Response of the antenna coupled TES with High-Frequency Readout to 0.65 THz radiation

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Antenna coupled TES bolometers have a great potential as ultra-low noise terahertz detectors. By decreasing the volume of the sensitive element to nanometer scale and operating temperature to millikelvins, one could reach ultra-low Noise Equivalent Power (NEP) for space astronomy which is limited only by cosmic background [1]. Avoiding influence of excess noises and interference through the biasing lines is a great challenge in this case. The well established method to readout the signal from TES is based on the low-noise DC-SQUID amplifiers. Frequency-division multiplexing (FDM) was suggested as a method for building an array of such bolometers [2]. However the bandwidth of SQUID amplifiers implies restriction for scalability of the readout circuit. This leads to an increase of complexity and cost of the system.

In order to improve the scalability of FDM and avoid low-frequency SQUID amplifiers along with the perfect isolation of the sensitive element from excess noise and unwanted interference, we suggested embedding antenna-coupled TES bolometer into high-Q GHz resonator as a load [3-4] and bias it with RF power applied through weakly coupled transmission line. The readout of THz signal is realized via demodulation of RF bias signal. We called this new type of detectors RF-TES.

To verify the feasibility of the new device concept we fabricated sub-micron sized prototypes of single pixel RF-TES for operation temperature of about 5.0 K. Device was fabricated from magnetron sputtered Nb thin films on sapphire substrate: 10 nm thick Nb for TES bridge (T_c~5K) and 250 nm for resonator (T_c~8.5 K). To define the geometry of our TES bridges we used e-beam lithography and ion milling. Since TES doesn't have DC connections we fabricated the witness bridges of the same size as TES to investigate DC transport and thermal properties. Witness bridges were made in same fabrication process and on the same wafer with RF-TES. RF measurements of the device were performed in transport He^4 Dewar using Network Analyzer. Resonance curves were investigated at different bath temperature and RF power levels. Cratered resonance was observed under certain temperature and bias conditions which were chosen as initial working point for further optical measurement at 0.65 THz. To measure response to THz radiation RF-TES was placed in the focus of the sapphire lens mounted in the detector block inside He^4 cryostat equipped with LNA and optical window. Results on achieved sensitivity and NEP will be presented and discussed.

References

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