DC and IF bandwidth measurements of superconducting diffusion-cooled hot electron bolometer mixers based on Nb/Au bilayer

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Hot electron bolometer (HEB) mixers based on a superconductor-normal bilayer [1] are expected to improve the overall performance, in comparison with existing Nb or NbN devices, namely lower mixer noise, larger intermediate frequency (IF) bandwidth, and in particular, lower LO power requirement. The bilayer takes advantage of the idea that one can engineer a superconducting layer with the required critical temperature and diffusion constant.

To verify this concept, we started with a combination of Nb and Au. Using a sputtered bilayer of a 5 nm Nb (bottom) and 5 nm Au(top), we obtained a T_c of 4.5 K and a sheet resistance of 10 Ω. We also fabricated bilayer HEB devices using a slightly modified fabrication process compared to our Nb HEB process. Two types of characterization, DC and IF bandwidth measurements, have been performed. The resistance vs temperature relation of the Nb/Au bridges shows similar behavior as obtained in the Nb devices [2]

IF bandwidth of a Nb/Au HEB with a bridge length of 630 nm and applying a spiral antenna shows bias-voltage dependent IF bandwidth, the maximum IF bandwidth being 1.9 GHz. The measurement was carried out at a RF frequency of 700 GHz. Assuming the whole bridge to be metallic, this gives a diffusion constant of 5 cm^2/s. In view of the long bridge, this result suggests the potential to improve the bandwidth obtained so far in Nb HEB devices.

The IV curves pumped with different LO powers have been measured at temperatures down to 500 mK using a ^{3}He cooler. No Y-factor could be measured with our current devices. We attributed this largely to the impedance mismatch between the low impedance bridge and the spiral antenna.

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2. D. Wilms Floet, J. Baselmans, T.M. Klapwijk and J.R. Gao, "Resistive Transition of Niobium Diffusion-Cooled Hot Electron Bolometers", Appl. Phys. Lett.,73, 2826-2828, 1998

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