INTERNATIONAL STANDARD

ISO 1853

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Conducting and dissipative rubbers, vulcanized or thermoplastic — Measurement of resistivity

Caoutchoucs vulcanisés ou thermoplastiques conducteurs et dissipants — Mesurage de la résistivité

Reference number
ISO 1853:2011(E)

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 1853 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analysis*.

This third edition cancels and replaces the second edition (ISO 1853:1998), which has been technically revised, mainly to add another two methods (methods 2 and 3).

Introduction

Rubber is normally regarded as a material of high electrical resistivity; consequently, it is widely used as an insulator. However, the incorporation of various materials, in particular certain forms of carbon black, greatly reduces the electrical resistance so that volume resistivities between 10^{13} Ω·m and 0,01 Ω·m are obtainable.

There are various technical and industrial purposes for which rubber with a reduced resistivity is a useful material, the most frequent application being for the dissipation of static charges. In certain circumstances, a lower limit of resistance has to be imposed on a product with this latter application, as a safety precaution to prevent its ignition or to prevent severe shock to a person in contact with it, in the event of faulty insulation or nearby electrical equipment.

Products which, while conducting away static charges, are sufficiently insulating to fulfill the safety requirements above are termed dissipative rubbers (the description antistatic rubber is also used). Products which do not fulfill the safety requirements are termed “conducting” rubbers. Since the dimensions of the product are involved, it is not possible to define a suitable range of volume resistivity for either of these classes, but only a range of resistance values between defined points. However, conductive materials are generally considered to have a resistivity below 10^6 Ω·m and dissipative materials to have a resistivity between 10^5 Ω·m and 10^{10} Ω·m.

The principal hazard, apart from static electricity, in most buildings and with most electrical equipment is from leakage currents from normal voltage supply mains. To guard against these hazards, it is recommended that the lower limit of resistance for a dissipative rubber product be 5×10^4 Ω for 250 V mains supplies, that is a maximum current of 5 mA. The limit can be proportionally less for lower voltages.

The maximum resistance which will permit the dissipation of static charges depends on the rate of generation of charge required to produce the minimum voltage which can be regarded as a hazard in a particular application.

Effect of temperature changes and strain on conducting and dissipative rubbers

The resistance of rubber and plastics made conductive by the addition of carbon black is very sensitive to strain and temperature history, since resistance depends on the structural configuration of the carbon particles in the matrix.

Under normal conditions of service with varying temperature and strain history, the resistance of a sample of a given material can vary considerably, for example by a hundred or more times, between freshly strained materials at room temperatures and material which has remained unstrained for a short period at 100 °C.

In order that valid comparisons can be made on test pieces, a conditioning treatment is specified so that the measurements are made on test pieces brought close to a condition of zero strain.

Electrode systems

Certain types of electrode, when applied to these rubbers, have a contact resistance which can be many thousands of times greater than the intrinsic resistance of the test piece. Dry contacts under light pressure or point contacts are particularly poor.

The definition of a suitable electrode system is therefore an important part of this International Standard and, in order to satisfy the various practical requirements for tests on laboratory-prepared test pieces, several electrode systems have been selected and are described in Clauses 3, 4 and 5.

Conducting and dissipative rubbers, vulcanized or thermoplastic — Measurement of resistivity

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard specifies the requirements for the laboratory testing of the volume resistivity of specially prepared test pieces of vulcanized or thermoplastic rubber compounds rendered conducting or dissipative by the inclusion of carbon black or ionizable materials. The tests are suitable for materials with a resistivity of less than about 10^8 Ω·m.

Method 1 is the preferred method when test pieces with bonded electrodes are not available.

Method 2 is the preferred method when test pieces are moulded with the inclusion of bonded electrodes.

Method 3 may be used if the apparatus for method 1 or 2 is not available, but it has lower accuracy.

If a reference to this International Standard is made without specifying the method, then method 1 shall be used.

2 Normative reference

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

3 Method 1

3.1 Apparatus and materials

See Figure 1 for a schematic diagram of the test circuit.

3.1.1 Current source: A source of direct current which has a minimum resistance to earth of 10^{12} Ω and which will not cause a dissipation of power greater than 0,1 W within the test piece.

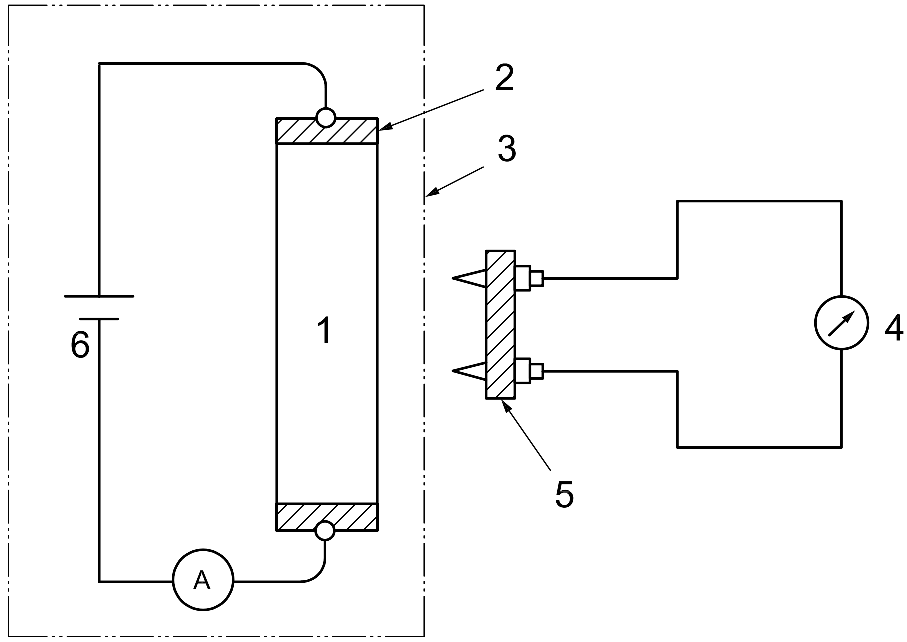
3.1.2 Means of measuring the current to an accuracy of 5 %.

