Combined operation of two small pixel Ir-TESs for optical application

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Introduction

In coherent optical communication, the limit of communication capacity (Shannon limit), which is defined by classical physics, is caused by the shot noise of light. If there was no shot noise, the communication capacity of optical communication could be increased dramatically. It is possible to avoid shot noise by using superposed quantum states, made by squeezed states and a photon number resolving detector. Therefore, we aim to realize a single-photon TES detector which greatly improves its sensitivity and response speed by minimizing of the thermometer volume and fabricate a simple detector with no mirror by increasing the film thickness for preventing transmission. Iridium (Ir) has a sharp superconducting transition at 112 mK in bulk, therefore, even if it is used as a single superconducting thin film for the thermometer of TES, excellent energy resolution is expected.

Fabrication

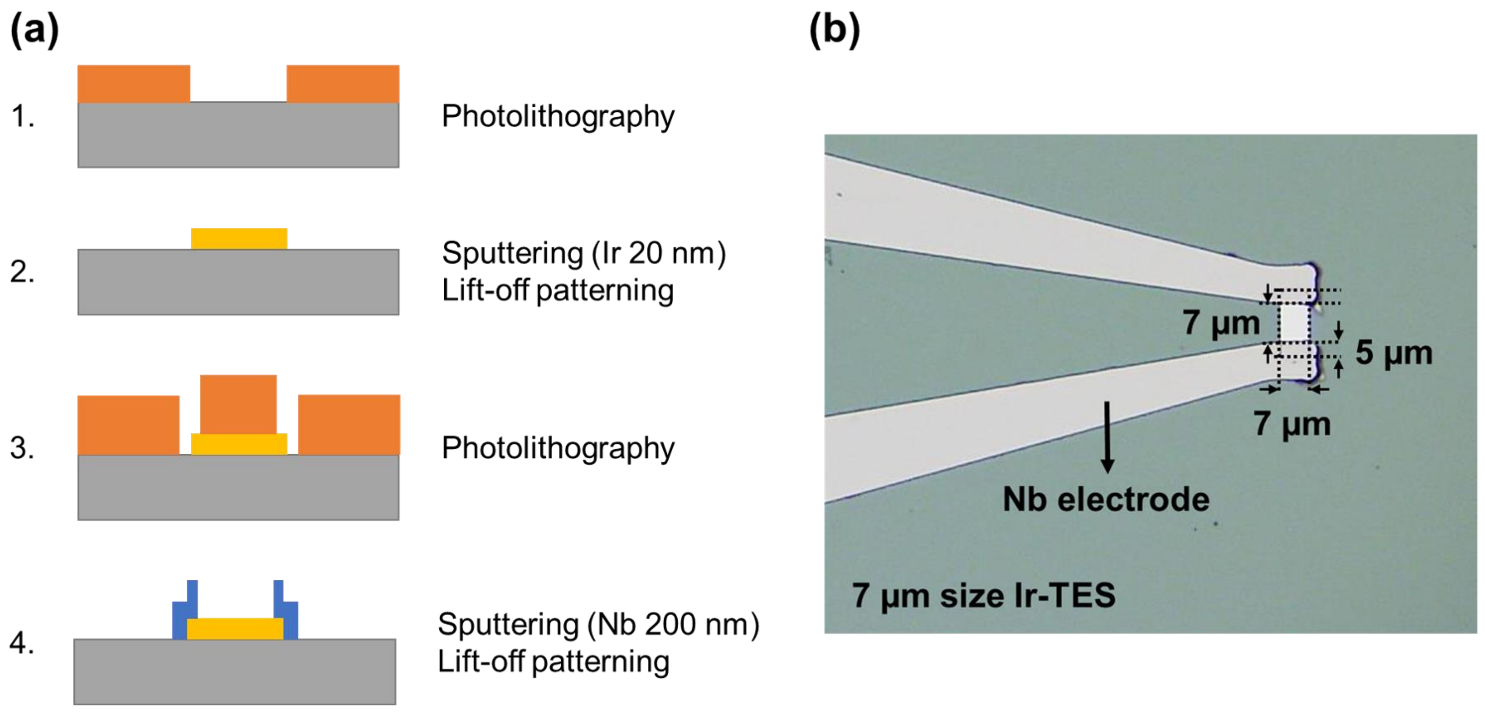

Fig. 2 (a) The fabrication process of small pixel Ir-TES
(b) The picture of small pixel Ir-TES (7 μm size)

