

---

**Varjenje - Mikro spajanje visokotemperaturnih superprevodnikov druge generacije  
- 3. del: Preskusne metode za zvarne spoje (ISO 17279-3:2021)**

Welding - Micro joining of second generation high temperature superconductors - Part 3:  
Test methods for joints (ISO 17279-3:2021)

Schweißen - Mikrofügen von Hochtemperatursupraleitern der 2. Generation - Teil 3:  
Prüfverfahren von Fügeverbindungen (ISO 17279-3:2021)

Soudage - Micro-assemblage des supraconducteurs à haute température de deuxième  
génération - Partie 3: Méthode d'essai des assemblages (ISO 17279-3:2021)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

**Ta slovenski standard je istoveten z: EN ISO 17279-3:2021**

---

**ICS:**

25.160.40	Varjeni spoji in vari	Welded joints and welds
29.050	Superprevodnost in prevodni materiali	Superconductivity and conducting materials

**SIST EN ISO 17279-3:2021****en,fr,de**

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN ISO 17279-3:2021](https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

EUROPEAN STANDARD

EN ISO 17279-3

NORME EUROPÉENNE

EUROPÄISCHE NORM

March 2021

ICS 25.160.01

English Version

## Welding - Micro joining of second generation high temperature superconductors - Part 3: Test methods for joints (ISO 17279-3:2021)

Soudage - Micro-assemblage des supraconducteurs à haute température de deuxième génération - Partie 3: Méthode d'essai des assemblages (ISO 17279-3:2021)

Schweißen - Mikrofügen von Hochtemperatursupraleitern der 2. Generation - Teil 3: Prüfverfahren von Fügeverbindungen (ISO 17279-3:2021)

This European Standard was approved by CEN on 4 March 2021.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Contents	Page
European foreword.....	3

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN ISO 17279-3:2021](https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021)  
<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

## European foreword

This document (EN ISO 17279-3:2021) has been prepared by Technical Committee ISO/TC 44 "Welding and allied processes" in collaboration with Technical Committee CEN/TC 121 "Welding and allied processes" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2021, and conflicting national standards shall be withdrawn at the latest by September 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

### Endorsement notice

iTeh STANDARD PREVIEW

The text of ISO 17279-3:2021 has been approved by CEN as EN ISO 17279-3:2021 without any modification.

[SIST EN ISO 17279-3:2021](https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN ISO 17279-3:2021](https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

# INTERNATIONAL STANDARD

# ISO 17279-3

First edition  
2021-02

---

---

## Welding — Micro joining of second generation high temperature superconductors —

### Part 3: Test methods for joints

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**  
*Soudage — Micro-assemblage des supraconducteurs à haute  
température de deuxième génération —  
Partie 3: Méthode d'essai des assemblages*

[SIST EN ISO 17279-3:2021](https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>



Reference number  
ISO 17279-3:2021(E)

© ISO 2021

## iTeh STANDARD PREVIEW (standards.iteh.ai)

SIST EN ISO 17279-3:2021

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>



### **COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland



# Contents

Page

Foreword.....	v
Introduction.....	vi
<b>1 Scope.....</b>	<b>1</b>
<b>2 Normative references.....</b>	<b>1</b>
<b>3 Terms and definitions.....</b>	<b>1</b>
<b>4 Test methods for joint.....</b>	<b>1</b>
4.1 General.....	1
4.2 Visual testing.....	2
4.2.1 General.....	2
4.2.2 Qualification of test personnel.....	2
4.2.3 Test equipment.....	2
4.2.4 Surface condition and preparation.....	2
4.2.5 Testing.....	2
4.2.6 Acceptance criteria.....	2
4.2.7 Test report.....	3
4.3 Four-point-probe testing.....	3
4.3.1 General.....	3
4.3.2 Qualification of test personnel.....	3
4.3.3 Test equipment.....	3
4.3.4 Surface condition and preparation.....	3
4.3.5 Testing.....	3
4.3.6 Acceptance criteria.....	9
4.3.7 Test report.....	9
4.4 Field-decay testing.....	9
4.4.1 General.....	9
4.4.2 Qualification of test personnel.....	9
4.4.3 Test equipment.....	9
4.4.4 Surface condition and preparation.....	9
4.4.5 Testing.....	9
4.4.6 Acceptance criteria.....	12
4.4.7 Test report.....	12
4.5 In-field testing.....	12
4.5.1 General.....	12
4.5.2 Qualification of test personnel.....	12
4.5.3 Test equipment.....	12
4.5.4 Surface condition and preparation.....	12
4.5.5 Testing.....	12
4.5.6 Acceptance criteria.....	15
4.5.7 Test report.....	15
4.6 Tensile testing.....	15
4.6.1 General.....	15
4.6.2 Qualification of test personnel.....	15
4.6.3 Test equipment.....	15
4.6.4 Surface condition and preparation.....	15
4.6.5 Testing.....	15
4.6.6 Acceptance criteria.....	16
4.6.7 Test report.....	16
4.7 Bend testing.....	16
4.7.1 General.....	16
4.7.2 Qualification of test personnel.....	16
4.7.3 Test equipment.....	16
4.7.4 Surface condition and preparation.....	16
4.7.5 Testing.....	16

