MICROWAVE MIXING AND IF BANDWIDTH IN SUB-MICRON LONG HIGH-T_c HOT-ELECTRON BOLOMETERS

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The hot-electron bolometer (HEB) mixer made from a high-T_c superconductor (HTS) was introduced recently as a competing alternative to a Schottky mixer. The HEB mixer would require 100-times less LO power and thus would be a desirable candidate for long-term observational missions such as atmospheric remote-sensing and planetary science. The required cooling temperatures between 65 K and 75 K can be achieved with available space-qualified coolers or even with passive radiative coolers.

The HEB mixer consists of a microbridge of HTS material between normal metal contacts. The performance of the mixer depends strongly on the total thermal conductance for heat removal from the phonon sub-system. This heat can be removed by escape of the phonons to the substrate or by diffusion of phonons to the normal metal contacts. In the case of diffusion, the mixer IF response would depend strongly on the microbridge length. We have systematically measured both the length and temperature dependence of the IF bandwidth of HEB mixers fabricated from 25 - 35 nm thick YBCO films on MgO substrates. The films were grown by a pulsed laser deposition technique and electron-beam lithography was used to define submicron bridge lengths down to 50 nm. Mixer measurements were done using signal and LO frequencies in the range of 1 - 20 GHz. IF signals between 10 MHz and 10 GHz were measured using spectrum analyzer. Self-heating was observed in most of our devices below about 70 K. For device lengths between 50 nm and 400 nm, the 3-dB bandwidth was about 100 MHz. At temperatures below 60 K, the hot-electron plateau was clearly seen starting around 2 - 3 GHz. In this temperature range we did not observe a length dependence to the IF bandwidths. At temperatures above 70 K, where self-heating disappeared and flux-flow effects begin to dominate, the measured IF bandwidth increased significantly to 1 - 8 GHz, while the overall conversion efficiency dropped by several dB. This temperature dependence of the IF bandwidth can account for previously reported unexpectedly high bandwidth of HTS mixers. The implications of these results on the usefulness of this mixer will be discussed.

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