Measurement

Table.1 Experimental setup

laser	λ [nm]	TES size[μm]
CW	1310	7
pulse	508, 855	10

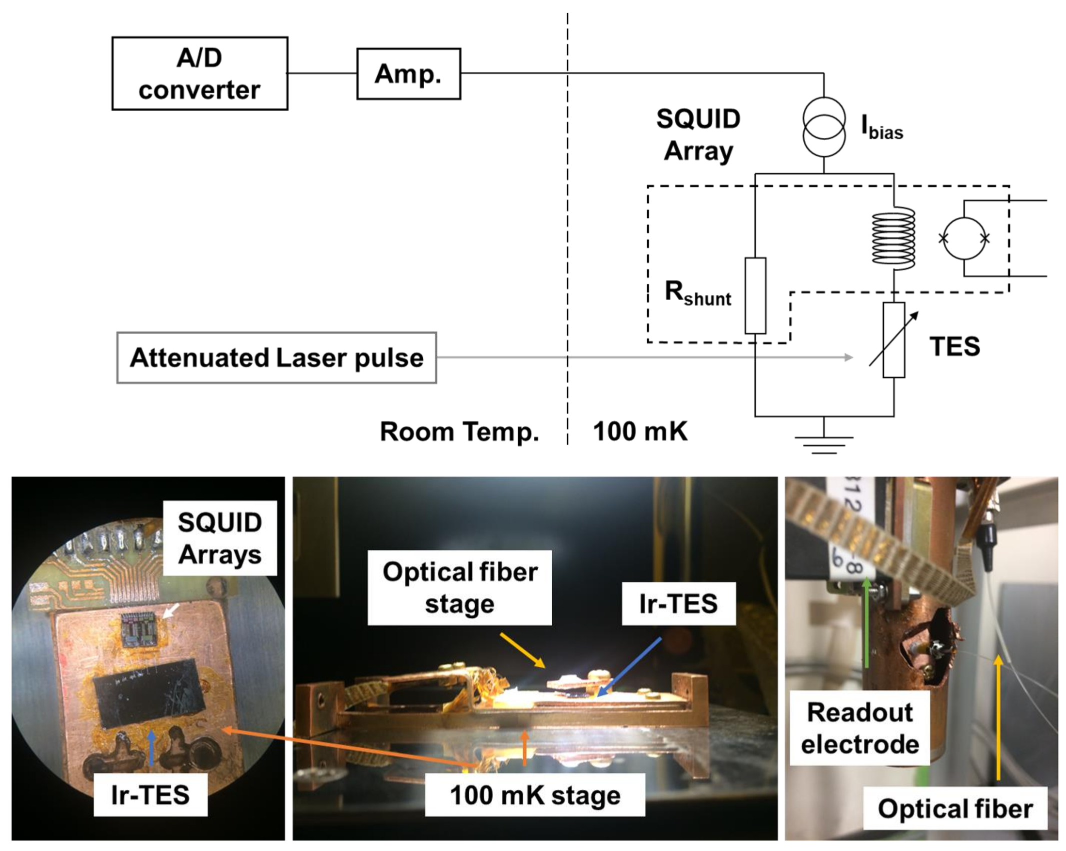

Fig.3 Measurement setup

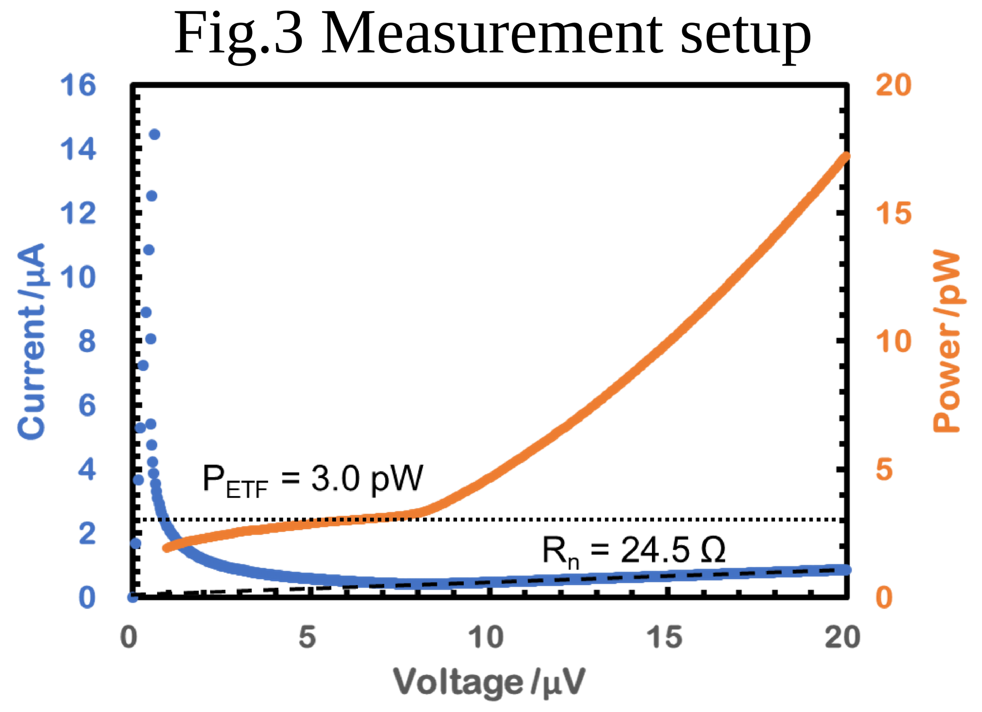

Fig. 4 The I-V characteristics of Ir-TES at 64 mK (T_c ~ 280 mK)

