



Designation: D 1829 – 90 (Reapproved 1999)

Standard Test Method for Electrical Resistance of Ceramic Materials at Elevated Temperatures¹

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1. Scope

1.1 This test method covers two procedures for the determination of insulation resistance and volume resistivity of ceramic insulating materials at elevated temperatures between 100 and 500°C.

1.1.1 Procedure A is suitable for obtaining a curve of the resistance versus temperature characteristics of a single specimen over a wide temperature range.

1.1.2 Procedure B is more suitable for rapid testing of large numbers of specimens at a fixed temperature.

1.2 These properties shall be determined in accordance with Test Methods D 257, except that the special procedures described in this method shall be used.

1.3 The values stated in inch-pound units are to be regarded as standard.

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. Specific hazard statements are found in Section 7.*

2. Referenced Documents

2.1 ASTM Standards:

D 257 Test Methods for D-C Resistance or Conductance of Insulating Materials²

D 1711 Terminology Relating to Electrical Insulation²

3. Terminology

3.1 **Definitions**—The definitions used in this test method are in accordance with Terminology D 1711.

4. Significance and Use

4.1 The significance and use of insulation resistance and volume resistivity measurements in general are discussed in Test Methods D 257. The influence of temperature is discussed in Appendix X1 of Test Methods D 257.

4.2 Insulation resistance and volume resistivity data can

indicate contamination of a part or material, as well as provide design data for high-temperature insulating devices.

5. Apparatus

5.1 **Resistance-Measurement Device**—The resistance between electrodes shall be measured with a suitable device having the required sensitivity and accuracy (see Test Methods D 257).

5.2 **Heating Chamber**—For heating the specimen, a suitable electric furnace shall be used. The construction of the furnace shall be such that the specimen is subjected to a uniform heat application with a minimum of temperature fluctuation. An adequate muffle should be provided to shield the specimen from direct radiation by the heating elements. This may be made of a ceramic such as aluminum oxide or equivalent. A grounded metallic shield shall also be provided within the furnace, preferably of silver, stainless steel, or equivalent, to isolate electrically the specimen test circuit from the heating elements.

5.3 Specimen Holder:

5.3.1 The specimen shall be mounted under sufficient pressure to make good contact between two electrode backing plates within the heating chamber. These backing plates and their respective leads should be made of silver or an equivalent metal of high thermal conductivity and thermal stability. Sufficient thickness, such as 3/4 in. (20 mm), shall be used to prevent warping and to provide heat equalization between the specimen and the electrode backing plates. The contact faces should be smaller than the test specimen electrodes, and one electrode backing plate shall be movable to allow insertion and removal of the specimen.

5.3.2 Bring the high voltage lead through a hole in the oven wall using a bushing or an insulated wire. The electrical insulation of the wire or bushing must have a high insulation resistance at the test temperature. Up to about 250°C, polytetrafluoroethylene or high alumina content ceramics are found suitable. At higher temperatures, it may be necessary to use a rigid lead passed through a hole in the oven wall and mounted on insulated supports outside the oven so that the lead does not contact the oven wall or any support within the oven. Even at very high temperatures air provides adequate insulation resistance.

5.3.3 Bring the low voltage electrode out of the oven using the techniques described in 5.3.2. Guard the low voltage lead

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² *Annual Book of ASTM Standards*, Vol 10.01.

(see Test Methods D 257 and 8.4 of this test method). Shielded leads insulated with polytetrafluoroethylene are available. If the rigid leads are used, it is necessary to provide a suitable guard in the insulation supports for the low voltage lead outside the oven.

5.4 Temperature-Control Device:

5.4.1 The temperature of the specimen shall be measured using a thermocouple mounted as close to the specimen as possible without causing any adverse electrical effects. A suggested method is to mount it directly into the ground electrode near the center in a hole extending almost to the upper surface of the plate. If neither backing plate is grounded, the thermocouple must be withdrawn during measurement.