## ISO 17279-3:2021(E)

4.7.6	Acceptance criteria .....	17
4.7.7	Test report .....	17
4.8	Critical magnetic field testing .....	17
4.8.1	General .....	17
4.8.2	Qualification of test personnel .....	17
4.8.3	Test equipment .....	17
4.8.4	Surface condition and preparation .....	17
4.8.5	Testing .....	18
4.8.6	Acceptance criteria .....	18
4.8.7	Test report .....	18
4.9	Critical current density distribution testing .....	18
4.9.1	General .....	18
4.9.2	Qualification of test personnel .....	18
4.9.3	Test equipment .....	19
4.9.4	Surface condition and preparation .....	19
4.9.5	Testing .....	19
4.9.6	Acceptance criteria .....	19
4.9.7	Test report .....	19
4.10	Microscopic and X-ray diffraction testing .....	19
4.10.1	General .....	19
4.10.2	Qualification of test personnel .....	19
4.10.3	Test equipment .....	19
4.10.4	Surface condition and preparation .....	19
4.10.5	Testing .....	20
4.10.6	Acceptance criteria .....	20
4.10.7	Reporting .....	20
<b>Annex A (informative) Report of visual testing results .....</b>		<b>21</b>
<b>Annex B (informative) Report of four-point-probe testing results .....</b>		<b>23</b>
<b>Annex C (informative) Report of field-decay testing results .....</b>		<b>26</b>
<b>Annex D (informative) Report of in-field testing results .....</b>		<b>29</b>
<b>Annex E (informative) Report of tensile testing results .....</b>		<b>33</b>
<b>Annex F (informative) Report of bend testing results .....</b>		<b>36</b>
<b>Annex G (informative) Report of critical magnetic field testing results .....</b>		<b>39</b>
<b>Annex H (informative) Report of critical current density distribution testing results .....</b>		<b>41</b>
<b>Annex I (informative) Report of microscopic and X-ray diffraction testing results .....</b>		<b>43</b>
<b>Bibliography .....</b>		<b>45</b>

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

This document was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Quality management in the field of welding*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 121, *Welding and allied processes*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 17279 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

Official interpretations of ISO/TC 44 documents, where they exist, are available from this page: <https://committee.iso.org/sites/tc44/home/interpretation.html>.

