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

GB/T 45982.2-2025

**Micro joining of 2nd generation high temperature
superconductors - Part 2: Qualification for welding and testing
personnel**

第二代高温超导体微连接 第2部分：焊接与试验人员资格

(English Translation)

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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 Part 2 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 17279-2:2018 "Welding of second generation high

temperature superconductors - Microjoints - Part 2: Welding and testing personnel" qualifications".

Compared with ISO 17279-2:2018, this document has many structural adjustments.

See Appendix A for the table.

The technical differences between this document and ISO 17279-2:2018 and their reasons are as follows.

- a) The scope of application of this document is expanded (see Chapter 1) to facilitate the application of this document;
- b) Added the normative reference document GB/T 19866 (see Chapter 3) and replaced it with the normative reference document GB/T 45982.1 ISO 17279-1 (see Chapter 3, 4.1, 4.3.1, 4.3.2, 4.4, 5.1 and 5.3) to apply my country's technical conditions;
- c) The symbols, abbreviations and normative references to ISO 15607:2003 (see Chapter 4 of ISO 17279-2:2018) have been deleted to adapt to the Using our country's technical conditions.

The following editorial changes have been made to this document.

- a) To coordinate with the existing standard, the name of the standard is changed to "Second generation high temperature superconductor micro-connection Part 2: Welding and testing personnel" qualifications";
- b) Deleted some explanatory descriptive content (see 5.2, 6.2, and 6.3 of ISO 17279-2:2018);
- c) Deleted the redundant statements in the chapter (see 5.3.2, 6.2 and 6.3 of ISO 17279-2:2018);
- d) Added some notes (see Table 4 in 4.5);
- e) Added a general description of the main parameters for test personnel qualification assessment (see 5.2);
- f) Deleted the evaluation results of the four-lead method test for measuring critical current density, critical magnetic field test and X-ray diffraction test (See Annex C, Annex D, and Annex E of ISO 17279-2:2018);
- g) Changed the name of the test method in the qualification assessment report for micro-joining and oxidation annealing operators to "four-lead method test" (See Appendix D);
- h) Added introductory words and titles to the tables (see Tables F.1 to F.3 in Appendix F).

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-connections and joint evaluation specifications.

"High-Temperature Superconductor Microconnections" is a universal management standard for second-generation high-temperature superconductor microconnections, and 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 started, current will flow forever in the anti-magnetic 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 various layers including the copper stabilization layer and the coating layer.

Layer composition and thickness. The two copper stabilization layers numbered 1 in Figure 1 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 μ 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), hard soldering or other filler methods to connect joints.

The high resistance at this point can create fatal defects in the superconductor.

a) Lap joint b) Bridge joint Index number description.

1---superconducting layer;

2---Soft solder.

Figure 2 Schematic diagram of 2GHTS soldering connection joint

This paper focuses on the direct self-bonding of 1 μ m to 3 μ m thick 2GHTS superconducting layers without the use of filler materials (see

3), and the superconducting properties were restored through oxidation annealing process, and the resistance at the joint was almost zero.

a) Lap joint

b) Bridging connector Index number description.

1---Superconducting layer.

Figure 3 Schematic diagram of the direct self-connection joint between two superconducting layers of 2GHTS

This document is a general standard for micro-joining of second-generation high-temperature superconductors, and specifies the relevant micro-joining and oxidation annealing operators and the qualifications of test personnel and other aspects will help to unify the micro-joining and oxidation annealing of second-generation high-temperature superconductor joints nationwide.

Qualification standards for operators and testers, as well as principles and methods for qualification examinations, in order to facilitate the development of second-generation high-temperature superconductor micro-connection technology in China.

Promote and apply it in various industries across the country.

Second generation high temperature superconductor microconnection Part 2: Qualification of welding and testing personnel