NOTE Very small currents can be computed from measurement of the voltage drop across a known resistance using an electrometer (3.1.5).

3.1.3 Test piece holder and current electrodes, comprising a polystyrene strip of about 10 mm thickness to which the current electrodes are fixed (see Figure 1). The current electrodes shall be of clean metal approximately 5 mm long and running across the full width of the test piece, and be held in place by suitable clamps or grips.

The distance between the current electrodes shall be at least 75 mm, and the resistance between them shall be greater than 10^{12} Ω.

A minimum of three test piece holders shall be available.



Key

1 test piece
2 current electrode
3 sheet of insulating material — resistivity at least 10^{13} Ω
4 electrometer
5 potentiometric electrode
6 adjustable direct-current voltage

Figure 1 — Schematic diagram of test circuit

3.1.4 Potentiometric electrodes, constructed so that they exert a contacting force of approximately 0,65 N for 10 mm wide test pieces or 1,3 N for 20 mm wide test pieces (see Figure 2). The resistance between the potentiometric electrodes shall be greater than 10^{12} Ω.

3.1.5 Electrometer, having an input resistance greater than 10^{11} Ω. References for such instruments are given in Annex A.

3.1.6 Sheet of insulating material, having a resistivity greater than 10^{13} Ω·m.

3.1.7 Oven, capable of being controlled at a temperature of (70 ± 2) °C.

3.2 Test piece

Each test piece shall be a strip, (10 ± 0,5) mm or (20 ± 0,5) mm wide, of vulcanized or thermoplastic rubber at least 70 mm long and normally 2 mm, 4 mm or 6,3 mm thick, with a tolerance of uniformity of thickness of ±5 %.

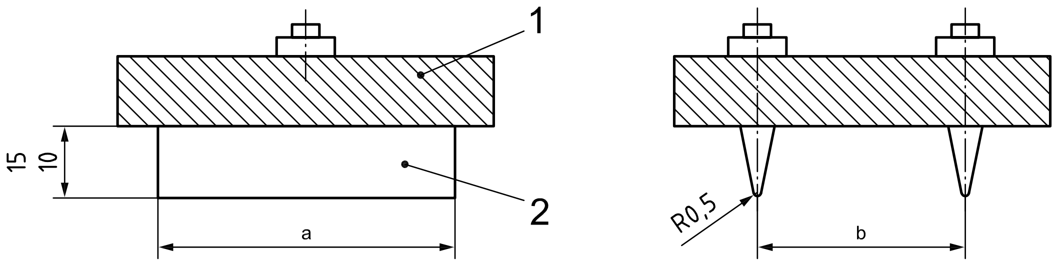
For comparison purposes, test pieces of the same size shall be used.

The test piece can be cut out with a knife or die, but care shall be taken to minimize distortion as this will affect the resistance values.

The surfaces of the test piece shall be clean; if necessary, they can be cleaned by rubbing with Fuller's earth (aluminium magnesium silicate) and water, washing with distilled water and allowing to dry. The surfaces shall not be buffed or abraded.

Do not clean the test pieces with organic materials that would attack or swell the rubber.

Dimensions in millimetres



Key

1 polystyrene strip

2 stainless steel

a Test piece width + at least 10 mm.

b 10 mm to 20 mm measured to ±2 %.

Figure 2 — Potentiometric electrodes

3.3 Number of test pieces

Three test pieces of equal size shall be prepared and tested.

3.4 Procedure

Allow the test piece to rest for not less than 16 h after vulcanization or moulding, in accordance with ISO 23529.

Immediately prior to the commencement of the test, place the test piece on the test piece holder and clamp the current electrodes to its ends.

Without removing it from the test piece holder, heat the test piece in the oven for 2 h ± 15 min at a temperature of (70 ± 2) °C and then condition for not less than 16 h at a standard laboratory temperature and humidity in accordance with ISO 23529. Place the two potentiometric electrodes in position with a distance of 10 mm to 20 mm between them, ensuring that the knife edges are at right angles to the current flow and that neither is nearer than 20 mm to a current electrode. Measure the distance between the potentiometric electrodes to an accuracy of ±2 %.

Apply the current and, after the current has been passing for 1 min, determine the steady potential between the potentiometric electrodes, using the electrometer at the same standard temperature and humidity as was used to condition the test piece.

Repeat the measuring procedure twice more on the same test piece, moving the potentiometric electrodes each time to obtain measurements over lengths of the test piece evenly distributed between the current electrodes.

Similarly, test the other two test pieces.