Development of ultra low noise TES Bolometer Arrays

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We are developing ultra low noise TES detectors based on TiAu bilayers with thin Ta film absorbers on silicon nitride (SiN) membranes, in which long and narrow SiN legs act as thermal links between the TES and a thermal bath. These bolometers can potentially be used in an imaging spectrometer instrument on an infrared space telescope with cryogenically cold mirror like SPICA. We have previously achieved dark NEPs of 4-5x10^{-19} W/√Hz for single pixels and 5-6x10^{-19} W/√Hz for an array of 8x9 using 1μm wide SiN legs. However, there are concerns about realizing TESes with even lower NEP:

- Can we achieve lower heat conductance and NEP values by going to narrower and thinner legs?
- What is the effect of the SiN island on the NEP? Does it create significant excess noise?
- What is the effect of the Ta Absorber on the NEP? Does it create significant excess noise?
- How dark is our setup? Can we accurately quantify that?
- What is the uniformity of ultra low noise array?

The aim of this work is to address some of these questions. We have replaced the wet KOH etching of the Si substrate by Deep Reactive Ion Etching (DRIE). This process enables us to fabricate the TES detectors on the substrate and release the membrane at the very last step. Therefore, the production of large arrays on thin SiN membrane

(250 nm) is feasible. It also makes it possible to realize narrow supporting SiN legs of < 1 μm.

A large variety of these devices has been fabricated with different leg geometry, SiN island size and SiN leg width and without the Ta absorber. Characterizing these devices shows the effect of an extra heat capacity due to the SiN island and the Ta film absorber on the noise. Comparing the detectors with and without Ta absorbers also quantifies the darkness of the experimental setup. These devices are characterized under AC bias using our Frequency-Division Multiplexing readout (1-3 MHz) system that enables us to measure many devices at the same time that give information about the uniformity of our array. The measurements and data analysis are currently in progress and our latest results will be presented.