

ICS 25.160.01
CCS J 33



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

GB/T 45982.3-2025

**Micro joining of 2nd generation high temperature
superconductors - Part 3: Test methods for joints**

第二代高温超导体微连接 第3部分：接头试验方法

(English Translation)

Issued on: August 1, 2025

Implemented on: February 1, 2026

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

Table of Contents

Preface
Introduction
1 Scope
2 Normative references
3 Terms and Definitions
4 Symbols and abbreviations
5 Joint test method
Appendix A (Informative) Comparison of structure numbers between this document and ISO 17279-3:2021
Appendix B (Informative) Visual Inspection Report
Appendix C (Informative) Four-lead method test report
Appendix D (Informative) Magnetic Field Attenuation Test Report
Appendix E (Informative) External Magnetic Field Test Report
Appendix F (Informative) Tensile Test Report
Appendix G (Informative) Bending Test Report
Appendix H (Informative) Critical Current Density Distribution Test Report
Appendix I (Informative) Optical Microscopy Test Report
Reference

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 Part 3 of GB/T 45982 "Micro-connections of the second generation of high temperature superconductors".

MicroConnect has published the following sections.

- Part 1: Process requirements;
- Part 2: Qualification of welding and testing personnel;
- Part 3: Test methods for joints.

This document is modified to adopt ISO 17279-3:2021 "Welded second-generation high-temperature superconductors microjoints Part 3: Joint test methods".

Compared with ISO 17279-3:2021, this document has many structural adjustments.

See Appendix A for the table.

The technical differences between this document and ISO 17279-3:2021 and their reasons are as follows.

- a) The scope of application of this document (see Chapter 1) has been changed to apply to my country's technical conditions;
- b) The normative reference document GB/T 19866 is used instead of ISO 15607:2019 (see Chapter 3);
- c) Added explanations of 19 symbols (see Chapter 4) to facilitate the application of this document;
- d) Deleted "Except for visual inspection, other tests should be carried out in a low temperature environment" (see 4.1 of ISO 17279-3:2021) to adapt to in response to my country's technical conditions;
- e) The qualification requirements for visual inspection test personnel (see 5.2.2) have been changed to apply my country's technical requirements;
- f) The reinforcement step for visual inspection of joint specimens (4.2.5 of ISO 17279-3:2021) has been deleted to adapt to my country's technical requirements;
- g) Deleted the test principle of the four-lead method, the measurement content of the heat-affected zone, the strip recorder used, test steps b), and the Formula (2) and formula (3) (see 4.3.5.1 of ISO 17279-3:2021) are applicable to my country's technical conditions;
- h) The temperature measuring instrument used in the four-lead method test [(see 5.3.5.1b)] and the temperature reached when the container is completely cooled [(see 5.3.5.1c)] to adapt to my country's technical conditions;
- i) Deleted the data acquisition system and software used in the four-lead method for measuring self-field critical current (see ISO 17279-3:2021 4.3.5.2) to suit my country's technical conditions;
- j) The four-lead method for measuring critical current density test (see 4.3.5.3 of ISO 17279-3:2021) has been deleted to adapt to my country's technology.

condition;

- k) Deleted part of the expression of the transformation formula (5) of VI to normal state when measuring n-value by four-lead method, and changed the representation of n-value.

The meaning of ISO 17279-3:2021 is 4.3.5.4, so as to be applicable to my country's technical conditions;

- l) The container for liquid nitrogen or refrigerant in the magnetic field attenuation test (see

5.4.5 and Figure D.2 in Appendix D) has been changed to suit my country's Technical conditions;

m) The general requirements for the applied magnetic field test (see 5.5.1) have been modified to suit my country's technical requirements;

n) The critical magnetic field test (see 4.8 of ISO 17279-3:2021) has been deleted to adapt to my country's technical requirements;

o) Scanning electron microscopy, transmission electron microscopy and X-ray diffraction tests (see ISO 17279-3:2021) have been deleted.

4.10) to suit my country's technical conditions.

The following editorial changes have been made to this document.

a) In order to comply with the requirements of my country's standard writing, the name of the standard is changed to "Second Generation High Temperature Superconductor Microconnections Part 3: Joints" Test Methods;

b) Deleted the redundant statements in the chapter (see 4.1, 4.2.3, 4.2.5, 4.3.5.2, 4.6.1, 4.7.1 and 4.9.5);

c) Deleted some notes (see 4.3.1 of ISO 17279-3:2021);

d) Deleted some explanatory descriptive content (4.3.5.1, 4.3.5.2, and 4.3.5.4 of ISO 17279-3:2021);

e) Added descriptions of the figures (see 5.7.5) and descriptions of the reference symbols in the figures (Figures 6, 7, 12, C.3, E.2 and G.2);

f) The results of the critical current density test in the report format have been deleted (see Annex B of ISO 17279-3:2021).

Record the results of scanning electron microscopy, transmission electron microscopy, and X-ray diffraction tests.

Results (see Annex I of ISO 17279-3:2021);

g) The critical magnetic field test report (see Annex G of ISO 17279-3:2021) has been deleted.

Introduction

With the widespread application of the second generation of high temperature superconductors (2GHTS) and the invention of 2GHTS resistance-free connection technology, it is necessary to this document has been developed to ensure that 2GHTS are connected in the most efficient way and that all implementation processes are properly controlled.

In order to achieve the best and uniform quality of 2GHTS joints, it is necessary to formulate national standards for micro-joining processes and joint evaluation specifications.

"Micro-connections of second-generation high-temperature superconductors" is a universal management standard for micro-connections of second-generation high-temperature superconductors, which is intended to consist of three parts.

--- Part 1: Process requirements;

--- Part 2: Qualification of welding and testing personnel;

--- Part 3: Test methods for joints.

Superconducting materials have zero resistance conduction and complete anti-magnetism below the critical temperature T_c , critical magnetic field strength B_c and critical current density J_c .

Once activated, current will flow forever in the diamagnetic closed loop of the superconducting material.

2GHTS consists of multiple layers with a total thickness of about $60\mu\text{m}$ ~ $100\mu\text{m}$, with or without copper stabilization layer coating.

The thickness of the superconducting layer prepared by (REBCO) is only $1\mu\text{m}$ ~ $3\mu\text{m}$, depending on the specifications of 2GHTS. Re represents rare earth materials, including

Figure 1 is a schematic diagram of the multilayer structure of a typical 2GHTS, and indicates the composition of each layer including the copper stabilization layer.

The two copper stabilization layers numbered 1 in FIG1 do not exist in the 2GHTS without stabilization layer.

Index number description.

1--- $20\mu\text{m}$ thick copper stabilization layer;

2--- $2\mu\text{m}$ thick silver protective layer;

3--- $1\mu\text{m}$ ~ $3\mu\text{m}$ thick REBCO superconducting layer;

4-5 buffer layers (total thickness 160nm);

5- $50\mu\text{m}$ thick Hastelloy alloy substrate.

Note: Not drawn to scale.

Figure 1 Schematic diagram of the multilayer structure of a typical 2GHTS

At present, the superconducting industry uses soft soldering (see Figure 2), brazing or other filling materials to connect joints.

High resistance at the head can create fatal defects in the superconductor.