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

GB/T 22586-2018

Replacing GB/T 22586-2008

**Electronic characteristic measurements -- Surface resistance of
superconductors at microwave frequencies**

电子学特性测量 超导体在微波频率下的表面电阻

(English Translation)

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Foreword

This standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This standard replaces GB/T 22586-2008 "High-temperature superconducting thin film microwave surface resistance test." Compared with GB/T 22586-2008, The main technical changes are as follows.

--- Added Appendix B (normative appendix), given "improved mirror dielectric resonator method" application "calibration technology" measurement of single-chip high Temperature superconducting film microwave surface resistance (RS) program. This scheme uses the modified TE₀₁ delta mode mirrored sapphire medium In the resonator method, the RS value of a single piece of superconducting thin film can be obtained by one measurement. This solution satisfies measurement variation With a coefficient of less than 20%, the test efficiency can be greatly improved, and it is suitable for large-scale industrial testing.

--- Added Appendix C (informative annex), given some additional information related to Appendix B, such as "improved image media resonance "Methods" theory deduction and so on.

This standard uses the redrafted method to modify the use of IEC 61788-7:2006 "Superconductivity Part 7. Measurement of superconductivity of electronic characteristics The surface resistance of the body at microwave frequencies, compared with IEC 61788-7:2006, the main technical differences are as follows.

--- Increased normative Appendix B and informative Appendix C. Appendix B is another alternative. This standard also made the following editorial changes.

--- The name "Superconductivity Part 7." was removed from the name of this standard so as to be consistent with the existing standard series.

Introduction

Since the discovery of some perovskite-structured copper-oxygen compounds, international research and development on oxide high-temperature superconductors has been conducted extensively.

Work is making great strides in the application of high magnetic field equipment, low-loss energy transmission, electronics, and many other technical fields.

In many fields of electronics, especially in the field of communications, microwave passive components, such as superconducting filters, are under development and After entering the field test stage [1,2].

Superconducting materials for microwave resonators, filters, antennas, and delay lines have the advantage of very low losses. Superconducting material loss characteristics The

development of new materials and the design of superconducting microwave devices are all very important. Superconducting material microwave surface resistance R_S and surface resistance with temperature The changing characteristics are important parameters needed to design low-loss microwave devices.

The latest advancement of HTS thin films, that is, its R_S value is several orders of magnitude lower than that of common metals, increasing the Rely on measurement technology requirements [3,4]. The traditional method for measuring rhenium and other low temperature superconducting materials R_S is to make a three-dimensional resonance with the measured material.

The cavity is tested for its Q value. The R_S value can be calculated by calculating the distribution of the electromagnetic field in the cavity. Another technique is in a larger cavity Put in a small sample. There are many forms of this technique, but when the loss of the HTS film is calculated from the experimentally measured total cavity loss, the Often contains the uncertainty introduced.

The best high-temperature superconducting thin film is an epitaxial thin film grown on a flat single crystal substrate. Up to now, it has not grown on curved surfaces.

High quality film. The requirement for high-temperature superconducting thin-film R_S measurement technology is that small flat samples can be used; samples do not need to be How to process; Will not damage or change the sample; High reproducibility; High sensitivity (as low as one thousandth of copper surface resistance); Dynamic range (up to copper The surface resistance); can drive high internal power at medium power input; wide temperature variation range (4.2K~150K).

In several methods for determining the microwave surface resistance [5, 6, 7], we have chosen the dielectric resonator method because so far this method is The most popular and practical. In particular, the sapphire resonator is an excellent tool for testing the surface resistance R_S of high-temperature superconducting materials.

With [8,9]. Since the improved mirror dielectric resonator method has the ability to directly test the microwave surface resistance of a monolithic superconducting film, and its measurement becomes The different coefficients are comparable to those of the dual-dielectric resonator method. This method is also recommended by us, so this standard is used as an alternative method in Appendix B. Given.

The test method given in this standard can also be applied to other flat superconducting blocks including low critical temperature materials.

The purpose of this standard is to provide an appropriate and recognized standard for engineers currently working in the fields of electronics and superconductor technology. technology.

The test method covered by this standard is based on VAMAS (Versailles Advanced

Materials and Standards Project) to determine the pre-standard characteristics of superconducting thin films. On the basis of the work. Electronic characteristics measurement Superconductor Surface Resistance at Microwave Frequency

1 Scope

This standard specifies the method of testing the surface resistance of a superconductor using the double resonator method at microwave frequencies. The test target is at the resonant frequency.

The following RS changes with temperature. The improved mirror dielectric resonator method, as an alternative method, is given in Appendix B.

This standard applies to surface resistance testing as follows.

--- Frequency. 8GHz \u003c\u003c30GHz;

--- Test resolution. 0.01m ohm (f = 10GHz).

The test report gives the surface resistance value at the test frequency and gives a value that is converted to 10 GHz using the relationship of RS is proportional to f^2 .

2 Normative references

The following documents are indispensable for the application of this document. For dated references, only dated versions apply to this article Pieces. For undated references, the latest version (including all amendments) applies to this document.

IEC 60050-815 International Electrotechnical terminology superconductivity [International electrotechnical vocabulary(IEV)-Part 815. Superconductivity]

3 Terms and definitions

The following terms and definitions as defined by IEC 60050-815 apply to this document.

3.1 Surface Impedance

The ratio of the electric field tangential component E_t to the magnetic field tangential component H_t of the conductor (including the superconductor). $Z_S = E_t/H_t = R_S + jX_S$ In the formula. R_S ---surface resistance; X_S --- surface reactance.

4 Requirements

Microwave signals input to dielectric resonators loaded with superconducting thin-film samples can be obtained by measuring dielectric resonator attenuation at different frequencies The superconducting thin film surface resistance R_S . The test frequency is scanned near the center of the resonance frequency, and the attenuation of the frequency