Low-Noise THz SIS Mixers Incorporating NbTiN/SiO_2/Al and Al/SiO_2/Al Tuning Circuits

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The development of the Heterodyne Instrument for the Far-Infrared (HIFI) requires low-noise SIS mixers for frequencies up to 1.25 THz. Past work has shown that the integration of a NbTiN/SiO_2/Al tuning circuit with standard Nb SIS junctions enables the development of state-of-the-art heterodyne receivers for frequencies up to at least 1 THz [1-3]. Following from the results of this previous work, the design of the waveguide mixer has been optimized to obtain both high sensitivity and wide RF band-widths.

In this paper, the RF design of mixers incorporating NbTiN/SiO_2/Al and Al/SiO_2/Al tuning circuits are presented, and their performances are compared with the mixer requirements for bands 3 and 4 of HIFI (800-960 and 960-1120 GHz). The use of a twin-junction NbTiN/SiO_2/Al tuning circuit is expected to yield low-noise performance up to at least 1 THz. However, above 1 THz, the performance of this tuning circuit is strongly dependent upon the quality of the NbTiN ground plane. In the absence of a NbTiN ground plane with a sufficiently large effective gap frequency, an all-normal-metal tuning circuit (Al/SiO_2/Al) is needed to yield high sensitivity at ~ 1.1 THz. The sensitivity of mixers incorporating this normal metal tuning circuit is strongly dependent upon the current-density and the quality of the SIS junctions being used (where the term junction quality refers to the relative magnitude of the junction's leakage current).

[1] A. M. Baryshev *et al.*, in *Proc. of the 11th Int. Symp. On Space THz. Technol.*, U. of Michigan, Ann Arbor, Michigan, May 1-3, 2000, pp. 129-138.

[2] B. D. Jackson *et al.*, *Appl. Phys. Lett.*, vol. 79, no. 3, pp. 436-438, 2001.

[3] B. D. Jackson *et al.*, *IEEE Trans. on Appl. Supercon.*, vol. 11, no. 1, pp. 653-656. 2001.