covering the unfinished product provide limits for these defects. A metal finisher can often remove defects through special treatments such as grinding, polishing, abrasive blasting, and special chemical treatments. However, these are not normal treatment steps. When they are desired, they must be agreed upon between the buyer and the producer.

6.2 *Thickness*—The thickness of the copper coating on the significant surfaces shall conform to the requirements of the specified class as defined in Section 4.

NOTE 4—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. As a result, 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. Therefore, 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.

NOTE 5—When electroplating threaded parts such as machine screws, care is required to avoid too much plate buildup on the crest of the thread. In such applications a maximum plate thickness allowable on the crests may require that thicknesses in other areas be thinner.

6.3 *Porosity*—When specified, the coating shall be sufficiently free of pores to pass the porosity test specified in 8.4.

6.4 *Solderability*—When specified, the coating shall meet the requirements of Test Method B 678.

6.5 *Pretreatment of Iron and Steel for Reducing the Risk of Hydrogen Embrittlement*—Parts for critical applications that are made of steels with ultimate tensile strengths of 1000 MPa, hardness of 31 HRC or greater, that have been machined, ground, cold formed, or cold straightened subsequent to heat treatment, shall require stress relief heat treatment when specified by the purchaser, the tensile strength to be supplied by the purchaser. Specification B 849 may be consulted for a list of pretreatments that are used widely.

6.6 *Post Coating Treatment of Iron and Steel for Reducing the Risk of Hydrogen Embrittlement*—Parts for critical applications that are made of steels with ultimate tensile strengths of 1000 MPa, hardness of 31 HRC or greater, as well as surface hardened parts, shall require post coating hydrogen embrittlement relief baking when specified by the purchaser, the tensile

strength to be supplied by the purchaser. Specification B 850 may be consulted for a list of post treatments that are used widely.

6.7 *Peening of Metal Parts*—If peening is required before electroplating to induce residual compressive stress to increase fatique strength and resistance to stress corrosion cracking of the metal parts, refer to MIL-S-13165, MIL-R-81841, MIL-W-81840, and Specification B 851.

6.8 *Supplementary Requirements:*

6.8.1 *Packaging*—If packaging requirements are to be met under this specification, they shall be in accordance with Practice D 3951, or as specified in the contract or order.

NOTE 6—**Caution:** Some contemporary packaging materials may emit fumes that are deleterious to the surface of the coating.

7. Sampling

7.1 The sampling plan used for the inspection of a quantity of the coated articles shall be as agreed upon between the purchaser and the seller.

NOTE 7—Usually, when a collection of coated articles, the inspection lot (7.2), is examined for compliance with the requirements placed on the articles, a relatively small number of the articles, the sample, is selected at random and is inspected. The inspection lot then is classified as complying or not complying with the requirements based on the results of the inspection of the sample. The size of the sample and the criteria of compliance are determined by the application of statistics. The procedure is known as sampling inspection. Three standards, Test Method B 602, Guide B 697, and Method B 762 contain sampling plans that are designed for the sampling inspection of coatings. Test Method B 602 contains four sampling plans, three for use with tests that are non-destructive and one when they are destructive. The buyer and seller may agree on the plan or plans to be used. If they do not, Test Method B 602 identifies the plan to be used. Guide B 697 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. Methods B 762 can be used only for coating requirements that have numerical limit, such as coating thickness. The test must yield a numerical value and certain statistical requirements must be met. Methods B 762 contains several plans and also gives instructions for calculating plans to meet special needs. The buyer and the seller may agree on the plan or plans to be used. If they do not, Methods B 762 identifies the plan to be used.

NOTE 8—When both destructive and non-destructive 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. A test may destroy the coating but in a non-critical area; or, although it may destroy the coating, a tested part can be reclaimed by stripping and recoating. The purchaser needs to state whether the test is to be considered destructive or non-destructive.

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 number used shall be that required in 8.1.1.

8. Test Methods

8.1 The permission or the requirement to use special test specimens, the number to be used, the material from which they are to be made, and their shape and size shall be stated by the purchaser.

NOTE 9—Test specimens often 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 specimen should duplicate the characteristics of the article that influence the property being tested.

8.1.1 Special test specimens used to represent articles in an adhesion, porosity, corrosion resistance, or appearance test shall be made of the same material, in the same metallurgical condition, and have the same surface condition as the articles they represent, and be placed in the production lot of and be processed along with the articles they represent.

