Detailed Characterization of Quasi-Optically Coupled Nb Hot Electron Bolometer Mixers in the 0.6-3 THz range

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Nb diffusion-cooled hot-electron bolometer mixers have shown promising performance for application above 1 THz. However, studies of the performance, e.g. the IF bandwidth, verse the fabrication process and the performance verse the detailed geometry of devices, are still lacking. Present work attempts to address these two aspects.

Devices used have Nb bridges with thick Au cooling pads for diffusion cooling and are designed for quasi-optical mixers. Two devices have been studied. One uses a twin-slot antenna designed for 700 GHz, with a bridge length of 200 nm. This device is fabricated using an *in situ*-process for the interface between the bridge and the cooling pads. We obtained an uncorrected receiver noise temperature of 1350 K at 650 GHz and an IF bandwidth of ~5 GHz in the optimum bias point. This indicates a clear improvement in performance compared to devices with the same geometry, fabricated using the non-situ process as we reported previously.

The second device uses a log-periodic antenna designed for a frequency range of 0.3-5 THz. The device has a bridge of 300 nm and is fabricated in the same way as the first one. We measured the direct response in the 0.3-3 THz using an FTS and also obtained the receiver noise temperatures at several frequencies (0.64, 1.9, and 2.5 THz). We characterized this device systematically at 0.64 THz by measuring the receiver noise temperature, gain, output noise verse bias and LO power level. Furthermore, the IF bandwidth has been measured, which is lower than one can expect from the bridge length.

Scanning electron micrographs (SEMs) of the device show that there is a misalignment of the Nb bridge with respect to the Au cooling pads. We are able to link this geometry feature to the measured current-voltage and gain-voltage characteristics making use of the hot-spot model. And the small IF bandwidth and high LO requirement can also be explained by the anomaly.

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