Next Generation of Hot-Electron Bolometer Mixers for Future Heterodyne Missions

S. Ryabchun*, M. Finkel, I. Tretyakov, A. Maslennikova, N. Kaurova, B. Voronov, and G. Gol'tsman
Department of Physics and Information Technology, Moscow State Pedagogical University, Moscow, Russia
* Contact: sryabchun@rplab.ru, phone +7-499-246 1202

***Abstract*— At frequencies well above 1 THz the only type of receiver with so far unmatched performance is the hot-electron bolometer (HEB) receiver, which has offered excellent noise characteristics (5*hν/k*), a wide gain bandwidth, and also requires much less local oscillator (LO) power than Schottky diodes. In 2009 the Herschel space telescope was successfully launched with and HEB receiver on board for observations in the terahertz range. The next two big projects that will require HEB receivers are SOFIA, a joint project between NASA and the German Aerospace Center (DRL), and Millimetron, a project of the Russian Astrospace Center.**

We present the results of the noise temperature, gain bandwidth and absorbed LO power measurements on new generation NbN HEB mixers with simultaneous phonon and diffusion cooling of the hot electrons. At 4.2 K the HEB receiver driven by a 2.5-THz gas discharge laser offered an uncorrected noise temperature of about 600 K (5*hν/k*). Such an unprecedentedly low value of the noise temperature results from the reduction of radio frequency loss at the interface between the mixing element and the contact pads due to the use of the *in situ* (without breaking vacuum) deposition technology. We have also found that the noise temperature remains almost constant across an intermediate frequency range of 1-7 GHz. Measurements near the superconducting transition have shown that the mixer time constant decreases with its length, following the predictions of the model of the HEB mixer with simultaneous phonon and diffusion cooling of the hot electrons. The model also predicts, in agreement with experiment, that the LO power required to drive the mixer to the low-noise operating point becomes independent of the mixer length when it becomes shorter than the thermal healing length.