8.1.2 Special test specimens used to represent articles in a coating thickness test may be made of a material that is suitable for the test method even if the represented article is not of the same material. For example, a low-carbon steel specimen may represent a brass article when the magnetic thickness test is used (Test Method B 499). The thickness specimen need not be carried through the complete process with the represented article. If not, introduce it into the process at the point where the coating is applied and carry it through all steps that have a bearing on the coating thickness. In rack plating, rack the specimen in the same way with the same distance from and orientation with the anodes and other items in the process as the article it represents.

NOTE 10—When special test specimens are used to represent coated articles in a thickness test, the specimens will not necessarily have the same thickness and thickness distribution as the articles unless the specimens and the articles are of the same general size and shape. Therefore, before finished articles can be accepted on the basis of a thickness test performed on special test specimens, the relationship between the thickness on the specimen 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*—Measure the coating thickness at locations on the significant surface designated by the purchser, and make the measurement with an accuracy of 10 % or better by use of one of the following test methods: Test Methods B 487, B 499, B 504, B 568, and B 588.

NOTE 11—Other thickness measurement methods may be used where it can be demonstrated that the uncertainty is less than 10 %.

8.3 *Adhesion*—Use one or more of the methods described in Test Methods B 571 as agreed and as specified in the purchase order or other specifying document.

8.4 *Porosity*—Conduct the ferroxyl test as described in Appendix X1. Observe the results after 5 min. The part fails if more than the number of pores per unit area specified by the purchaser is found.

8.5 *Solderability*—Conduct the test in accordance with Test Method B 678. The coating shall be deemed solderable if the solder coating is adherent, bright, smooth, and uniform over at least 95 % of the test surface.

NOTE 12—Electroplated copper surfaces become more difficult to solder as they age. It may be necessary to clean the copper surface just prior to the soldering test or soldering operation.

8.6 *Embrittlement Relief*—Parts shall be examined visually for cracks indicating embrittlement failure, or the effectiveness of the relief treatment shall be determined by a procedure specified by the purchaser.

NOTE 13—Method F 519 describes hydrogen embrittlement testing that utilizes specially machined test specimens.

9. Rejection and Rehearing

9.1 Materials that fail to conform to the requirements of this specification shall be rejected. Rejection shall be reported to the producer or the supplier promptly, and in writing. In case of dissatisfaction with the results of a test, the producer or supplier may make a claim for a rehearing. Finishes that show imperfections during subsequent manufacturing operations may be rejected.

10. Certification

10.1 The purchaser may require in the purchase order or contract that the producer or supplier give to the purchaser certification that the finish was produced and tested in accordance with this specification and found to meet the requirements. The purchaser may similarly require that a report of the test results be furnished.

APPENDIX

(Nonmandatory Information)

X1. MODIFIED FERROXYL TEST (ALSO SEE GUIDE B 765)

X1.1 General

X1.1.1 This method reveals discontinuities, such as pores, in electroplated copper on iron or steel.

NOTE X1.1—This test is slightly corrosive to copper, particularly if the test period is extended appreciably (3 min or more) beyond the 5-min period. The test is very sensitive to the superficial presence of iron, that is, blue spots can occur on an electrodeposited copper surface that has been in sufficient contact with a piece of iron to leave a trace of the iron on the copper surface.

X1.2 Materials

X1.2.1 Three solutions and strips of "wet strength" filter paper are required.

X1.2.1.1 *Solution A*, is prepared by dissolving 50 g of white gelatine and 50 g of sodium chloride in 1 L of warm (45°C) distilled water.

X1.2.1.2 *Solution B*, is prepared by dissolving 50 g of sodium chloride and 0.1 g of a non-ionic wetting agent in 1 L of distilled water.

X1.2.1.3 *Solution C*, is prepared by dissolving 10 g of potassium ferricyanide in 1 L of distilled water.

X1.3 Procedure

X1.3.1 Immerse filter paper strips in Solution *A* (which is kept sufficiently warm to keep the gelatine dissolved), then remove and allow to dry. Just before use, immerse the dry filter paper strips in Solution *B* just long enough to thoroughly wet all of the filter paper. Firmly press the filter paper against the thoroughly cleaned and degreased electroplated copper surface to be tested. Allow 5-min contact time for the test period (see Note X1.1). If the filter paper should become dry during the test, moisten again with Solution *B*. Remove the papers at the end of the contact period and place at once into Solution *C*. Sharply defined blue markings will appear on the papers indicating basis metal corrosion or porosity.

X1.4 Report

X1.4.1 The report shall include the following information:

X1.4.1.1 The area of surface tested.

X1.4.1.2 The total number and diameter of all spots on the filter paper oriented to surface area tested.

X1.4.1.3 The highest number of spots visible within a square area as defined and specified by the purchaser.