Tantalum Hot-Electron Bolometers for Heterodyne Receivers

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During the last few years, superconducting hot-electron bolometer (HEB) mixers have been rapidly developed for radioastronomy applications at frequencies above 1 THz. Instruments are currently being built for both *Herschel* and *SOFIA*. Future instruments using this technology should provide higher sensitivity and higher IF bandwidth than those of today. Theory predicts that the mixer noise of HEBs should scale with the transition temperature (Tc) of the device. A lower Tc also means reduced LO power requirements. One promising material for lower-Tc bolometers is tantalum, which has a transition of about 3K in thin films. Tantalum devices could have resistances as low as 20 Ω/square, which implies significant electronic heat conductivities (≥ Nb). The lower Tc, the insignificant end effects at the contacts, and the high heat conductivity should make possible a short (0.2 μm) device with low mixer noise and high IF bandwidth. Submicron-size bolometers have recently been fabricated at JPL from Ta films deposited on a 1.5 nm Nb seed layer. Transitions up to 2.3 K, with transition widths of less than 0.2 K and a resistance of 36 Ω/square were achieved. At high bias currents the thermal noise is proportional to the square root of the applied DC power (consistent with diffusion-cooling). A fully instrumented He3 test receiver has been set up that can measure mixer performance from 0.4 K to 100 K both at microwave frequencies and submillimeter wavelengths. The presentation will include the most recent rf results with these Ta bolometers. This work was supported by NASA.