# T2B

# Noise Measurements in Ti Hot-Electron Nanobolometers

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***Abstract*—We present the current progress for the titanium (Ti) hot-electron nanobolometers operating at ~ 0.04-0.4 K. The ultimate goal of the work is to develop a submillimeter direct detector with the noise equivalent power NEP = $10^{-18}$-$10^{-20}$ W/Hz$^{1/2}$ for the moderate resolution spectroscopy and CMB studies on future space telescope (e.g., SAFIR, SPECS, SPICA, CMBPol) with cryogenically cooled (~ 4-5 K) mirrors.**

**Recently [1], we have achieved the extremely low thermal conductance (~ 2 fW/K at 300 mK and ~ 0.1 fW/K at 40 mK) due to the electron-phonon decoupling in Ti nanodevices with Nb Andreev contacts fabricated on Si. This thermal conductance translates into the NEP ≈ $3\times10^{-21}$ W/Hz$^{1/2}$ at 40 mK and NEP ≈ $10^{-18}$ W/Hz$^{1/2}$ at 300 mK. These record data indicate the great potential of the hot-electron nanobolometers for meeting many application needs. As the next step towards the practical demonstration of the HEDD, we fabricated and tested somewhat larger devices (~ 4 µm × 0.4 µm x 40 nm) whose critical temperature is well reproduced and is in the range 300-350 mK. The output electrical noise measured in these devices in the voltage-bias mode with a low-noise (~ 2 pA/Hz$^{1/2}$) dc SQUID amplifier was completely dominated by the thermal energy fluctuations (phonon noise). The corresponding electrical NEP was in the range (2-7)$\times10^{-18}$ W/Hz$^{1/2}$ depending on the detector device size. The time constant of these devices was too short to be measured directly with the available SQUID readout electronics and is estimated to be of the order of a µs or less.**

**Beside the record low NEP, the ultimately small nanobolometers have a very low electron heat capacitance that makes them promising for detecting single THz photons. The larger devices studied in this work were tested using NIR photons (wavelength 1550 nm). Depending on the average number of photons per pulse, a typical Poisson-like statistics of counts has been observed. The photon numbers greater than 2 were, however, difficult to observe since the detector output was almost saturated by just a single photon of this wavelength. The minimum detectable energy for these devices is estimated to be about h×5THz.**

**The on-going effort is aimed at fabrication of the antenna-coupled detector devices and direct optical measurements of the NEP at 650 GHz. A setup for single THz photon detection utilizing a pulsed quantum cascade laser is also being built. The progress in these areas will be reported during the meeting.**

**[1] J.Wei et al., *Nature Nanotechnology* 3, 496 (2008).**