Results and Discussion

Single photon measurement

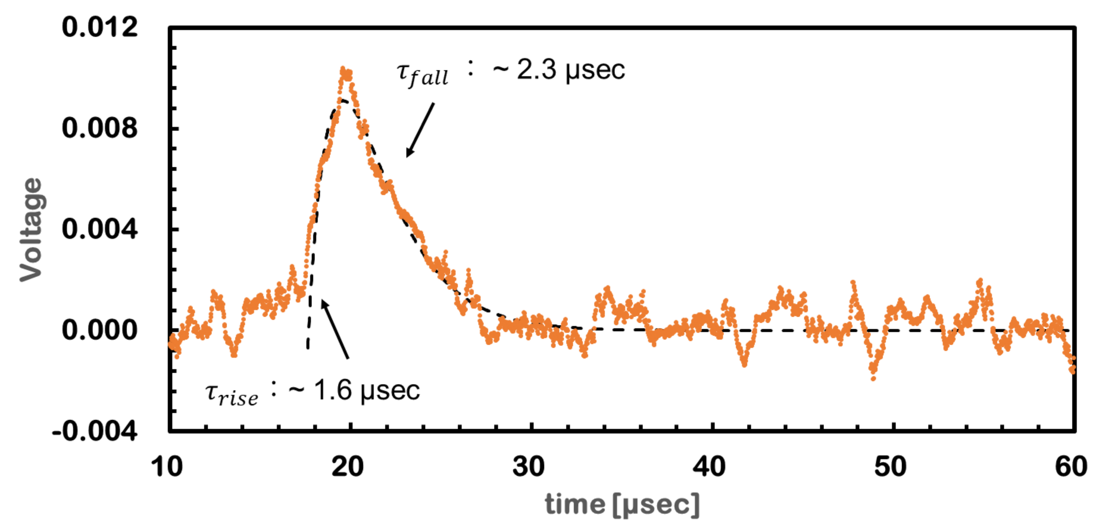

Fig. 5 Averaged signals of 1310 nm single photons

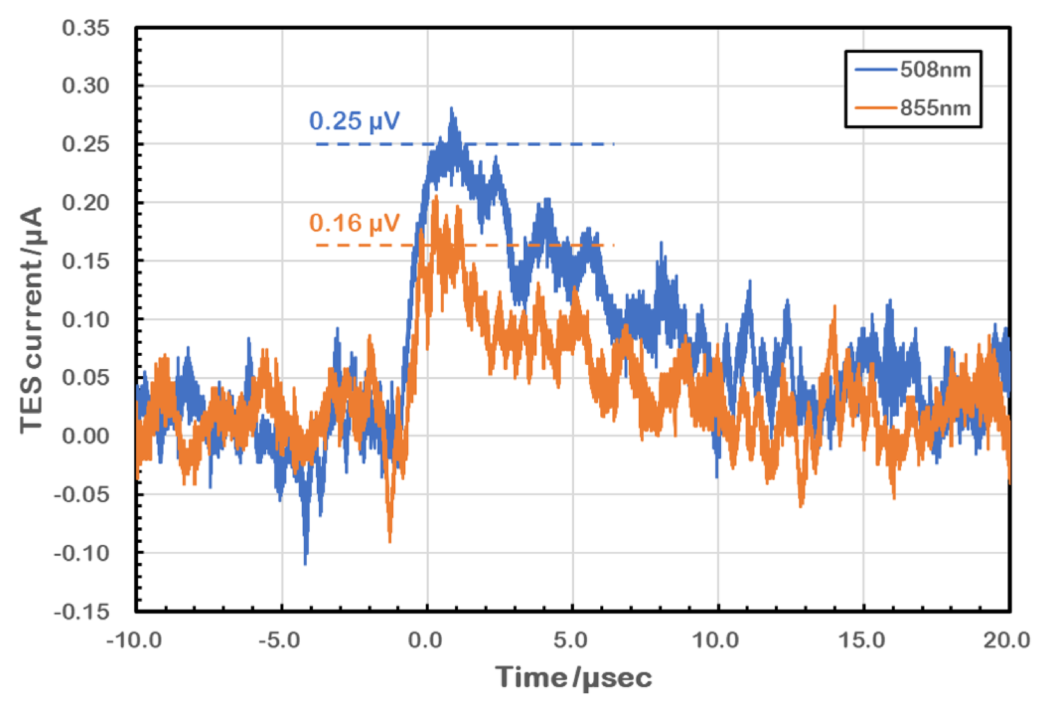

Fig. 6 Observed signals of 508 and 855 nm pulsed single photons

Table.2 Results of optical measurements

laser	λ [nm]	TES size [μm]	τ_{rise} [μsec]	τ_{fall} [μsec]
CW	1310	7	1.6	2.3
pulse	508 855	10	0.5	6.0

- We successfully observed a spectrum corresponding to a single photon detection in the visible and near infrared region.
- We will plan to optimizing the setup of the optical fiber coupling for improving the detection efficiency.

LTspice simulation