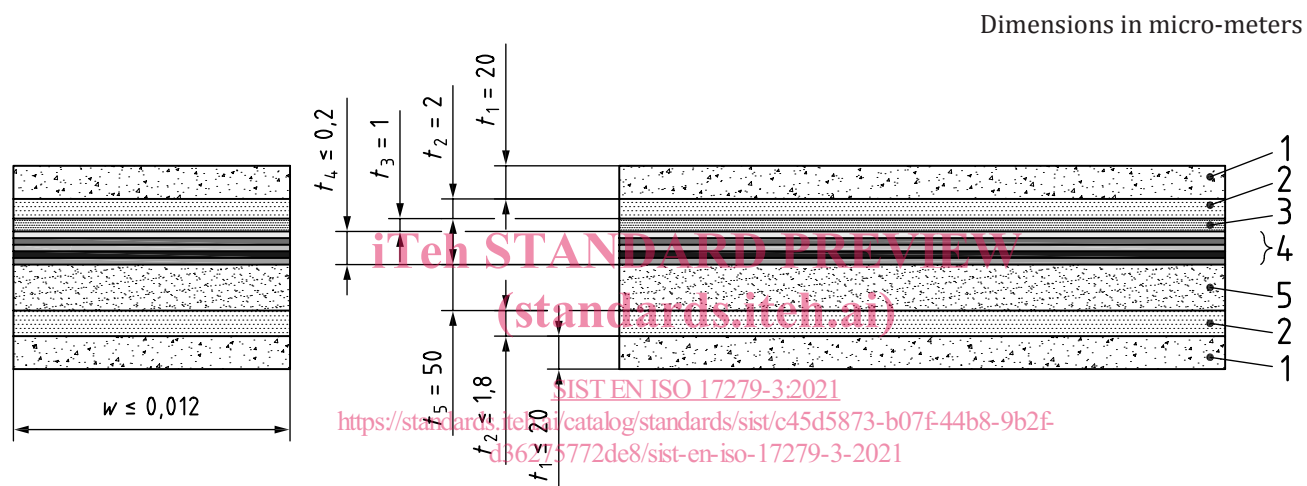
## ISO 17279-3:2021(E)

## Introduction

The increasing use of second-generation high temperature superconductors (2G HTSs) and invention of resistance-free joining on 2G HTSs have created the need for the ISO 17279 series in order to ensure that joining is carried out in the most effective way and that appropriate control is exercised over all aspects of the operation. ISO standards for micro-joining and joint evaluation procedure are accordingly essential to get the best and uniform quality of 2G HTS joint.

Superconductor is a material that conducts electricity without resistance and has diamagnetism below critical temperature ( $T_c$ ), critical magnetic field ( $B_c$ ) and critical current density ( $J_c$ ). Once set in motion, electrical current flows forever in a closed loop of superconducting material under diamagnetism.

2G HTS constitutes of multi-layers and total thickness is around 60  $\mu\text{m}$  to 90  $\mu\text{m}$  and the superconducting layer made from REBa<sub>2</sub>Cu<sub>3</sub>O<sub>7-x</sub> is only 1  $\mu\text{m}$  to 3  $\mu\text{m}$  thick depending on manufacturer's specifications. [Figure 1](#) shows schematic drawing of typical multiple layers, and the constituents and thicknesses of each layer in the 2G HTS.



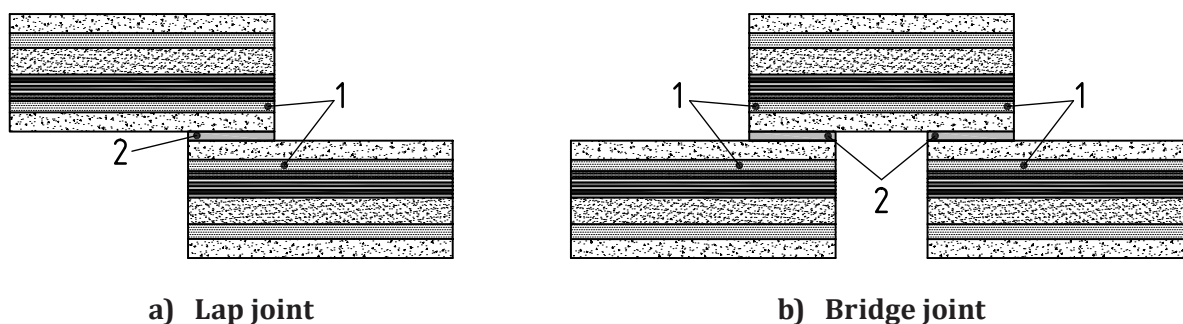
## Key

1	Cu stabilizer	$t_1$	thickness of layer 1
2	Ag overlayer	$t_2$	thickness of layer 2
3	REBCO-superconducting layer	$t_3$	thickness of layer 3
4	buffer stack	$t_4$	thickness of layer 4
5	hastelloy®C-276 substrate	$t_5$	thickness of layer 5

NOTE Not to scale.

