Superconducting Nanowires for Detecting Single Photons at Telecommunication Wavebands

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Abstract- **NbN thin films (a few nm thick) are deposited on MgO substrates and patterned into meander lines to make single photon detectors at telecommunication wavebands of 1310 nm and 1550 nm. Typically the width of the meander line is 100 nm, and the detection area is 10× 10 μm². The detector efficiency, dark count rate, time jitter, and response speed of the single photon detectors are discussed. Possible practical applications of these devices are explored.**

I. Introduction

Single photon detectors (SPDs) with high efficiency, low dark count rate, low time jitter and high response speed are essential for quantum communication [1, 2], failure diagnoses of integrated circuits [3], single photon source characterization [4, 5] and high speed optical communications [6]. InGaAs avalanche photo diodes (APD) [7, 8] are generally used experimentally in quantum telecommunication as single photon detector at telecommunication wavelengths. But the response speed is quite low (about 1 MHz) and the dark count rate is high. Superconducting transition edge sensors (TES) [9-11] and superconducting nanowire single photon detectors (SNSPD) [12, 13], which are capable of detecting visible and near-infrared photons at the single-photon level, are widely exploited in recent decade. The recovering time with TES is long, making SNSPDs the most promising one so far. In our work NbN thin films (a few nm thick) are deposited on MgO substrates and patterned into meander lines to make single photon detectors at telecommunication wavebands of 1310 nm and 1550 nm. Various aspects of such SPDs as well as their possible applications will be discussed in this paper.

II. Film Fabrication

We use DC magnetron sputtering to deposit NbN films on MgO substrates. For SPDs applications, it is important to keep the films thin enough which inevitably degrades the critical temperature, microwave surface impedance and other parameters of the films. Having overcome these difficulties, we are able to fabricate NbN films good enough for the purpose.

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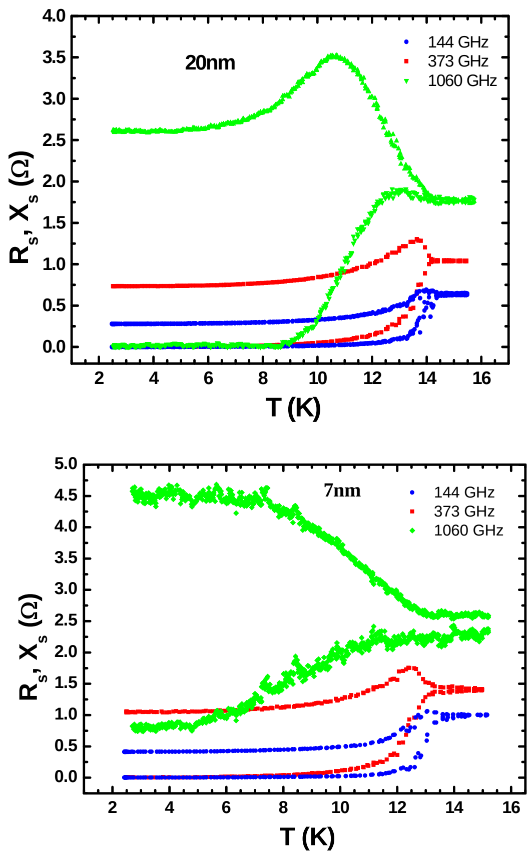

Fig. 1. Microwave surface impedance of NbN films at various frequencies. (a) film thickness 20 nm, and (b) film thickness 7 nm.

Fig. 1 shows the microwave impedances of the films at various frequencies, indicating very good results.

E-beam lithography and reaction ion etching are used to pattern the NbN films into meander lines with a width of 100 nm. A typical device is shown in Fig. 2

III. Results and Discussions

Shown in Fig. 3 are our typical results at the time of abstract submission where detector efficiency and dark count

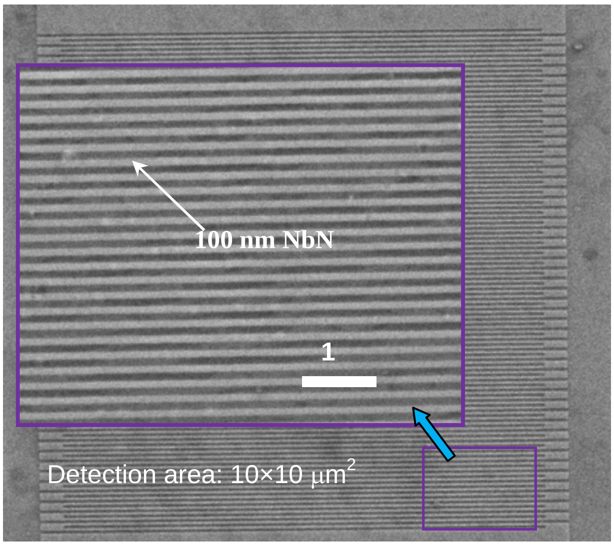

Fig. 2. SEM image of SNSPD with meandered NbN nanowire of 100 nm in width over a detection area of 10×10 m2

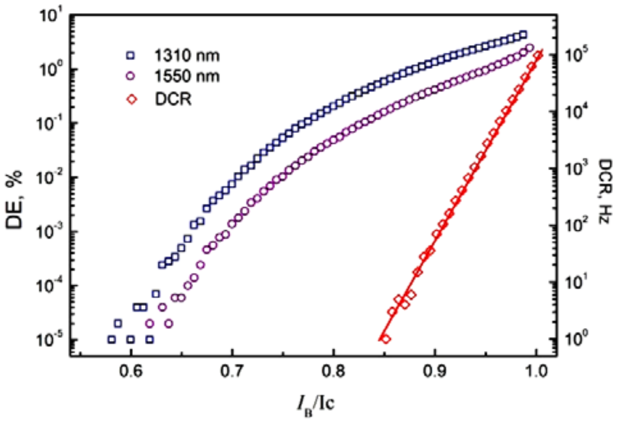

Fig. 3. Detector efficiency and dark count rate vs bias current for 100 nm NbN nanowires at 4.2 K

rate are given vs bias current. The results will be renewed at the conference.

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