Optimization of the intermediate frequency bandwidth in the THz HEB mixers

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We report on the studies of the intermediate frequency (IF) bandwidth of quasi-optically coupled NbN hot-electron bolometer (HEB) mixers which are aimed at the optimization of the mixer performance at terahertz frequencies. Extension of the IF bandwidth due to the contribution of electron diffusion to the heat removal from NbN microbolometers has been already demonstrated for NbN HEBs at subterahertz frequencies. However, reducing the size of the microbolometer causes degradation of the noise temperature. Using in-situ multilayer manufacturing process we succeeded to improve the transparency of the contacts for electrons which go away from microbolometer to the metallic antenna. The improved transparency and hence coupling efficiency counterbalances the noise temperature degradation. HEB mixers were tested in a laboratory heterodyne receiver with a narrow-band cold filter which allowed us to eliminate direct detection. We used a local oscillator with a quantum cascade laser (QCL) at a frequency of 4.745 THz [1] which was developed for the H-Channel of the German Receiver for Astronomy at Terahertz frequencies (GREAT). Both the noise and gain bandwidth were measured in the IF range from 0.5 to 8 GHz using the hot-cold technique and preliminary calibrated IF analyzer with a tunable microwave filter. For optimized HEB geometry we found the noise bandwidth as large as 7 GHz. We compare our results with the conventional and the hot-spot mixer models and show that further extension of the IF bandwidth should be possible via improving the sharpness of the superconducting transition. The cross characterization of the HEB mixer was performed in the test bed of GREAT at the Max-Planck-Institut für Radioastronomie with the same QCL LO and delivered results which were consistent with the laboratory studies.

References

1. see presentation H. Richter