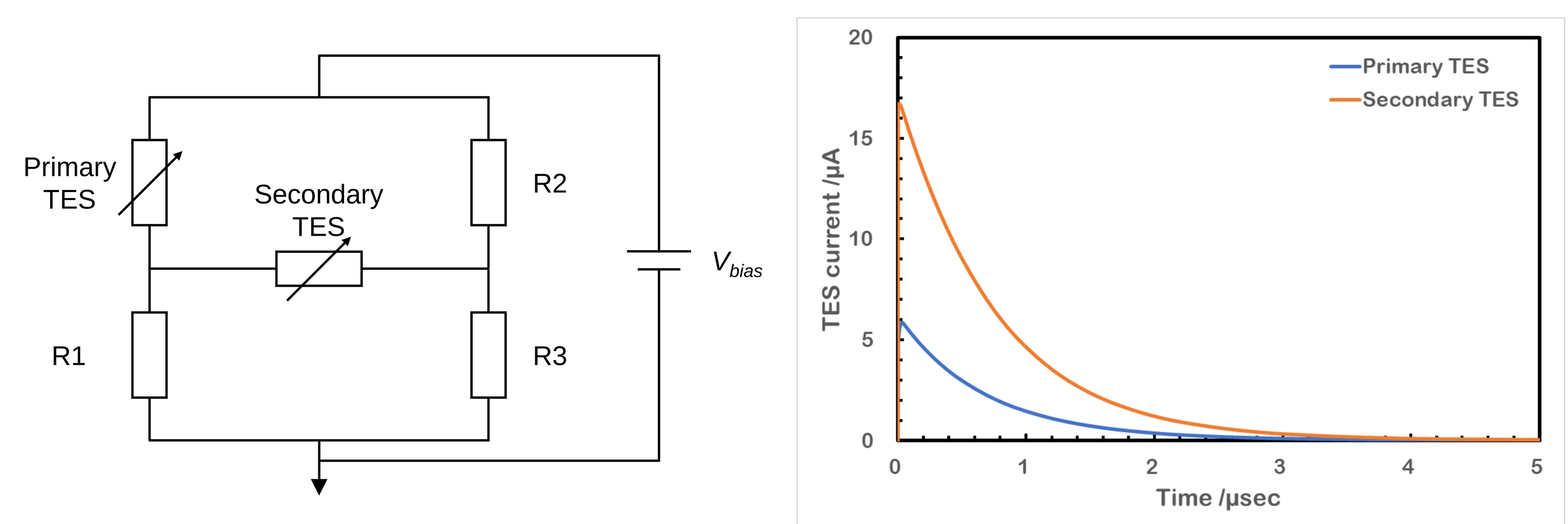

Fig. 7 Simple bridge circuit with two TESs and simulation result (LTD-17th, PB-24)

- We successfully confirmed 3 times higher TES current with using a simple bridge circuit.

Conclusion

- We aimed to fabricate a small pixel Ir-TES at 100 mK and demonstrated the operation of 7 and 10 μm size Ir-TES.
- We clearly observed the several peaks, which represent single photon absorbed in the TES film.
- In the LTspice simulation, we confirmed 3 times higher TES current with using a simple bridge circuit.
- Now we are optimizing the setup of the optical fiber coupling increase the coupling efficiency.