



Designation: D2149 – 13 (Reapproved 2021)

Standard Test Method for Permittivity (Dielectric Constant) and Dissipation Factor of Solid Dielectrics at Frequencies to 10 MHz and Temperatures to 500 °C¹

This standard is issued under the fixed designation D2149; 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 test method covers the determination of the relative permittivity (dielectric constant) and dissipation factor of solid dielectrics from 50 Hz to 10 MHz over a range of temperatures from –80 to 500 °C.^{2,3} Two procedures are included as follows:

1.1.1 *Procedure A*—Using Micrometer Electrode.

1.1.2 *Procedure B*—Using Precision Capacitor.

NOTE 1—In common usage the word “relative” is frequently dropped.

1.2 *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.*

1.3 *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*:⁴

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

D1711 Terminology Relating to Electrical Insulation

E197 Specification for Enclosures and Servicing Units for

¹ This test method is under the jurisdiction of ASTM Committee D09 on Electrical and Electronic Insulating Materials and is the direct responsibility of Subcommittee D09.12 on Electrical Tests.

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² “Alternating-Current Loss and Permittivity Measurements,” Chapter 2 of *Engineering Dielectrics Volume IIB Electrical Properties of Solid Insulating Materials: Measurement Techniques*, ASTM STP 926, ASTM International, 1987.

³ “Dielectric Loss in Solids,” Chapter 1 of *Engineering Dielectrics Volume IIA Electrical Properties of Solid Insulating Materials: Molecular Structure and Electrical Behavior*, ASTM STP 783, ASTM International, 1983.

⁴ 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.

Tests Above and Below Room Temperature (Withdrawn 1981)⁵

3. Terminology

3.1 *Definitions*:

3.1.1 Permittivity and dissipation factor are fully defined in Terminology D1711. Briefly, the permittivity of an insulating material is the ratio of the capacitance between two conductors when embedded in the material to the capacitance between the same configuration of conductors in a vacuum (or air). The dissipation factor is the ratio of the resistive to capacitive currents in the dielectric. The product of the permittivity and dissipation factor is the loss index.

4. Significance and Use

4.1 Permittivity and dissipation factor are sensitive to changes in chemical composition, impurities, and homogeneity. Measurement of these properties is, therefore, useful for quality control and for determining the effect of environments such as moisture, heat, or radiation.

5. Apparatus

5.1 *Measuring Circuits*—Suitable measuring circuits are described in Test Methods D150. For measurements from 50 Hz to 100 kHz a substitution method using a low-voltage capacitance bridge is recommended. For measurements at 1 MHz and above, a resonant-circuit susceptance variation method is recommended. The Q of the circuit has to be at least 200 except for very low loss materials, for which a Q of 500 or higher is desirable.

5.2 *Test Enclosure*—Unless testing only at room temperature, it is necessary to adapt a Hartshorn-Ward type specimen holder to a temperature-controlled test enclosure. Where applicable, use the requirements for a grade A enclosure as in Specification E197. A suggested arrangement is shown in Fig. 1. This arrangement provides terminal connections away from the temperature zone.

⁵ The last approved version of this historical standard is referenced on www.astm.org.