Cold-Electron Bolometer Arrays for THz Detection

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***Abstract*— Various concepts of Cold-Electron Bolometer (CEB) Arrays are considered for THz detection from 300 GHz to 7 THz. A series array of 64 cold electron bolometers designed for 7 THz operation was fabricated and dc tested at temperatures down to 50 mK. At 277 mK temperature sensitivity is 50 µV/mK. Optical response to THz radiation is 300 µV for 2.7/0.3 K temperature difference. Noise of such array is 26 nV/Hz$^{1/2}$. Response of more than 2 mV was measured for 5 K blackbody temperature in array designed for 350 GHz**

I. Introduction And Background

We develop cold electron bolometers for use in the SAFARI detector for the SPICA (SPace Infrared telescope for Cosmology Astrophysics) space borne 3.5 m diameter telescope. The SAFARI (SpicA FAR-infrared Instrument) instrument 34-210 µm wave band is divided into several channels. Our design is intended for 7 THz channel with spectral range 34-60 µm (5-9 THz). The goal is to obtain the noise equivalent power down to NEP=10^{-19} W/Hz$^{1/2}$ for power load P_0=20 aW at operating base temperature 50 mK. Another application of such array could be a detector in cryogenic Fourier Transform Spectrometer (FTS) in THz frequency band.

Image of the sample is presented in Fig. 1. In the center of chip there are placed 4 arrays each consisting of 64 bolometers. Diagonal pairs of arrays are receiving orthogonal polarizations. Each bolometer is connected to a dipole antenna designed for 7 THz central frequency.

II. Results

Samples were dc tested in dilution refrigerator at temperatures down to 50 mK. For sensitivity measurements chip with such sample was placed on the flat side of extended hyper-hemisphere Si lens and optically tested using a blackbody radiation source. At base temperature of 277 mK we measured temperature sensitivity and response to hot/cold load (Fig. 2). Temperature response is consistent to our previous measurements both with single bolometers and arrays consisting of 10 bolometers. Obtained optical response for 7 THz 2.7 K blackbody radiation is 100 µV/K. Such structure also receives radiation at multiple wavelengths up to x8, which means that we also measuring response at some frequencies below 7 THz. Similar array scaled for 350 GHz frequency band demonstrated optical response up to 2 mV for 5K blackbody temperature.

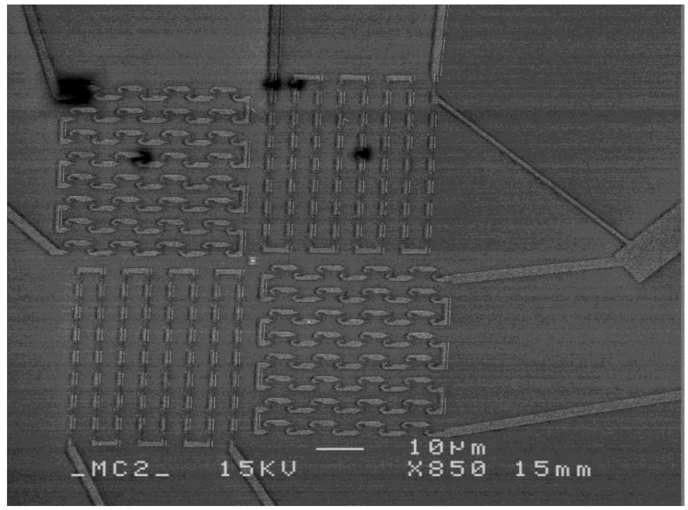

Figure 1. SEM image of the sample with four arrays each consisting of 64 bolometers.

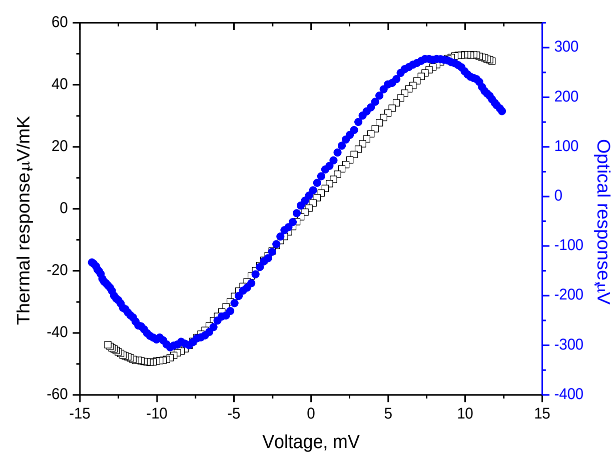

Figure 2. Voltage response of array to small temperature change at 277 mK and voltage response to hot/cold load with temperature difference 3 K.

References

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