Low Noise, Superconducting Hot-Electron Microbolometer Mixer for Heterodyne Detection at 0.5 to 2 THz with Gigahertz IF Bandwidth

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Abstract[1]

We present a new device concept for a mixer element for THz frequencies. This uses a superconducting transition-edge microbridge biased at the center of its superconducting transition near 4.2 K. It is fed from an antenna or waveguide structure. Power from a local oscillator and an rf signal produce a temperature and resulting resistance variation at the difference frequency. The new aspect is the use of a very short bridge in which very rapid (<0.1 ns) outdiffusion of hot electrons occurs. This gives large intermediate frequency (if) response. The mixer offers ≈4 GHz if bandwidth, ≈80 ohm rf resistive impedance, good match to the if amplifier, and requires only 1 - 20 nW of local oscillator power. The upper rf frequency is determined by antenna or waveguide properties. Predicted mixer conversion efficiency is 1/8, and predicted receiver noise temperatures are 260K and 90K for transition widths of $0.1T_c$ and $0.5\ T_c$ respectively.

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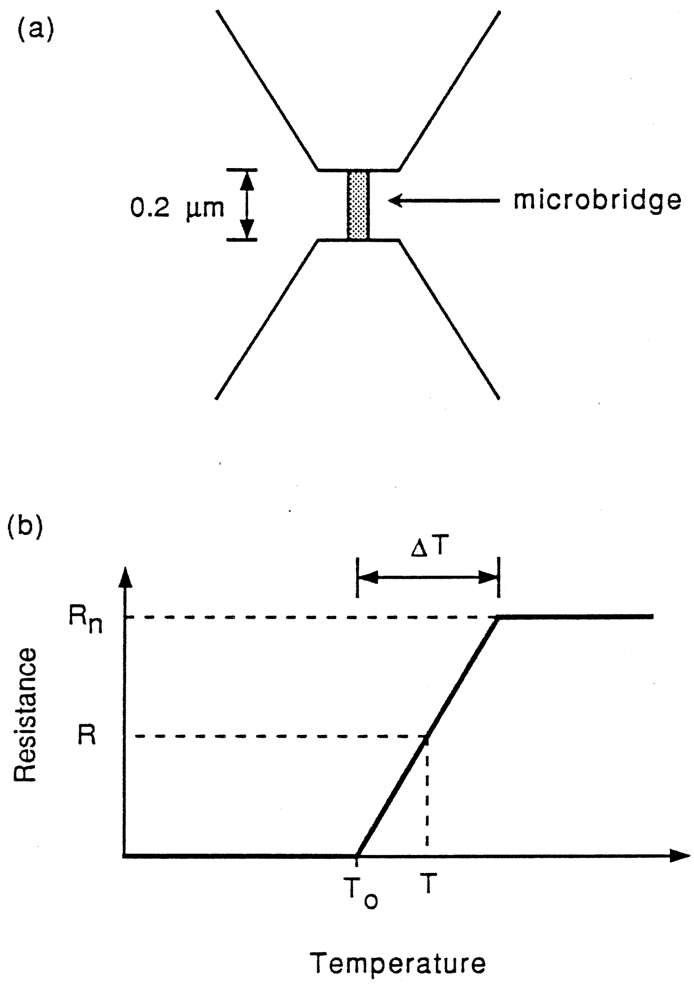

Fig. a. Layout of microbridge mixer; bridge is shaded, thick pads are unshaded; b. Resistive transition with bridge biased at R and T.

Table - Device properties for Nb microbolometer mixer, this work.

T = 4.4 K; receiver conversion efficiency η =1/10 for computation of T_R. For a planar antenna or corner-reflector mount, a smaller value of η is realistic, and the values of T_R (DSB) would be larger than given below.

R_n	80 ohms
Dimensions (μm^3)	0.2 x 0.05 x 0.01
G	0.8×10^{-8} W/K
S (ω = 0) for $\Delta T = 0.1T$	1.1×10^5 V/W
P_{lo} for $\Delta T = 0.1T$	1 nW
$\Delta T = 0.5$ T	5 nW
τ	0.04 ns
IF response (-3db)	4 GHz
T_R (DSB) for $\Delta T = 0.1$ T	260 K
$\Delta T = 0.5$ T	90 K