

ICS 17.220, 29.050
CCS L 85



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

GB/T 45506-2025

**Residual resistance ratio measurement - Residual resistance
ratio of cavity-grade Nb superconductors**

剩余电阻比测量 谐振腔级铌超导体剩余电阻比测量

(English Translation)

Issued on: April 25, 2025

Implemented on: November 1, 2025

**Issued by: State Administration for Market Regulation, China National
Standardization Administration**

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part 1: Structure and drafting rules for standardization documents"

Drafting.

This document is equivalent to IEC 61788-23:2024 "Superconductivity Part 23: Residual resistance ratio measurement of resonant cavity grade niobium superconductors Measurement of Volume Residual Resistance Ratio.

The following minimal editorial changes were made to this document.

--- In order to include this standard into the technical standard system, the name of the standard was changed to "Residual Resistance Ratio Measurement of Residual Resistance of Cavity-Grade Niobium Superconductors" Resistance Ratio Measurement.

Introduction

High-purity niobium is the preferred material for manufacturing radio frequency superconducting cavities, and similar levels of niobium may also be used in the production of superconducting wires.

In the quality control of delivered products, the residual resistance ratio is often used to indicate the purity of the metal. For non-superconducting metals, the residual resistance ratio the resistance measured at low temperature is usually called residual resistance. The higher the residual resistance ratio, the higher the purity of the material.

Since niobium enters a superconducting state at a temperature of about 9K, the DC resistance of niobium is zero below this temperature.

The residual resistance ratio obtained by definition will be infinite. This document introduces a measurement method for obtaining the residual resistance of niobium.

Under these conditions, the niobium sample was gradually heated from low temperature to above the superconducting transition temperature, and the resistance-temperature curve was obtained.

The resistance when it changes (about 10K) is the residual resistance, and thus the residual resistance ratio is obtained.

There are also international standards for the measurement of the residual resistance ratio of superconducting wires. Superconducting wires are usually a composite of superconducting materials and non-superconducting materials.

The RRR value can only represent the non-superconducting part, while the samples to be tested in this document are completely superconducting niobium. Niobium products usually include niobium plates, niobium bars, There are no niobium wires and niobium rods. Therefore, the size of the cross section (perpendicular to the current direction) of the niobium sample is generally several millimeters.

The ratio of length to diameter is much smaller than that of wire, and a higher current can

produce a sufficiently large voltage signal. Therefore, the test of niobium samples is similar to that of wire.

The dimensions and electrical connections of the niobium samples are detailed in Appendix A. The test setup also takes into account various factors, such as the orientation of the sample to be tested relative to the liquid helium surface, the convenience of placing it in the liquid helium dewar, the design of the electrical contacts, and the minimization of the sample length direction.

Thermal gradient. The above factors make this document and the residual resistance ratio measurement standards of wires very different.

Other methods can also be used to measure the residual resistance ratio. Appendix A compares this document with other methods.

Yes, other methods can produce systematic differences of up to 10%, which is higher than the uncertainty target in this document and needs to be verified according to Appendix A.

Appropriate corrections.

Residual resistance ratio measurement Measurement of residual resistance ratio of resonant cavity-level niobium superconductor

1 Scope

This document describes the test method for the resonator level niobium residual resistance ratio (rRRR).

This document is applicable to high purity niobium with rRRR in the range of 150~600. The niobium superconductors in this document have rectangular or circular cross-sections and cross-sectional areas.

1mm²~20mm², length not less than 10 times but not more than 25 times the width or diameter.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in this document.

For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version (including all amendments) applies to this document.

cabulary(IEV)-Part 815: Superconductivity]

Note 1: GB/T 2900.100-2017 Electrical terminology Superconductivity (IEC 60050-815:2015, IDT)

3 Terms and definitions

For this document, the terms and definitions defined in IEC 60050-815 and listed below apply. ISO and IEC maintain the following terms for standardization purposes.

The database is at the following URL.

The ratio of the resistance value at room temperature to the resistance value just above the superconducting transition temperature is shown in formula (1).

$$rRRR=R1/R2 \text{ (1)}$$

Where.

R1---Resistance at room temperature (293K);

R2---The resistance just above the superconducting transition temperature (i.e. about 10K).