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Critical bending diameter measurement of Bi-2223 superconducting tapes

临界弯曲直径测量 液氮温区Bi-2223超导带材的临界弯曲直径测量

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Table of Contents

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 is required. Please

note that some of the contents of this document may involve patents. The issuing organization of this document does not assume the responsibility for identifying patents. This document was proposed by the Chinese Academy of Sciences. This document is under the jurisdiction of the National Superconductivity Standardization Technical Committee (SAC/TC 265). This document was drafted by: Institute of Electrical Engineering, Chinese Academy of Sciences, Institute of Physics, Chinese Academy of Sciences, Hefei Institute of Physical Science, Chinese Academy of Sciences Institute, Tsinghua University, Huazhong University of Science and Technology, North China Electric Power University, Suzhou New Materials Research Institute Co., Ltd., Guangdong Power Grid Co., Ltd., Shanghai Cable Research Institute Co., Ltd., China Electric Power Research Institute Co., Ltd. The main drafters of this document are. Zhang Guomin, Zhang Dong, Du Xiaoji, Jing Liwei, Shi Yue, Yang Lihong, Gu Chen, Zheng Jinxing, Shi Jing, Pi Wei, Wang Yushan, Song Meng, Zong Xihua, Qiu Ming, Wu Yilong, Jia Shiqi.

High-temperature superconductors have broad application prospects in many fields such as superconducting power, superconducting magnets, and superconducting magnetic levitation. Superconducting materials are mainly Bi and Y series. Among them, Bi2223 tape has good superconducting properties and can be prepared into long tapes. It is the first generation of practical high Warm superconducting tape. In high-field magnets, superconducting cables, superconducting transformers and other application devices, superconducting tapes need to be wound into coils or spirals. In the form of a conductor that carries electricity, bending is inevitable. High-temperature superconductors are ceramic oxide materials with poor mechanical properties, and bending will cause superconductivity to The critical current of the tape decreases. Superconducting tape has a critical bending diameter. When the bending diameter is smaller than the critical bending diameter, its critical current drops significantly. Therefore, the critical bending diameter needs to be determined in the design of superconducting devices. At present, although some measurement standards have been established for the critical current of high-temperature superconductors, such as GB/T 18502-2018 and GB/T 42472-2023, but there is no standard for the measurement of the critical bending diameter of high-temperature superconducting tapes. This document describes the measurement method of the critical bending diameter of Bi2223 strip in the liquid nitrogen temperature zone based on the existing critical current measurement standard. Provide guidance to application engineering technicians. Critical bending diameter measurement Bi-2223 superconducting tape in liquid nitrogen temperature zone Critical bending diameter measurement

1 Scope

China's national method for measuring the critical bending diameter of Bi-2223 superconducting tape. Bismuth strontium calcium copper oxide tape is the first generation of high temperature superconductor: fine ceramic filaments in a silver matrix, drawn and rolled into a flat tape. The ceramic is brittle, and bending the tape past a certain radius

cracks the filaments and destroys the superconductivity - permanently and, crucially, without any visible sign. The critical bending diameter is the smallest diameter the tape tolerates without losing critical current, and it is the parameter that determines how a coil can be wound and how the tape can be handled during installation. Measuring it means bending specimens to progressively smaller radii and measuring the critical current after each, which identifies the threshold at which degradation begins rather than the point at which it becomes obvious.

This document describes the method for measuring the critical bending diameter of Bi2223 superconducting tapes at liquid nitrogen temperature. This document applies to Bi with rectangular cross section, silver/silver alloy sheath and strip critical current less than 300 A (77 K, self-field, 1 μV/cm) 2223superconducting tape sample.

2 Normative references

The contents of the following documents constitute the 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. in this document.

GB/T 2900.100-2017 Electrical terminology Superconductivity

GB/T 18502-2018 Critical current measurement of silver and/or silver alloy sheathed Bi2212 and Bi2223 oxide superconductors Boundary current

GB/T 42472-2023 Critical current measurement Retention critical current of silver-sheathed Bi2223 superconducting wire after double bending at room temperature

3 Terms and definitions

The terms and definitions defined in GB/T 2900.100-2017 and GB/T 18502-2018 and the following apply to this document.

3.1 critical current Ic In a superconductor, the maximum DC current that can be considered to flow with almost no resistance.

Note. I c is a function of magnetic field strength and temperature. [Source: GB/T 2900.100-2017,8151201]

3.2 critical current criterion Ic criterion The criterion for determining the critical current Ic is determined based on the electric field strength E or the resistivity rho.

Note. The commonly used electric field criterion is E=10 μV/m or E=100 μV/m, and the resistivity criterion is rho=10-14 Omega·m or rho=10-13 Omega·m. [Source: GB/T 2900.100-2017,8151202]

3.3 n-value (of a superconductor) In a specific range of electric field strength and resistivity, the voltage-current curve U(I) of a superconductor can be approximately expressed as UIn, where the power of I refers to The number is the n value of the superconductor.

Note. For oxide high-temperature superconductors, the UIn equation is not applicable to a wide voltage range.