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Standard Guide for Determining Mass Per Unit Area of Electrodeposited and Related Coatings by Gravimetric and Other Chemical Analysis Procedures[1]

This standard is issued under the fixed designation B767; 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 guide outlines a general method for determining the mass per unit area of electrodeposited, electroless, mechanically-deposited, vacuum-deposited, anodicoxide, and chemical conversion coatings by gravimetric and other chemical analysis procedures.

1.2 This guide determines the average mass per unit area over a measured area.

1.3 The stripping methods cited are described in specifications or in the open literature or have been used routinely by at least one laboratory.

1.4 The procedures outlined can be used for many coating-substrate combinations. They cannot be used where the coating cannot be separated from the substrate by chemical or physical means as would be the case if white brass were plated with yellow brass.

1.5 In principle, these procedures can be used to measure very thin coatings or to measure coatings over small areas, but not thin coatings over small areas. The limits depend on the required accuracy. For example, 2.5 mg/cm^2 of coating might require 2.5 mg of coating covering 1 cm^2, but 0.1 mg/cm^2 of coating would require 25 cm^2 to obtain 2.5 mg of coating.

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

1.7 *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.*

1.8 *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]

A90/A90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

A309 Test Method for Weight and Composition of Coating on Terne Sheet by the Triple-Spot Test (Withdrawn 2015)[3]

A428/A428M Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles

B137 Test Method for Measurement of Coating Mass Per Unit Area on Anodically Coated Aluminum

B449 Specification for Chromates on Aluminum

2.2 *British Standards Institution Documents:*[4]

BS 729 Hot Dip Galvanized Coatings on Iron and Steel Articles, Specification for

BS 1706 Electroplated Coatings of Cadmium and Zinc on Iron and Steel, Specification for

BS 1872 Electroplated Coatings of Tin, Specification for

BS 3189 Phosphate Treatment of Iron and Steel, Specification for

BS 3382 Electroplated Coatings on Threaded Components, Specification for

BS 3597 Electroplated Coatings of 65/35 Tin-Nickel Alloy, Specification for

2.3 *Government Standards:*

2.3.1 *DOD Standard:*[5]

DOD-P-16232F Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals)

[1] This guide is under the jurisdiction of ASTM Committee B08 on Metallic and Inorganic Coatings and is the direct responsibility of Subcommittee B08.10 on Test Methods.

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[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from British Standards Institute (BSI), 389 Chiswick High Rd., London W4 4AL, U.K.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

2.3.2 *Federal Standards:*[6]
FED-STD 151b Metals; Test Methods: Test 513.1 for Weight of Coating on Hot Dip Tin Plate and Electrolytic Tin Plate
RR-T-51D Tableware and Flatware—Silverplated
2.3.3 *Military Standard:*[5]
MIL-M-45202C Magnesium Alloys, Anodic Treatment of

2.4 *ISO Standards:*[7]
ISO 2081 Metallic Coatings—Electroplated Coatings of Zinc on Iron or Steel
ISO 2082 Metallic Coatings—Electroplated Coatings on Cadmium on Iron or Steel
ISO 2093 Metallic Coatings—Electrodeposited Coatings of Tin, Annex B
ISO 2106 Anodizing of Aluminum and its Alloys—Determination of Mass Per Unit Area (Surface Density) of Anodic Oxide Coatings—Gravimetric Method
ISO 3892 Conversion Coatings on Metallic Materials—Determination of Coating Mass Per Unit Area—Gravimetric Methods
ISO 4522/1 Metallic Coatings—Test Methods for Electrodeposited Silver and Silver Alloy Coatings—Part 1: Determination of Coating Thickness
ISO 4524/1 Metallic Coatings—Test Methods for Electrodeposited Gold and Gold Alloy Coatings—Part 1: Determination of Coating Thickness

3. Summary of Guide

3.1 The mass of a coating over a measured area is determined by the following:

3.1.1 Weighing the test specimen before and after dissolving the coating in a reagent that does not attack the substrate.

3.1.2 Weighing the coating after dissolving the substrate in a reagent that does not attack the coating, or

3.1.3 Dissolving both the coating and the substrate and quantitatively analyzing the resulting solution.

3.2 The mass per unit area is calculated from the mass and area measurements, the thickness from the mass, area, and density of the coating materials.

4. Significance and Use

4.1 The thickness of a coating is critical to its performance and is specified in many specifications calling for coatings.

4.2 These procedures are used for acceptance testing and appear in a few specifications.

4.3 Coating thickness instruments are often calibrated with thickness standards that are based on mass and area measurements.

4.4 The average thickness of a coating on the measured area can be calculated from its mass per unit area only if the density of the coating material is known.

5. Apparatus

5.1 In addition to normal chemical laboratory equipment for handling small amounts of corrosive and toxic chemicals, an accurate ruler or vernier caliper and a good balance are required. See Sections 7 and 8.

6. Specimen Preparation

6.1 *Size*—The specimen must be large enough to permit area and mass measurement of adequate accuracy. (See Section 7 and 8.2.)

6.2 *Shape*—The shape of the test specimen must be such that the surface area can be easily measured. A rectangular or circular test specimen is usually suitable.

6.3 *Edge Condition*—If the area to be measured is small and needs to be known accurately, the edges must be dressed to remove smeared coating, to remove loose burrs, and to provide well-defined and (for rectangles) straight edges. This should be considered for areas less than 100 mm^2. One method of dressing the edges of a rectangular specimen is to clamp the specimen between two plastic or metal blocks with the edge of the specimen flush with the edges of the blocks and then to grind and polish the edges metallographically.

6.4 *Heat Treatment*—If the substrate is to be dissolved leaving the coating intact, it is desirable to first heat-treat the test specimen so that the coating will not curl up tightly or fall apart. Some gold deposits of 1.5 mg/cm^2 will fall apart when their substrates are dissolved, but after heat treatment at 120 °C for 3 h will support themselves. If the thickness of a coating (instead of its mass per unit area) is being determined, one should not use a heat treatment that might change the density of the coating material.

7. Measurement of Coated Area:

7.1 *Measurement Method*—The accuracy of the area measurement must be better than the desired accuracy of the mass per unit area measurement. Hence the method of measuring the area will depend on the desired accuracy and the specimen size.

7.2 *Equipment*—The area can be measured with a planimeter, but it is usually determined by linear measurements. Often a micrometer or vernier caliper is used. For large areas, however, a ruler may do. For maximum accuracy, a measuring microscope is used.

7.3 *Number of Measurements*—Because circular or rectangular specimens will not be perfectly circular or rectangular, it is desirable to measure each dimension in three places. For a rectangle, one would measure the length of each edge and the length and width through the center and obtain an average for each dimension.

NOTE 1—In the case of a cylinder one would normally measure the diameter and length. In one specification for galvanized wire (fencing), the length of the wire specimen is not measured, but in effect is calculated from the mass (which is measured anyway), the radius, and the density of the steel substrate. ($l = m/\pi r^2 D$)

8. Gravimetric Determination of Mass of Coating:

8.1 *Specimen Size*—The accuracy of the mass measurement must be better than the desired accuracy of the mass per unit

[6] Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401.
[7] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036.