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An American National Standard

Standard Test Methods for Thin Thermally Conductive Solid Materials for Electrical Insulation and Dielectric Applications[1]

This standard is issued under the fixed designation D6343; 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 standard is a compilation of test methods for evaluating properties of thermally conductive electrical insulation sheet materials to be used for dielectric applications.

1.2 Such materials are thin, compliant sheets, typically produced by mixing thermally conductive particulate fillers with organic or silicone binders. For added physical strength these materials are often reinforced with a woven or nonwoven fabric or a dielectric film.

1.3 These test methods apply to thermally conductive sheet material ranging from about 0.02 to 6-mm thickness.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.* See also 18.1.2 and 19.1.2.

1.5 The values stated in SI units are to be regarded as standard.

NOTE 1—There is no IEC publication or ISO standard equivalent to this standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D149 Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

D150 Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D374M Test Methods for Thickness of Solid Electrical Insulation (Metric)

D412 Test Methods for Vulcanized Rubber and Thermoplastic ElastomersTension

D624 Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D883 Terminology Relating to Plastics

D1000 Test Methods for Pressure-Sensitive Adhesive-Coated Tapes Used for Electrical and Electronic Applications

D1458 Test Methods for Fully Cured Silicone Rubber-Coated Glass Fabric and Tapes for Electrical Insulation

D1711 Terminology Relating to Electrical Insulation

D2240 Test Method for Rubber PropertyDurometer Hardness

D5470 Test Method for Thermal Transmission Properties of Thermally Conductive Electrical Insulation Materials

D6054 Practice for Conditioning Electrical Insulating Materials for Testing

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *apparent thermal conductivity, n*—the time rate of heat flow, under steady conditions, through unit area, per unit temperature gradient in the direction perpendicular to the area, for a nonhomogeneous material.

3.1.1.1 See 16.1 for a discussion of the terms *thermal conductivity* and *apparent thermal conductivity*. To avoid confusion, these test methods use *apparent thermal conductivity* for measurements of homogeneous and nonhomogeneous materials.

[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 D09.19 on Dielectric Sheet and Roll Products.

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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.

3.1.2 See Terminologies D1711 and D883 for definitions of other terms used in these test methods.

4. Significance and Use

4.1 These test methods are useful to determine compliance of thermally conductive sheet electrical insulation with specification requirements established jointly by a producer and a user.

4.2 These test methods have been found useful for quality assessment. Results of the test methods can be useful in apparatus design.

5. Specimen Preparation

5.1 From a sample of sufficient size, prepare test specimens of the dimensions and of the quantity to meet the requirements for each test procedure.

6. Conditioning

6.1 Unless otherwise specified, condition specimens in accordance with Procedure A of Practice D6054. Perform all tests on specimens that are in equilibrium with the conditions of Procedure A of Practice D6054. Make the tests in a chamber maintained at 23 ± 2°C and 50 ± 5 % relative humidity.

6.2 When required by a test procedure, condition specimens in accordance with Procedure D of Practice D6054 except that either distilled or deionized water ~~may~~ are permitted to be used. In such cases, remove the specimens from the water into air maintained at 23 ± 2°C and 50 ± 5 % relative humidity, remove surface water with a paper towel, and begin testing within 30 s.

7. Precision and Bias

7.1 No evaluation of precision or bias has been established for the test methods herein as they relate to these thin thermally conductive materials. For general guidance only, ~~reference may be made~~it is suitable to make reference to Precision and Bias statements in the referenced test methods as listed in Section 2.

8. Thickness

8.1 *Significance and Use*—The accurate determination of thickness is essential for design purposes for both thermal conduction and electrical insulation. Thickness enters into the calculation of thermal, electrical, and tensile properties.

8.2 *Procedure*:

8.2.1 Make thickness measurements on specimens in accordance with Test Methods D374M, Method H. This test method uses a micrometer which applies a pressure of 26 ± 4 kPa on the specimen, using a 6.25-mm diameter presser foot.

8.2.2 Clean the surfaces where the measurements are to be made. Take five randomly spaced measurements to cover the length and width of the specimen. Take measurements at least 6 mm from the edges of the specimen.

NOTE 2—At the compressive loads of this test method, some materials will undergo compression or compression deflection. ~~The buyer and~~ It is important for the ~~seller may wish~~buyer and seller to agree on other conditions of pressure, anvil and presser foot geometry, and the dwell time to be used.

8.3 *Report*—Report the thickness in millimetres as the average of the five measurements.

9. Adhesion Strength

9.1 *Significance and Use*—Materials covered by this test method are optionally coated with a pressure sensitive adhesive on one or both sides. In some cases performance in a particular application can be affected by the adhesion strength.

9.2 *Procedure*—Test three specimens of 25-mm width in accordance with Test Methods D1000 except, clean the steel panel with isopropyl alcohol.

9.3 *Calculation*—From the ~~3~~three specimens, calculate the average adhesion strength.

9.4 *Report*—Report the average adhesion strength in newtons per metre of width.