5.4.2 A temperature-control system should be provided that can maintain chamber temperature to $\pm 5^\circ\text{C}$ over the required temperature range. A recommended method is to use two thermocouples, one in the chamber for control and a second for actual specimen temperature readings using a precision potentiometer.

6. Hazards

6.1 **Warning**— *Lethal voltages may be present during this test. 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 the 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.*

7. Test Specimens

7.1 If the specimens are supplied with electrodes attached, no further preparation is required.

7.2 Otherwise the specimens to be tested shall be in the form of flat plates of any practical shape, but preferably circular disks. They shall be from 1 to 3 in. (25 to 75 mm) in diameter, preferably 2 in. (50 mm), and from 0.020 to 0.250 in. (0.5 to 6 mm) in thickness with the faces parallel within 0.001 in. (0.02 mm).

7.3 Electrodes:

7.3.1 Electrodes shall be circular and consist of fired-on conducting paint or a conducting coating evaporated onto the specimen faces.

7.3.2 Guard electrodes are not required under these conditions.

7.3.3 To eliminate surface effects on the edges as a result of handling in preparing the specimen, it is recommended that the minimum distance from the electrodes to the edge of the specimen be equal to the thickness of the specimen. However, if the same specimens are to be used for relative permittivity

and dissipation factor measurements, the electrodes should be made to extend to the edge of the specimen. Refer to Test Methods D 257 for discussion of surface and edge conductance effects and precautions.

8. Procedure

8.1 Procedure A, Stepwise Heat:

8.1.1 Mount the specimen tightly between the electrodes, within the heating chamber.

8.1.2 Raise the temperature at a rate not exceeding $10^\circ\text{C}/\text{min}$ from each temperature to the next test temperature.

8.1.3 Take readings at 25°C intervals, with large intervals permitted if they provide sufficient accuracy for the specific requirement. Before each reading, allow the chamber and specimen to reach thermal equilibrium at the desired temperature by soaking a sufficient length of time.

8.2 Procedure B, Hot Insertion:

8.2.1 Before measurement, bring the heating chamber to thermal equilibrium at the desired test temperature.

8.2.2 Place the specimen in the chamber between the electrodes.

8.2.3 Allow sufficient time for the specimen and chamber to reach thermal equilibrium.

8.2.4 Following the reading, remove the specimen and insert the next specimen. The time to reach equilibrium can be reduced if the specimens are preheated by placing them all in the furnace at the start and inserting them successively into the electrode holder.

8.3 Electrification:

8.3.1 In both Procedure A and Procedure B, the time of electrification shall be 1 min and the applied potential shall be 500–V dc.

8.3.2 If the 500-V potential cannot be maintained because of an excessive decrease in resistance, it may be necessary to lower the applied voltage accordingly in increments of 100 V until satisfactory measurement can be made.

8.3.3 In cases in which the material being tested contains an increasingly conductive glass phase, polarization effects may play a part as a result of ionic buildup at one electrode. In this case, it will be necessary to make second readings with reversed polarity and take the average of the two readings.

8.4 **Special Precautions in Measurements**—If the material used to insulate the leads is located within the oven, its insulation resistance may become low enough to affect the measurements. This should be checked as follows:

8.4.1 If the circuit (see Test Methods D 257) is grounded between the current-measuring instrument and the constant-voltage power supply (such as battery) (both sides of specimen insulated from ground), a conductance between the high-potential lead and ground can be ignored provided it does not constitute too large a drain on the constant-voltage power supply. A conductance between the low-potential lead and ground constitutes a shunt on the current-measuring instrument, and it must be established that the resistance to ground is high (10 to 100 times) compared to the resistance of the current-measuring instrument, which may be $10^{11}\Omega$ or more for the most sensitive instruments. This must be established by a separate measurement at each temperature.

8.4.2 If the circuit is grounded between the specimen and