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Standard Test Methods for Thickness of Solid Electrical Insulation[1]

This standard is issued under the fixed designation D374/D374M; 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 U.S. Department of Defense.

1. Scope

1.1 These test methods cover the determination of the thickness of several types of solid electrical insulating materials employing recommended techniques. Use these test methods except as otherwise required by a material specification.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 *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.*

1.4 *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]

D618 Practice for Conditioning Plastics for Testing

D1711 Terminology Relating to Electrical Insulation

E252 Test Method for Thickness of Foil, Thin Sheet, and Film by Mass Measurement

3. Terminology

3.1 Refer to Terminology D1711 for definitions pertinent to this standard.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *1 micron, μm, n*—a dimension equivalent to 0.03937 mils.

3.2.2 *1 mil, n*—a dimension equivalent to 0.0010 in.

3.2.3 *absolute uncertainty (of a measurement), n*—the smallest division able to be read directly on the instrument used for measurement.

3.2.4 *micrometer, n*—an instrument for measuring any dimension with absolute uncertainty of 1 mil [25 μm] or smaller.

4. Summary of Test Methods

4.1 This standard provides eight different test methods for the measurement of thickness of solid electrical insulation materials. The test methods (identified as Test Methods A through H) employ different micrometers that exert various pressures for varying times upon specimens of different geometries. Tables 1 and 2 display basic differences of each test method and identify test methods applicable for use on various categories of materials.

5. Significance and Use

5.1 Some electrical properties, such as dielectric strength, vary with the thickness of the material. Determination of certain properties, such as relative permittivity (dielectric constant) and volume resistivity, usually require a knowledge of the thickness. Design and construction of electrical machinery require that the thickness of insulation be known.

6. Apparatus

6.1 *Apparatus A—Machinist's Micrometer Caliper*[3] with Calibrated Ratchet or Friction Thimble:

6.1.1 Apparatus A is a micrometer caliper without a locking device but is equipped with either a calibrated ratchet or a friction thimble. By use of a proper manipulative procedure and a calibrated spring (see Annex A1), the pressure exerted on the specimen is controllable.

6.1.2 Use an instrument constructed with a vernier capable of measurement to the nearest 0.1 mil [2 μm].

[1] These test methods are under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and are the direct responsibility of Subcommittee D09.12 on Electrical Tests.

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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] Hereinafter referred to as a machinist's micrometer.

TABLE 1 Test Methods Suitable for Specific Materials

Material	Test Method
Plastic sheet and film	A B C or D
Paper (all thicknesses)	E
Paper (over 2 mils [50 µm] thickness)	F or G
Rubber and other elastomers	H

TABLE 2 Test Method Parameter Differences

Test Method	Apparatus	Diameter of Presser Foot or Spindle, mils [mm]	Pressure on Specimen, approximate, PSI [kPa approximate]
A	Machinist micrometer with calibrated ratchet or thimble	250 [6]	not specified
B	Machinist micrometer without ratchet/thimble	250 [6]	unknown
C	Dead-weight dial type bench micrometer—Manual	125 to 500 [3 to 13]	0.5 to 130 [4 to 900]
D	Dead-weight dial type bench micrometer—Motor operated	125 to 500 [3 to 13]	0.5 to 130 [4 to 900]
E	Dead-weight dial type bench micrometer—Motor operated	250 [6]	25 [172]
F	Dead-weight dial type bench micrometer—Manual	250 [6]	25 [172]
G	Machinist micrometer with calibrated ratchet or thimble	250 [6]	25 [172]
H	Dead-weight dial type bench micrometer—Manual	250 [6]	4 [27]

6.1.3 An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.1.

6.1.4 Use an instrument with the diameter of the anvil and spindle surfaces (which contact the specimen) of 250 mil ± 1 mil [6.35 mm ± 0.05 mm].

6.1.5 Use an instrument conforming to the requirements of 7.1, 7.2, 7.5, 7.6.1, and 7.6.2.

6.1.6 Periodically, test the micrometer for conformance to the requirements of 6.1.5.

6.2 *Apparatus B—Machinist's Micrometer Without a Ratchet:*

6.2.1 Apparatus B is a micrometer caliper without a locking device.

6.2.2 Use an instrument constructed with a vernier capable of measurement to the nearest 0.1 mil [2 µm].

6.2.3 An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.2.

6.2.4 Use an instrument with the diameter of the anvil and spindle surfaces (which contact the specimen) 250 mil ± 1 mil [6.35 mm ± 0.05 mm].

6.2.5 Use an instrument conforming to the requirements of 7.1, 7.2, 7.5.1, 7.5.2, 7.5.3, 7.6.1, and 7.6.3.

6.2.6 Periodically, examine and test the micrometer for conformance to the requirements of 6.2.5.

6.3 *Apparatus C—Manually-Operated, Dead-Weight, Dial Type Thickness Gauge:*[4]

[4] Herein referred to as a dial gauge.

6.3.1 Use a dead-weight dial-type gauge in accordance with the requirements of 7.1, 7.3, 7.4, 7.6.1, 7.6.4, that has:

6.3.1.1 A presser foot that moves in an axis perpendicular to the anvil face,

6.3.1.2 The surfaces of the presser foot and the anvil (which contact the specimen) parallel to within 0.079 mil [2 µm] or 0.1 mil [2.54 µm] (see 7.3),

6.3.1.3 A vertical dial spindle,

6.3.1.4 A dial indicator essentially friction-free and capable of repeatable readings within ±0.05 mil [±1.2 µm] at zero setting, or on a steel gauge block,

6.3.1.5 A frame, housing the indicator, of such rigidity that a load of 2.92 lbf [13 N] or 3 lbf [13.34 N] applied to the dial housing, out of contact with the presser foot spindle (or any weight attached thereto) will produce a deflection of the frame not greater than the smallest scale division on the indicator dial, and,

6.3.1.6 A dial diameter at least 2 in. [50 mm] and graduated continuously to read directly to the nearest 0.079 mil [2 µm] or 0.1 mil [2.54 µm]. If necessary, equip the dial with a revolution counter that displays the number of complete revolutions of the large hand.

6.3.1.7 An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.3.

6.3.2 The preferred design and construction of manually operated dead-weight dial-type micrometers calls for a limit on the force applied to the presser foot. The limit is related to the compressive characteristics of the material being measured.

6.3.2.1 The force applied to the presser foot spindle and the weight necessary to move the pointer upward from the zero position shall be less than the force that will cause permanent deformation of the specimen. The force applied to the presser foot spindle and the weight necessary to just prevent movement of the pointer from a higher to a lower reading shall be more than the minimum permissible force specified for a specimen.

6.4 *Apparatus D—Motor-Operated Dead-Weight Dial Gauge:*

6.4.1 Except as additionally defined in this section, use an instrument that conforms to the requirements of 6.3. An electronic instrument having a digital readout in place of the dial indicator is permitted if that instrument meets the other requirements of 6.3 and 6.4.

6.4.2 Use a motor operated instrument having a presser foot spindle that is lifted and lowered by a constant speed motor through a mechanical linkage such that the rate of descent (for a specified range of distances between the presser foot surface and the anvil) and the dwell time on the specimen are within the limits specified for the material being measured. Design the mechanical linkage so that the only downward force upon the presser foot spindle is that of gravity upon the weighted spindle assembly without any additional force exerted by the lifting/lowering mechanism.

6.4.2.1 The preferred design and construction of motor operated dead-weight dial-type micrometers calls for a limit on the force applied to the presser foot. The limit is related to the compressive characteristics of the material being measured.