10. Breaking Strength

10.1 *Significance and Use*~~—Breaking strength can be a significant limitation on methods of applying tapes. Hence it may be important to measure the tensile force they can withstand.~~ —In some cases, breaking strength is a significant limitation on methods of applying tapes. Hence, measurements of the tensile force they are able to withstand are potentially important data.

10.2 *Procedure*:

10.2.1 Prepare three specimens at least 500 mm long and 25 mm wide. If the material contains reinforcing fibers, cut the test specimen such that the machine direction reinforcing fibers are parallel to the long axis of the specimen. In the case of materials narrower than 25 mm, test the full width as received.

10.2.2 Test the breaking strength in accordance with Test Methods D1458.

10.3 *Calculation*—From the test measurements on the ~~3~~three specimens, calculate the average breaking strength.

10.4 *Report*—Report the average breaking strength in newtons per metre of width.

11. Tensile Strength and Elongation

11.1 *Significance and Use*—Tensile test results with these materials will vary with specimen geometry and conditions of testing.

Hence, these tensile measurements are not always reliable indicators of usefulness in a particular application. Tensile properties of glass-fiber-reinforced materials vary with the ratio of the glass-fiber thickness to the total thickness. Measurements of tensile properties vary with the direction of the glass fibers with respect to the direction in which the specimen is cut.

11.2 *Procedure*:

11.2.1 Prepare three specimens in accordance with Test Methods D412 using Die C.

11.2.2 If the material contains reinforcing fibers, cut the test specimen such that any reinforcing fibers are at 45 ± 10° to the long axis of the specimen.

11.2.3 In accordance with Test Methods D412, measure the tensile breaking strength and tensile elongation at a jaw separation rate of 500 mm/min (20 in./min).

11.3 *Calculation*:

11.3.1 Calculate the tensile strength in kilopascals using the initial thickness and width for each specimen. Calculate the average tensile strength from the three test measurements.

11.3.2 Similarly, calculate each elongation at break as a percentage of the initial jaw separation. Calculate the average from the three test measurements.

11.4 *Report*—Report the average tensile strength in kilopascals and the average elongation in percent.

12. Hardness

12.1 *Significance and Use*—This test method is empirical and intended for control purposes only.

12.2 *Procedure*:

12.2.1 Prepare a sufficient number of specimens to form a stack approximately 6 mm high.

12.2.2 Determine the indentation hardness in accordance with Test Method D2240 with the following exception:

12.2.2.1 Read the scale within 2 s after the presser foot is in firm contact with the specimen.

12.3 *Calculation*—From the five measurements taken at different locations on the specimen, calculate the average hardness.

12.4 *Report*—Report the average hardness in accordance with the Shore Hardness system.

13. Specific Gravity

13.1 *Significance and Use*—Specific gravity ~~can be~~ is a potentially useful tool to help verify proper filler loading and ~~distribution. This value may also be~~distribution and it is information occasionally required by designers of specific applications of these materials.

13.2 *Procedure*—Prepare two specimens of at least 650 mm^2 in area and test in accordance with Test Methods D792, Method A-1.

13.3 *Report*—Report the average of the two test measurements as the specific gravity.

14. Tear Strength

14.1 *Significance and Use*:

14.1.1 In certain applications, these materials are stressed during installation in such a way as to introduce tearing stresses on the material. Tear strength measurements provide a means of comparing or specifying materials for such applications.

14.1.2 The type of reinforcement, testing rate, and specimen size affect the tear resistance. The results obtained by this test method are predictive of performance only under certain specific conditions of use.

14.2 *Procedure*:

14.2.1 Prepare three specimens using Die C of Test Method D624.

14.2.2 If the material contains reinforcing fibers, cut the test specimen such that any reinforcing fibers are at 45 ± 10° to the long axis of the specimen (the "A" dimension of Die C).

14.2.3 Measure the tear strength in accordance with Test Methods D412 using a jaw separation rate of 500 mm/min (20 in./min).

14.3 *Calculation*—Calculate the tear strength for each specimen by dividing the maximum force by the specimen thickness. Calculate the average from the three test measurements.

14.4 *Report*—Report the average tear strength in newtons per millimetre.

15. Thermal Impedance

15.1 *Significance and Use*—Thermal impedance measurements are affected by applied pressure, thickness, any surface irregularities, and uniformity of heat flow. Since the results obtained by these test methods represent thermal characteristics of a material under a specific set of conditions, it is not appropriate to use these results to predict performance in an application where conditions differ from those of the test.

15.2 *Procedure*:

15.2.1 Prepare specimens for two determinations as required by either Method A or Method B of Test Method D5470.

15.2.2 Measure the thermal impedance in accordance with Test Method D5470, using a pressure of 3.0 ± 0.1 MPa and an average specimen temperature of 50 ± 5°C.

15.3 *Calculation*—From the two determinations, calculate the average thermal impedance.

15.4 *Report*—Report the average thermal impedance in $(m^2 \cdot K)/W$ and the test method used.