



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

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**Solid insulating materials - Dielectric and resistive properties - Part 7:
Resistive properties(DC method) - Measurement of volume resistance
and volume resistivity at elevated temperatures**

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1 Scope

This document specifies the test methods for the volume resistance and volume resistivity of insulating materials, under DC voltage and temperature not higher than 800 °C.

This document applies to high-temperature resistant mica plates, alumina ceramics and other materials.

2 Normative references

The contents of the following documents constitute essential provisions of this document through normative references in the text. Among them, for dated references, only the version corresponding to the date applies to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 10580-2015 Standard conditions for the use of solid insulating materials before and during testing (IEC 60212:2010, IDT)

IEC 62631-3-1 Dielectric and resistive properties of solid insulating materials - Part 3-1: Determination of resistive properties (DC methods) - Volume resistance and volume resistivity - General methods

3 Terms and definitions

The following terms and definitions apply to this document.

The terms and definitions in ISO and IEC, which are used in this document, are available at:

3.1 Heating chamber A device, that provides a high temperature to the specimen.

3.2 Volume resistance The portion of insulation resistance, which is determined by volume conductivity.

Note: The unit of volume resistance is expressed in ohm (ohm).

3.3 Volume resistivity Volume resistance, which is related to material volume.

Note 1: The unit of volume resistivity is expressed in ohm meter (ohm.m).

Note 2: For insulating materials, the volume resistivity is usually measured, by applying electrodes on sheet specimens.

Note 3: According to IEC 60050-121, in electromagnetism, the "conductivity" is defined as a scalar or tensor, whose product with the electric field strength in the medium is equal to the current density; the "resistivity" is defined as "the reciprocal of conductivity, where there is an inverse". When measured in this way, the volume resistivity is the average value of the resistivity of possible inhomogeneities, within the volume in the measurement, including the effects of possible polarization phenomena, at the electrodes.

4 Significance

Certain insulating materials are used at temperatures as high as 800 °C, such as mica plates for supporting electrolytic aluminum cells, high-temperature crucibles, or alumina ceramics for tubular resistance furnaces, etc.

Therefore, it is desirable for these materials to have the highest possible insulation resistance. Measurements of volume resistance and volume resistivity can be used as an aid, in selecting insulating materials for specific applications. Resistivity may vary significantly with temperature. The conditions of use of electrical insulating materials shall be understood, when designing products.

5.1 Overview

The test methods, which are specified in this document, are applicable to specific which is perpendicular to the surface of the specimen, OR on the side of the backing plate, which is parallel to the surface of the specimen. If the thermocouple is installed in the electrode's backing plate, the wire and the thermocouple shall be well insulated;

otherwise, the thermocouple shall be disconnected or removed, during measurement.

5.3.5 Special precautions during measurement

Errors in current measurement may be caused by the current measurement device, which

is shunted by resistances, between the protection terminal and the protection system. In order to ensure the good operation of the equipment, measurements shall be made, when the wires from the voltage source to the specimen are disconnected. In this case, the device shall exhibit infinite resistance, within its sensitivity range. If a suitable standard specimen of known value is available, it can be used to test the operation of the equipment.

Because the insulation of the wiring is heated in the oven, it may reduce the volume resistance, thereby affecting the measurement. The leakage resistance shall be measured individually, at each temperature. There may be thermocouple potentials, between different metals, so when the wiring metal and the electrode metal are different, measurement errors may be caused. Using a short circuit, instead of the power supply, the measured current can indicate the magnitude of the potential effect of the thermocouple.

5.4 Calibration

The measuring equipment shall be calibrated, at room temperature, according to the resistance value range of the measured volume.

Note: The commercial standard resistance has reached 100 Tohm.

6.1 Continuous heating (method A)

This method is suitable for the test, to quickly obtain the approximate relationship, between the volume resistance and temperature of the specimen, in a wide temperature range. It is only suitable for the comparison of materials, which have negligible dielectric absorption, or similar materials. The specimen shall be installed tightly between the electrode's backing plates, but not too tight, so as not to deform the specimen when heated. The specified voltage is applied to the specimen. The heating rate depends on the thickness of the material, which is not more than 5 K/min. As the temperature increases, a sufficient number of resistance measurements shall be made, to determine the relationship, between resistance and temperature.

6.2 Staged heating (method B)

This method is suitable for tests, that obtain a more accurate relationship, between resistance and temperature, than continuous heating. It is also suitable for specimens, which have dielectric absorption.

The specimen shall be installed tightly, between the electrode's backing plates, but not too tight, so as not to deform the specimen when heated. Increase the temperature of the specimen, from room temperature to the desired test temperature. Then gradually increase from one test temperature to the next.

Note 1: The control method of the test chamber should ensure that, the temperature of the electrode's backing plate does not exceed the required test temperature. It is usually

necessary to maintain sufficient temperature intervals, to ensure that the specimen temperature meets the requirements, within the higher temperature range. If the temperature exceeds the required test temperature, it will take a period of time, for the specimen temperature to reach the final test temperature.

When the temperature of the electrode's backing plate is within the test temperature range, which is specified in Table 2 of GB/T 10580-2015, apply the voltage, which is specified in the material specification, to the specimen for 1 min (or other specified time). Then measure the volume resistance. When the measurement is completed, it shall remove the voltage; connect the high voltage electrode, measuring electrode, guard electrode to each other (short-circuit).

A sufficient number of test temperatures shall be selected, but not less than five, to accurately obtain the relationship, between temperature and resistance, within the specified temperature range. At lower temperatures, the temperature increment shall be relatively small, such as 10 K. As the temperature increases, the temperature increment also increases.

Note 2: The logarithm of volume resistance (or volume resistivity) is usually plotted as a function of the reciprocal absolute temperature.

6.3 Precautions to be taken

Due to the dielectric relaxation, when the current cannot be stabilized, within the specified measurement time, it is necessary to determine the function of resistance and time, so as to estimate the volume resistance value, in the steady state.

When the resistance of the tested material is relatively low, it is necessary to reduce the voltage for measurement, to avoid the heating effect of the specimen.

For those materials with polarization effects, the test results are prone to errors, due to the concentration of charges on one or two electrodes.

Unless there are special requirements for the effect of thermal degradation, the specimen shall be kept at the test temperature, for a sufficient time to reach thermal equilibrium. According to the time interval or longer interval, which is required by the