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**NATIONAL STANDARD OF THE
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GB/T 42747-2023

Superconducting strip photon detector - Dark count rate

超导条带光子探测器 暗计数率

(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 modified to adopt IEC 61788-22-3:2022 "Superconductivity Part 22-3: Dark counting of superconducting strip photon detectors Rate":

Compared with IEC 61788-22-3:2022, this document has more structural adjustments: Structure number change comparison between two files See Appendix A for a list:

The technical differences between this document and IEC 61788-22-3:2022 and their reasons are as follows:

--- Added a normative reference to GB/T 2900.100-2017 to adapt to my country's technical conditions (see Chapter 3):

The following editorial changes have been made to this document:

--- Added Appendix A (informative) "Contrast between this document and IEC 61788-22-3:2022 structure number":

Please note that some contents of this document may refer to patents: The issuing agency of this document assumes no responsibility for identifying patents:

This document was proposed by the Chinese Academy of Sciences:

This document is under the jurisdiction of the National Superconducting Standardization Technical Committee (SAC/TC265):

Introduction

Use superconductivity to perform ultra-high-sensitivity sensing or measurement of many physical quantities: GB/T 39722-2020 lists a variety of is one of a kind:

A typical basic structure of a strip detector is a superconducting meander structure, for example, fabricated on a superconducting thin film with a thickness less than 10 nm:

Strips with a line width of tens of nanometers or hundreds of nanometers and a length of about several millimeters: Its structure is nanoscale: In GB/T 30544.1-2014 the length range of nanoscale is defined as 1nm~100nm: Because an object with one-dimensional length of nanoscale is a nano-object, so Superconducting meander wires are classified as nano-objects:

The term "nanowire" is often used to denote superconducting meander wires, but is not recommended in this document: In the ISO vocabulary, nanowires are defined as conductive or semiconducting nanofibers, two of the outer dimensions are nanoscale and

the third dimension is much larger: While the scale differences in the first two dimensions are usually to be less than 3 times: If the difference between the first two dimensions is too large, use "nanosheet", "nanosatin" or "nanoribbon" to describe the meander line structure: However, these terms are less commonly used in the field of electronics: In addition, in the ISO definition of nano-objects, the structure of the superconducting meander line may not meet the the structure of the line is commonly used, because the line needs to have a circular transverse interface: Although in some cases the shape of the nanowire conforms to the ISO definition, such as wire the thickness of the strip is 5nm and the width is 15nm, but from the theoretical point of view of the single-photon detection principle, the "strip" is more reasonable than the "nanowire": the width is far larger than the superconducting coherence length and has two-dimensional properties: Therefore, in GB/T 39722-2020, the name "nano "Rice" was replaced with "strip": According to the definition of the standard, the strip-type detectors are unified into superconducting strip photon detectors
[supercon-Abbreviation for SSPD:

SSPDs typically operate well below their transition temperature and are biased near the critical current region: The mechanism of photon detection is the superconducting library the disintegration of the Purer pairs leads to the formation of hot spots or vortex motion, resulting in an electrothermal resistive zone: A clear and unified detection model is currently not fully the current mainstream model is the hotspot model: Since the photon energy (1eV) in the optical communication band is higher than the binding energy of the Cooper pair (several meV) About 2~3 orders of magnitude higher, when a photon is absorbed by the strip, hundreds of Cooper pairs will be dismantled and a large number of quasiparticles will be generated:

A localized hotspot of obstruction is produced on the belt: Through the electrothermal feedback process, the normal region will spread across the entire line width of the strip and in the direction of current flow:

Diffuse a small amount, which results in a resistive region on the superconducting strip: Besides that, there are some other possible detection models, such as vortex-Anti-vortex versus dissociation or single vortex traverse etc: Vortex motion may cause the same electrothermal feedback to create a resistive zone: Finally, since in the strip the bias current will be diverted to the readout circuit, which will cause the normal area to cool down rapidly and eventually disappear: above process A voltage pulse will be generated corresponding to a single photon absorption event:

The main application fields of SSPD detectors are quantum information, laser communication, light detection and ranging, fluorescence spectroscopy and quantum computing:

The performance of SSPD detectors in all aspects (as described in the next paragraph) has far exceeded that of semiconductor single-photon detectors such as photomultiplier tubes and avalanche photodiodes:

polar tube etc: The market size of SSPDs is rapidly increasing owing to the surging demand for ultrasensitive photon detection in the mid-infrared: The standardization of SSPD does not it is not only conducive to industry applications, but also conducive to the development of scientific research:

As a photon detector, some key parameters are usually used to characterize its performance, such as detection efficiency, time jitter, dead time and dark count:

rate etc: Among them, the dark count rate affects the measurement of other parameters, so it is generally preferred to measure the dark count rate:

Dark count rate of superconducting strip photon detector

1 Scope

This document describes the measurement of the dark count rate (DCR or RD), one of the performance parameters of a superconducting strip photon detector (SSPD), and the accompanying the test method of the dark count rate of the relationship between the bias current (I_b) and the working temperature (T): Defined the terms, definitions, symbol:

This document is applicable to dark counting measurements of superconducting strip photon detectors of various materials and structures:

2 Normative references

The contents of the following documents constitute the essential provisions of this document through normative references in the text: Among them, dated references for documents, only the version corresponding to the date is applicable to this document; for undated reference documents, the latest version (including all amendments) is applicable to this document:

GB/T 2900.100-2017 International Electrotechnical Vocabulary Superconductivity (IEC 2900.100:2015, IDT)

3 Terms and Definitions

The following terms and definitions defined in GB/T 2900.100-2017 apply to this document:

Dark count the number of pulse counts generated when there is no photon input to the detector:

NOTE: One typical pulse of dark counting is shown in Figure 1: The inset shows the dark count pulse train over time: