Designation: B 244 – 97 (Reapproved 2002)

An American National Standard
Endorsed by American
Electroplaters' Society
Endorsed by National
Association of Metal Finishers

Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments[1]

This standard is issued under the fixed designation B 244; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the use of eddy-current instruments for the nondestructive measurement of the thickness of a nonconductive coating on a nonmagnetic basis metal.

1.2 This test method is particularly useful for measuring the thickness of an anodic coating on aluminum alloys. Chemical conversion coatings are too thin to be measured by this test method.

2. Referenced Documents

2.1 *ASTM Standards:*

B 499 Test Method for Measurement of Coating Thicknesses by Magnetic Method: Nonmagnetic Coatings on Magnetic Basis Metals[2]

3. Significance and Use

3.1 The thickness of a coating is often critical to its performance. This eddy-current method is nondestructive and is suitable for measuring the thickness of anodic coatings on aluminum, as well as the thickness of most nonconductive coatings on nonmagnetic basis metals.

3.2 This test method requires that the conductivity of the substrate be the same in the calibration standard and in the coated article to be measured.

4. Apparatus

4.1 The coating thickness shall be determined with an electromagnetic instrument that measures the changes in apparent impedance of the coil inducing the eddy currents into the basis metal.[3] The design of the instrument shall be such that variations in apparent impedance, produced by variations in coil to basis metal spacing, can be calibrated to indicate the thickness of coatings.

5. Factors Affecting the Measuring Accuracy

5.1 Inherent in the test method is a measuring uncertainty that, for thin coatings, is constant and independent of the coating thickness, and, for a single measurement, not less than 0.5 µm; for thicknesses greater than about 25 µm, this uncertainty is proportional to the coating thickness.

5.2 *Electrical Properties of the Basis Metal*—Eddy-current measurements are affected by the electrical conductivity of the basis metal, which itself is often affected by heat treatments.

5.3 *Basis-Metal Thickness*—For each measurement, there is a critical thickness of the basis metal above which the measurements will not be affected by an increase in that thickness. Its value should be determined experimentally, if not supplied by the manufacturer of the measuring instrument, since it depends on both the measuring frequency of the probe system and the electrical conductivity of the basis metal.

5.3.1 *General Rule*—For a given measuring frequency, the higher the conductivity of the basis metal, the smaller its critical thickness. For a given basis metal, the higher the measuring frequency, the smaller the critical thickness of the basis metal.

5.4 *Edge Effect*—This method is sensitive to abrupt changes in the surface contour of the test specimen. Therefore, measurements made too near an edge or inside corner will not be valid unless the instrument is specifically calibrated for such a measurement.

---

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

Current edition approved April 10, 1997. Published March 1998. Originally published as B 244 – 49 T. Last previous edition B 244 – 79 (1993).

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

[3] The following instruments have been found satisfactory for this purpose:

Permascope—Type EC-8-Ty, Twin City Testing Corp., P.O. Box 552, Tonawanda, NY 14150

Boonton Metal Film Gage—Type 255-A, Boonton Radio Corp., Boonton, NJ 07005 (This instrument is no longer manufactured, but many are still in use.)

Dermitron Thickness Tester, Unit Process Assemblies, Inc., 53-15 37th Ave., Woodside NY 11377

Filmeter, American Instrument Co., Silver Spring, MD 20910

Elcotector—MK-II, Ferro Engineering Div. of Ferro Corp., 4150 East 56th St., Cleveland, OH 44105; also available from East Lancashire Chemical Co., Ltd., Fairfield, Manchester, England.

Accuratest Mark II, Coloral Products, Ltd., Steward St., Birmingham 18, England.

Isometer—Type 2–080, Institute, Dr. Forster, Reutlingen/Wurtt. Grathwohlstrasse 4, West Germany.

5.5 *Curvature*—Measurements are affected by the curvature of the test specimen. The influence of curvature varies considerably with the make and type of instrument, but always becomes more pronounced as the radius of curvature decreases.

5.6 *Surface Roughness*:

5.6.1 Measurements are influenced by the surface topography of the substrate and the coating, and a rough surface will give individual instrument readings that will vary from point to point. In this case, it is necessary to make many readings at different positions to obtain a average value that is representative of the mean coating thickness.

5.6.2 If the basis metal is rough it may also be necessary to check the zero of the instrument at several positions on a sample of the uncoated rough substrate. If the roughness of the substrate surface is small, relative to the coating thickness, its effect will probably be negligible.

