INTERNATIONAL

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# Standard Test Methods for Glass-Bonded Mica Used as Electrical Insulation[1]

This standard is issued under the fixed designation D1039; 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 These test methods cover the evaluation of the characteristics of glass-bonded, natural, or synthetic mica materials intended for use as electrical insulation.

1.2 Glass bonded mica materials are commercially available in both injection molded and compression molded types. These test methods are applicable to both types except for tensile strength methods. (See Section 41.)

1.3 The test methods appear in the following sections:

| Test Method | Section | ASTM Test Method |
|---|---|---|
| Arc Resistance | 57 – 59 | D495 |
| Compressive Strength | 33 – 35 | D695 |
| Conditioning | 5 | D618 |
| Dielectric Strength | 48 – 51 | D149 |
| Dissipation Factor | 43 – 47 | D150 and D2149 |
| Heat Distortion Temperature | 24 – 29 | D648 |
| Impact Resistance | 36 – 39 | D256 |
| Modulus of Rupture | 30 – 32 | D790 and C674 |
| Permittivity | 43 – 47 | D150 and D2149 |
| Porosity | 13 – 16 | D116 |
| Resistivity, Volume and Surface | 52 – 56 | D257 |
| Rockwell Hardness | 10 – 12 | D785 |
| Specific Gravity | 6 – 9 | D792 |
| Specimens | 4 | |
| Tensile Strength | 40 – 42 | D638 and D651 |
| Terminology | 3 | D1711 |
| Thermal Conductivity | 17 – 19 | C177 and E1225 |
| Thermal Expansion | 20 – 23 | E228 and E289 |
| Thickness | 49 and 54 | D374 |

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

1.5 *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.* See also Sections 45, 49, 54, and 58.

1.6 *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]

C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C674 Test Methods for Flexural Properties of Ceramic Whiteware Materials

D116 Test Methods for Vitrified Ceramic Materials for Electrical Applications

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

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D374 Test Methods for Thickness of Solid Electrical Insulation (Metric) D0374_D0374M

D495 Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D648 Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position

D651 Test Method for Test for Tensile Strength of Molded Electrical Insulating Materials (Withdrawn 1989)[3]

D695 Test Method for Compressive Properties of Rigid Plastics

D785 Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials

D790 Test Methods for Flexural Properties of Unreinforced



[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 D09.01 on Electrical Insulating 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] The last approved version of this historical standard is referenced on www.astm.org.

and Reinforced Plastics and Electrical Insulating Materials
D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
D1711 Terminology Relating to Electrical Insulation
D2149 Test Method for Permittivity (Dielectric Constant) and Dissipation Factor of Solid Dielectrics at Frequencies to 10 MHz and Temperatures to 500 °C
D6054 Practice for Conditioning Electrical Insulating Materials for Testing (Withdrawn 2012)[3]
E228 Test Method for Linear Thermal Expansion of Solid Materials With a Push-Rod Dilatometer
E289 Test Method for Linear Thermal Expansion of Rigid Solids with Interferometry
E1225 Test Method for Thermal Conductivity of Solids Using the Guarded-Comparative-Longitudinal Heat Flow Technique

## 3. Terminology

3.1 For definitions of terms used in this standard see Terminology D1711.

## 4. Test Specimens

4.1 Except for thermal expansion and thermal conductivity tests and unless otherwise specified for injection molded materials, the preferred form of specimen is a disk approximately 100 mm diameter and 2.5 mm to 7.5 mm thickness. Alternatively, it is allowable for injection molded specimens to have the final shape and form of the finished device.

4.2 Except for thermal expansion and thermal conductivity tests and unless otherwise specified for compression molded materials, the preferred form of specimen is a disk 100 mm to 150 mm diameter, or a square plate 100 mm to 150 mm on a side, with thickness 2.5 mm to 7.5 mm. It is allowable for the plate or disk to be molded to size or machined from a compression molded sheet.

4.3 For thermal expansion test specimens use specimens in accordance with Test Method E228 or Test Method E289 as appropriate.

4.4 For thermal conductivity specimens use specimens in accordance with Test Method E1225.

## 5. Conditioning

5.1 Unless otherwise specified, condition all samples and test specimens in accordance with Procedure A of Practice D6054, except condition all thicknesses for at least 16 h.

## TEST METHOD A: SPECIFIC GRAVITY

## 6. Significance and Use

6.1 This characteristic is useful for specification purposes and has utility as a quality control parameter.

## 7. Test Specimens

7.1 From specimens obtained in accordance with Section 4 and conditioned in accordance with Section 5, cut pieces weighing from 5 g to 25 g and prepare them in accordance with Test Methods D792.

