Characterization of Diffusion-Cooled Hot-Electron Bolometers for Heterodyne Array Receiver Applications

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We are characterizing the performance of diffusion-cooled hot-electron bolometers (HEBs) as mixing elements for superheterodyne receivers. The objective of this work is developing mixer technology for submillimeter and THz astronomical applications and assessing usability for heterodyne array cameras. HEBs currently are the most sensitive mixing devices in the THz region and in contrary to SIS mixers do not exhibit a material dependent upper mixing frequency limit. In particular the diffusion-cooled HEBs can offer a larger IF bandwidth than the phonon-cooled HEBs, which gains importance with increasing operation frequency of the astronomical application.
The HEB devices were fabricated at Yale University with an in-situ two-step deposition process on fused quartz substrates. The waveguide HEB devices consist of a several hundred nanometer long, 10 nm thin Nb micro bridge between two normal metal pads made of proximitized Nb/Al bilayers that also define the RF choke structure. DC and RF device performance at microwave frequencies (10s of GHz) is measured at Yale University and then extended to submillimeter frequencies (345 and 810 GHz) at the University of Arizona. The submillimeter heterodyne measurements use waveguide mixer blocks of proven design, with the 345 GHz block being a modification of a DesertSTAR mixer, manufactured on Arizona's Kern MMP micromilling machine, and the 810 GHz block originating from KOSMA. We will present the fabrication process, discuss DC I-V and R-T as well as RF and IF results and set the goals for array camera development based on waveguide mixer technology at THz frequencies.