Designation: D4496 – 21ε1

Standard Test Method for D-C Resistance or Conductance of Moderately Conductive Materials[1]

This standard is issued under the fixed designation D4496; 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.

ε1 NOTE—Editorially updated adjunct stock code in December 2022.

1. Scope

1.1 This test method covers the determination of electrical resistance and electrical resistivity of materials that are generally categorized as moderately conductive and are neither good electrical insulators nor good conductors.

1.2 This test method applies to the materials that exhibit volume resistivity in the range of 10^0 to 10^7 Ω-cm or surface resistivity in the range of 10^3 to 10^7 Ω (per square).

1.3 This test method is designed for measurements at standard conditions of 23 °C and 50 % relative humidity, but its principles of operation can be applied to specimens measured at lower or higher temperatures and relative humidities.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.* Specific precautionary statements are given in 8.3.

1.5 *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]

D257 Test Methods for DC Resistance or Conductance of Insulating Materials

D374/D374M Test Methods for Thickness of Solid Electrical Insulation

D618 Practice for Conditioning Plastics for Testing

D991 Test Method for Rubber Property—Volume Resistivity Of Electrically Conductive and Antistatic Products

D1711 Terminology Relating to Electrical Insulation

2.2 *ASTM Adjuncts:*

Carbon black test cell (two drawings)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *moderately conductive*—a solid material having volume resistivity between 10^0 and 10^7 Ω·cm.

3.1.2 For definitions of the terms used, but not defined in this standard, refer to Terminology D1711.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *steady state*—for the purpose of this test method, steady-state is attained if any rate of change in the observed resistance (or conductance) averages less than 0.25 %/s.

4. Summary of Test Method

4.1 Specimens of the test material are conditioned at prescribed conditions and subjected to direct-voltage stress. Resistance or conductance is measured and used with the dimensional aspects of the specimen to compute the resistivity of the material. The apparatus and techniques used in this test method are selected in accordance with the general principles set forth in Test Methods D257 and D991.

5. Significance and Use

5.1 This test method is useful for the comparison of materials, as a quality control test, and for specification purposes.

5.2 This test method is useful in the selection and use of materials in wires, cables, bushings, high-voltage rotating

[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] 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] Available from ASTM International Headquarters. Order Adjunct No. ADJD4496-E-PDF. Original adjunct produced in 2015. Adjunct last revised in 2015.

machinery, and other electrical apparatus in which shielding or the distribution of voltage stress is of value.

5.3 Commercially available "moderately conductive" materials frequently are comprised of both conductive and resistive components (that is, cellulose fibers with colloidal carbon black particles attached to portions of the surfaces of those fibers, or discrete conductive particles adhered to the surfaces of electrical insulating polymers). Such commercially available materials are often manufactured in a manner that results in anisotropy of electrical conduction. Hence, the significance of tests using this test method depends upon the orientation of the specimen tested to the direction of the electric field and the relationship between this orientation and the orientation of the material in the electrical apparatus, which uses these materials.

6. Apparatus

6.1 Use apparatus conforming to the general requirements set forth in Test Methods D257 and D991.

6.2 *Power Source*—Capable of limiting the magnitude of the direct voltage applied to the specimen. (See Appendix X1 for discussion of voltage stress and specimen heating.)

6.3 *Test cells,* that have been found to be satisfactory are depicted in Figs. 1-3.[3]

NOTE 1—Conductive paint is a suitable electrode material for specimens of certain materials and testing such specimens does not require test cell assemblies similar to ones shown in Fig. 1, Fig. 2, and Fig. 3 (see Annex A1 for additional information).

7. Specimen Preparation and Selection

7.1 Take specimens from a sample of material that has been obtained in a random manner. Take care to protect the sample and the specimens from any contamination, which will affect the results of the resistance or conductance tests. Such contamination can include, in particular, salts or moisture from human hands. Be aware of elevated temperatures, extremes of high or low humidity, and the presence of chemical vapors, etc.

7.2 Prior to testing, condition all specimens to equilibrium in the standard laboratory atmosphere prescribed in Practice D618. For many materials the time of conditioning to equilibrium will require only a few hours (that is, less than 24 h). Equilibrium with standard laboratory conditions is declared attained if two consecutive volume resistance measurements on the same specimen agree within ±1 %. The two consecutive measurements are to be made at the intervals separated at least by 4 h.

7.3 Determine the dimensions of the test specimens to within ±2 % on material in equilibrium with the standard laboratory atmosphere. Make all thickness measurements in accordance with Method D of Test Methods D374/D374M using the appropriate procedure for the material being tested.

7.4 For specimens incorporating conductive paint electrodes see Annex A1.

7.5 For anisotropic materials, label and prepare specimens for testing in each of the principal directions of anisotropy. This may require using more than one type of test fixture depending on sample shape and orientation.

NOTE 2—Moderately conductive paper exhibits three axes of anisotropy. The principal axes in paper are machine direction (MD); cross-machine direction (CMD); and thickness direction (TD). Extruded polymeric materials frequently show anisotropy with the axis of extrusion (direction of flow) compared to the axis of the material at right angles to that direction of flow.

8. Procedure

8.1 Unless otherwise specified, make all measurements using an electrification time of less than 1 min. The electrification time shall be long enough to attain a "steady state" and the magnitude of the voltage shall not be so great as to cause heating of the test specimen. See Appendix X1 for discussion of time effects of voltage application and specimen heating.

8.2 Do not apply to the test specimen a power input exceeding 1 W. For very conductive materials it is useful to

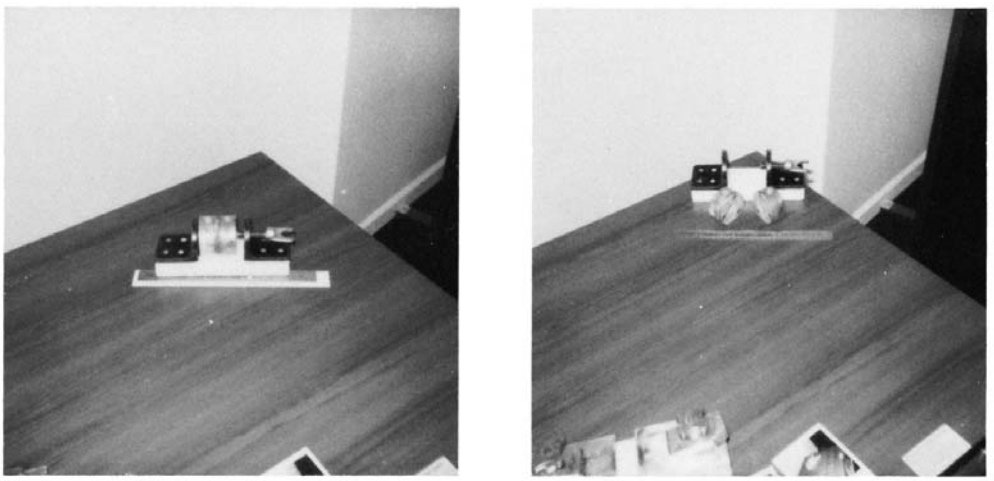

FIG. 1 Cell for Volume Resistivity With Electrodes Made With Metal Foil, Conductive Paint or Similar High Conductivity Material as Described in Test Method D257