## 8. Procedure and Report

8.1 Determine specific gravity and report the results in accordance with Test Methods D792.

## 9. Precision and Bias

9.1 The precision and bias statement of Test Methods D792 applies to the materials covered in these test methods.

## TEST METHOD B: ROCKWELL HARDNESS

## 10. Significance and Use

10.1 This property is useful as a quality control test and has application for use in specifications.

## 11. Procedure and Report

11.1 From specimens obtained in accordance with Section 4 and conditioned in accordance with Section 5, determine and report the Rockwell hardness in accordance with Procedure A of Test Method D785. Use the Rockwell A scale if the hardness is 115 or less, otherwise use the Rockwell E scale.

## 12. Precision and Bias

12.1 The precision and bias statement of Test Method D785 applies to the materials covered in these test methods.

## TEST METHOD C: POROSITY

## 13. Significance and Use

13.1 This characteristic serves as a measure of the integrity of the material. The test is useful for quality control and specification purposes.

## 14. Specimens

14.1 Prepare specimens in accordance with Section 4 and condition them in accordance with Section 5. Then break the material in accordance with the porosity sections of Method B of Test Methods D116.

## 15. Procedure and Report

15.1 Test the glass-bonded mica for porosity and report the results in accordance with Test Methods D116.

## 16. Precision and Bias

16.1 The precision and bias statement of Test Methods D116 applies to the materials covered in this standard.

## TEST METHOD D: THERMAL CONDUCTIVITY

## 17. Significance and Use

17.1 Knowledge of this property of glass-bonded mica is important for design of electrical apparatus. The test is useful for quality control and specification purposes.

## 18. Procedure and Report

18.1 Using specimens obtained in accordance with Section 4, make determinations and report the results for thermal conductivity in accordance with Test Method E1225.

NOTE 1—If thermal conductivity values are required over a broader temperature range or of a lower order of magnitude than obtainable with Test Method E1225, Test Method C177 has been found to be satisfactory for measurement of the thermal conductivity perpendicular to the surface of specimens having large areal dimensions.

## 19. Precision and Bias

19.1 The precision and bias statement of the referenced test methods apply to the materials covered in these test methods.

## TEST METHOD E: THERMAL EXPANSION

## 20. Significance and Use

20.1 Data on thermal expansion of glass-bonded mica is useful for a designer to match materials in a component so as to minimize mechanical strains caused by temperature variations encountered by the component in service. The data is useful to estimate the amount of strain that develops in service.

20.2 The interferometric method is better suited for examination of physically small specimens, interfaces, or local areas that are under investigation. The dilatometer method is not as precise or sensitive as the interferometric method but the dilatometer method is useful at higher temperatures and can accommodate larger specimens. The results of the dilatometer method are more representative of large pieces.

## 21. Procedure

21.1 Using specimens obtained in accordance with Section 4, measure the thermal expansion characteristics of the glass-bonded mica in accordance with either Test Method E228 or Test Method E289.

## 22. Report

22.1 Report the following information:
22.1.1 The identity of the glass-bonded mica,
22.1.2 The method used,
22.1.3 The thermal expansion for the specimen expressed as a change in linear dimensions resulting from a specific change in temperature, and
22.1.4 The temperature range used.

## 23. Precision and Bias

23.1 The precision and bias statement of the referenced test methods apply to the materials covered in these test methods.

## TEST METHOD F: HEAT DISTORTION TEMPERATURE

## 24. Significance and Use

24.1 This test is useful for the comparison of material from different producers. It is suitable for use as a specification requirement.

## 25. Apparatus

25.1 A set-up for support and loading of the specimen and a means for measuring the deflection is described in Test Method D648. Modifications of this set-up in accordance with 25.2 are found satisfactory for use on specimens of glass-bonded mica.

25.2 The materials of construction of the Test Method D648 apparatus must be capable of withstanding exposure up to 600 °C. The oven used for heating of the specimen shall be capable of temperature control within ±5 °C throughout the temperature range 300 °C to 600 °C.

## 26. Test Specimens

26.1 Cut bars of glass-bonded mica approximately 120 mm by 13 mm with thickness of 3 mm to 13 mm. Prepare at least two specimens for testing at each load stress mandated by Test Method D648. Measure each specimen dimension to the nearest 0.02 mm and record these measurements.

## 27. Procedure

27.1 Determine the heat distortion temperature in accordance with Test Method D648 except start the test at 300 °C. Allow each specimen to reach equilibrium before obtaining the initial readings.

27.2 Increase the temperature 50 °C.

27.3 Maintain the increased temperature for 60 ± 5 min before taking readings.

27.4 Continue the 50 °C interval increments until the bar deflects 0.25 mm or more. The temperature at which 0.25 mm deflection occurs is the heat distortion temperature.

## 28. Report

28.1 Report the following information:
28.1.1 The three dimensions of the specimen,
28.1.2 The distance between the supports,
28.1.3 The load and the stress applied to each specimen, and
28.1.4 The heat distortion temperature for each specimen.

