1. Scope

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

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 374 Terminology Relating to Electroplating
B 487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of a Cross Section
B 504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method
B 507 Practice for Design of Articles To Be Electroplated on Racks
B 555 Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test
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 Test Methods for Adhesion of Metallic Coatings
B 588 Test Method for Measurement of Thickness of Transparent or Opaque Coatings by Double-Beam Interference Microscope Technique
B 602 Test Method for Attribute Sampling of Metallic and Inorganic Coatings
B 659 Guide for Measuring Thickness of Metallic and Inorganic Coatings
B 678 Test Method for Solderability of Metallic-Coated Products
F 519 Method for Mechanical Hydrogen Embrittlement Testing of Plating Processes and Aircraft Maintenance Chemicals

3. Terminology

3.1 Descriptions 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 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 Definitions B 374.

4. Classification

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

<table>
<thead>
<tr>
<th>Class</th>
<th>Minimum Thickness, μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

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 Table 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 9).

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 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 2—Electroplated finishes generally perform better when the substrate over which they are applied is smooth and free of deep scratches, torn metal, 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 3—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 307) 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 requirements, 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 4—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 9.3.

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

6.5 Stress Relief Treatment—All steel parts having an ultimate tensile strength of 1000 MPa and above, and that are machined, ground, cold-formed or cold-straightened shall be heated to 190 ± 15°C for a minimum of 3 h for stress relief before cleaning and electroplating or as otherwise specified by the purchaser.

6.6 Hydrogen Embrittlement Relief—Unless otherwise specified by the purchaser, all steel parts having a hardness of Rockwell C 35 or higher (or an ultimate tensile strength of 1200 MPa or greater) shall be baked at 190 ± 15°C for a minimum of 3 h, within 4 h after electroplating. Electroplated springs or other parts subject to flexure shall not be flexed before the hydrogen embrittlement relief.

7. Sampling

7.1 A random sample of the size required by Method B 602 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 Method B 602.

NOTE 5—Method B 602 contains four sampling plans for the original inspection of coated articles. Three are to be used where the test methods are nondestructive; that is, the test method does not make the article nonconforming. The fourth plan is used where the test method is destructive. If it is not clear if the test is destructive or not, the buyer shall identify which test methods are destructive and which are nondestructive. In some instances, both nondestructive and destructive test methods may exist for the testing of the conformance of a coating to a particular requirement. The buyer should state which is to be used.

8. Test Specimens

8.1 Separate Specimens—When the coated articles are of such a form as to be not readily adaptable to a test specified herein, or when destructive tests would unreasonably reduce the number of pieces in small lots, the purchaser shall specify whether a test shall be made by the use of separate specimens electroplated concurrently with the articles represented. The separate specimens shall be of a basis metal equivalent to that of the articles represented. "Equivalent" basis metal includes chemical composition, grade, condition, and finish of surface before electroplating, that is, a cold-rolled steel surface shall not be used to represent a hot-rolled surface. These specimens shall be introduced into a lot at regular intervals before the cleaning operations preliminary to electroplating, and shall not be separated from the lot until after completion of electroplating. Conditions affecting the electroplating of specimens including the spacing and positioning with respect to anodes and to other objects being electroplated shall correspond as nearly as practicable to those affecting the significant surfaces of the articles represented.

8.2 Unless a need can be demonstrated, separately prepared specimens shall not be used in place of production items for nondestructive tests and visual examination.

9. Test Methods

9.1 Thickness—Use an appropriate method as outlined in Guide B 659. Examples of these methods are: Methods B 487, B 499, B 504, B 567, B 568, B 588, and Guide B 555.

NOTE 6—Other thickness measurement methods may be used when it can be demonstrated that the uncertainty is less than 10%.
9.2 Adhesion—Use one or more of the methods as agreed upon and as described in Test Methods B 571 and as specified on the purchase order or other specifying document.

9.3 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.

9.4 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 7—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.

9.5 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 8—Method F 519 describes hydrogen embrittlement testing that utilizes specially machined test specimens.

10. Rejection and Rehearing

10.1 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.

11. Certification

11.1 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

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 0.01 to 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.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapprroved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, 1916 Race St., Philadelphia, PA 19103.