**Figure 1 — Typical 2G HTS multi-layers, and the constituents and thicknesses of each layer**

Currently soldering, brazing or any filler is applying in superconducting industry as shown in [Figure 2](#), which shows high electrical resistance at the joint providing fatal flaw in the superconductor.

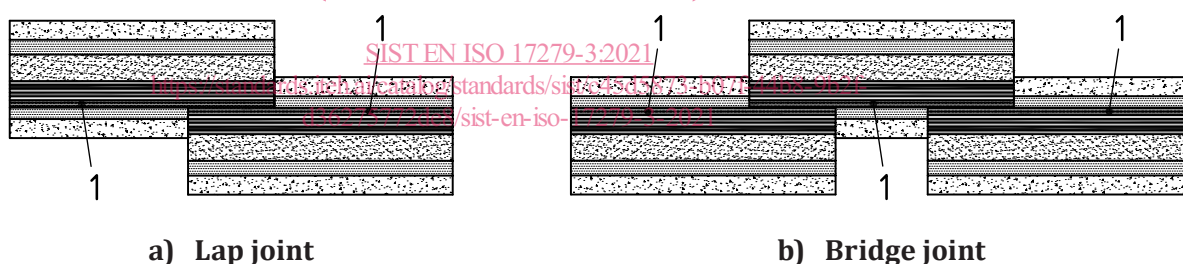


#### Key

- 1 REBCO-superconducting layer
- 2 solder

**Figure 2 — Soldering to join 2G HTS**

However, the ISO 17279 series focuses on the direct autogenous joining of 1  $\mu\text{m}$  to 3  $\mu\text{m}$  thick superconducting layers of 2G HTSs as shown in [Figure 3](#) without filler metals and recovery of superconducting properties by oxygenation annealing process, which shows almost none electrical resistance at the joint.



#### Key

- 1 REBCO-superconducting layer

**Figure 3 — Direct autogenous joining of 1  $\mu\text{m}$  to 3  $\mu\text{m}$  thick superconducting layers of 2G HTSs for superconducting joint**

ISO 17279-1 specifies requirements for the qualification of 2G HTS joining procedure. 2G HTS joints should be capable of performing required electric, magnetic and mechanical properties and free from serious imperfections in production and in service. To achieve that goal, it is necessary to provide controls during design and fabrication.

ISO 17279-2 specifies requirements for the qualification of personnel performing welding and testing.

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

[SIST EN ISO 17279-3:2021](#)

<https://standards.iteh.ai/catalog/standards/sist/c45d5873-b07f-44b8-9b2f-d36275772de8/sist-en-iso-17279-3-2021>

# Welding — Micro joining of second generation high temperature superconductors —

## Part 3: Test methods for joints

### 1 Scope

This document specifies the requirements for the test methods for joint of micro-joining of 2G HTS to fulfil the requirements of ISO 17279-1 and ISO 17279-2.

This document specifies test methods for determining the capability of joints for the production of the specified quality. It defines specific test requirements, but does not assign those requirements to any specific product group.

### 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 17279-1:2018, *Welding — Micro joining of 2nd generation high temperature superconductors — Part 1: General requirements for the procedure*

ISO 15607:2019, *Specification and qualification of welding procedures for metallic materials — General rules*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 17279-1 and ISO 15607 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

### 4 Test methods for joint

#### 4.1 General

ISO 17279-1:2018, 5.5.4, describes requirements for qualification of test personnel, for test methods, witness during testing and retesting. Especially, ISO 17279-1:2018, Table 1, shows the type of testing, the extent of testing, the confirmation of testing, and required tests for the procedure qualification according to ISO 17279-1. ISO 17279-1:2018, 5.9, requires the acceptance criteria of the tests. The manufacturer can have at their disposal sufficient competent personnel for the testing and operating the test equipment, or can contract the specific tests to the specialized organizations. The manufacturer can witness the tests from specimen preparation to data acquisition and analysis according to manufacturer's quality assurance requirements.

The operating procedures and cautions of the test equipment shall be applied when the equipment is used for testing according to this document. The operator of the specific equipment shall establish the capability to perform the required test, and calibration and qualification of the test equipment shall