## 29. Precision and Bias

29.1 The precision and bias statement of Test Method D648 applies to the materials covered in these test methods.

## TEST METHOD G: MODULUS OF RUPTURE

## 30. Significance and Use

30.1 The modulus of rupture is a convenient means for comparing mechanical properties of glass-bonded mica from different producers.

30.2 The method is useful for quality control and specification purposes.

## 31. Procedure and Report

31.1 Take cylindrical specimens 13 mm in diameter and 150 mm in length and test and report in accordance with Test Methods C674.

NOTE 2—It is desirable that the specimens conform to the dimensions suggested in Table 1 of Test Methods D790 as closely as is practicable.

## 32. Precision and Bias

32.1 The precision and bias statement of Test Methods C674 applies to the materials covered in these test methods.

### TEST METHOD H: COMPRESSIVE STRENGTH

**33. Significance and Use**

33.1 The test results have utility for quality control and specification purposes. It is useful in comparison of glass-bonded mica from different producers.

**34. Procedure and Report**

34.1 Take specimens in accordance with Test Method D695. Determine and report compressive strength in accordance with Test Method D695.

**35. Precision and Bias**

35.1 The precision and bias statement of Test Method D695 applies to the materials covered in these test methods.

### TEST METHOD I: IMPACT RESISTANCE

**36. Significance and Use**

36.1 The test measures the reaction of the material to a very sudden application of forces on a very concentrated area of a specimen. This reaction is a measure of the brittleness of glass-bonded mica.

36.2 The test result has utility for quality control and specification purposes.

**37. Specimens**

37.1 Prepare rods 13 mm ± 1 mm in diameter, conforming to 11.5 of Test Method D256.

37.2 Condition specimens in accordance with Section 5 of these test methods.

**38. Procedure and Report**

38.1 Determine impact resistance and report the results in accordance with Test Method D256 using Method B (the simple beam test).

**39. Precision and Bias**

39.1 The precision and bias statement of Test Method D256 applies to the materials covered in these test methods.

### TEST METHOD J: TENSILE STRENGTH

**40. Significance and Use**

40.1 The results of tests for this property are useful for specification and quality control purposes.

**41. Procedure and Report**

41.1 *For Injection-Type Molded Materials*—Mold test specimens to the form and dimensions of Fig. 2 in Test Method D651. Condition in accordance with Section 5 of these test methods. Determine tensile strength and report the results in accordance with Test Method D651.

41.2 *For Compression-Type Molded Materials*—In accordance with Section 5 of these test methods, condition test specimens that conform to the dimensions of Fig. 1 of Test Method D638. Determine tensile strength and report the results in accordance with Test Method D638.

**42. Precision and Bias**

42.1 The precision and bias statement of the referenced test methods apply to the materials covered in these test methods.

### TEST METHOD K: RELATIVE PERMITTIVITY AND DISSIPATION FACTOR

**43. Significance and Use**

43.1 The results of this test have utility for quality control and specification purposes.

43.2 In many cases, the design of efficient electrical apparatus requires knowledge about these characteristics of glass-bonded mica.

43.3 For further information regarding the significance of these properties, see Test Methods D150.

**44. Specimens**

44.1 Prepare and condition specimens in accordance with Sections 4 and 5 of these test methods if relative permittivity and dissipation factor at room temperature and 50 % relative humidity are required.

44.2 If these properties are to be evaluated at high humidity, apply silver paint electrodes to the specimens following the concepts of Test Methods D150, which deal with electrode systems comprised of conducting paint or fired-on silver.



NOTE 3—These electrodes are sufficiently porous to permit diffusion of moisture.

44.3 For high humidity testing, condition specimens in accordance with Procedure C of Practice D6054, which is 96 h at 90 % relative humidity and 35 °C.



44.4 For high temperature testing, prepare specimens having dimensions that are in accordance with Test Method D2149.

**45. Procedure**

45.1 **Warning—**Lethal voltages may be present during these tests. It is essential that the test apparatus, and all associated equipment that may be electrically connected to it, be properly designed and installed for safe operation. Solidly ground all electrically conductive parts that any person might come in contact with during the test. Provide means for use at the completion of any test to ground any parts which: were at high voltage during the test; may have acquired an induced charge during the test; may retain a charge even after disconnection of the voltage source. Thoroughly instruct all operators in the proper way to conduct tests safely. When making high voltage tests, particularly in compressed gas or in oil, the energy released at breakdown may be sufficient to result in fire, explosion, or rupture of the test chamber. Design test equipment, test chambers, and test specimens so as to minimize the possibility of such occurrences and to eliminate the possibility of personal injury.

45.2 Specify on the material specification or the purchase order the temperature, humidity, voltage frequency, the voltage stress, and any other requirements for the tests.