5.7 *Foreign Particles*—The probes of eddy-current instruments must make physical contact with the test surface and are, therefore, sensitive to foreign material that prevents intimate contact between the probe and the coating surface.

5.8 *Pressure*—The pressure with which the probe is applied to the test specimen affects the instrument readings, and should, therefore, be kept constant.

5.9 *Number of Readings*—The precision of the measurements can be improved by increasing the number of readings in accordance with statistical principles.

6. Calibration of Instruments

6.1 Before use, each instrument shall be calibrated in accordance with the instructions of the manufacturer, employing suitable thickness standards. During use, the calibration shall be checked at frequent intervals, at least once an hour. Attention shall be given to the factors listed in Section 5 and to the procedures described in Section 7.

6.2 Calibration standards of known thickness are available either as foils or as coated specimens.

6.2.1 *Calibration Foils*:

6.2.1.1 The calibration foils used for the calibration of eddy-current instruments are generally made of plastic. They are advantageous for calibration on curved surfaces, and are more readily available than coated standards.

6.2.1.2 To prevent measurement errors, it is necessary to ensure that intimate contact is established between foil and substrate. Resilient foils should be avoided if possible. Calibration foils are subject to indentation and should, therefore, be replaced frequently.

6.2.2 *Coated Standards*—These calibration standards consist of nonconductive coatings of known, uniform thickness permanently bonded to the substrate material.

6.3 The basis metal of the calibration standards shall have electrical properties similar to those of the basis metal of the coated test specimen. To confirm their suitability, a comparison of the readings obtained with the basis metal of the bare standard and that of the test specimen is recommended.

6.4 The basis metal thickness for the test and the calibration shall be the same if the critical thickness, defined in 4.3, is not exceeded. When possible, back up the basis metal of the standard or of the test specimen with a sufficient thickness of similar material to make the readings independent of the basis metal thickness. A way to determine if the basis metal thickness exceeds the critical thickness is to make measurements before and after backing up the basis metal with copper or aluminum at least 3 mm thick. If there is no difference between the readings, the critical thickness is exceeded.

6.5 If the test specimen is soft and thin, it is subject to indentation by the probe. Because of this, and despite the use of special probes or fixtures, measurements on such specimens are sometimes impossible to make.

6.6 If the curvature of the test specimen to be measured is such as to preclude calibration on a flat surface, the curvature of the coated standard or of the substrate on which the calibration foil is placed shall be the same as that of the test specimen.

7. Procedure

7.1 Operate each instrument in accordance with the instructions of the manufacturer. Give appropriate attention to the factors listed in Section 5.

7.2 Check the calibration of the instrument at the test site each time the instrument is put into service and at frequent intervals during use to assure proper performance.

7.3 Observe the following precautions:

7.3.1 *Basis Metal Thickness*—Check whether the basis metal thickness exceeds the critical thickness. If not, either use the back-up method in 6.4, or make sure that the calibration has been made on a standard having the same thickness and electrical properties as the test specimen.

7.3.2 *Edge Effects*—Do not make readings close to an edge, hole, inside corner, etc., of a specimen, unless the validity of the calibration for such a measurement has been demonstrated.

7.3.3 *Curvature*—Do not make readings on a curved surface of a specimen unless the validity of the calibration for such a measurement has been demonstrated.

7.3.4 *Number of Readings*—Because of normal instrument variability, it is necessary to make several readings at each position. Local variations in coating thickness may also require that a number of measurements be made in any given area; this applies particularly to a rough surface (see 5.9).

7.3.5 *Surface Cleanliness*—Before making measurements, clean any foreign matter such as dirt, grease, and corrosion products from the surface without removing any coating material.

8. Accuracy

8.1 The instrument, its calibration, and its operation shall be such that the coating thickness can be determined within 10 % or 1 µm, whichever is greater, of the true thickness.

9. Report

9.1 The report shall include the following information:

9.1.1 Type of instrument used,

9.1.2 Size and description of test specimen,

9.1.3 Whether special jigs were used,

9.1.4 Type of calibration standard and the method used, and

9.1.5 Thickness of coating as determined from the measurements.

NOTE 1—Although, theoretically, this test method can be used for

measuring nonconductive coatings on a magnetic basis metal, its use for coatings below 25 µm is not recommended, and the magnetic method outlined in Method B 499 shall be used.

10. Precision and Bias

10.1 The precision of this test method is being determined.