

Quasi-Optical SIS Mixer with a Silicon Lens for Submillimeter Astronomy**N.G. Ugras*, J. Zmuidzinas*, H.G. LeDuc****

We have designed and tested a quasi-optical low-noise SIS receiver for the submillimeter band. The radiation is focused onto a twin slot antenna by a hyperhemispherical silicon lens. The forward coupling efficiency for silicon ($\epsilon_r=11.7$) is 91% compared to 70% in quartz ($\epsilon_r=4.5$). However the relatively high dielectric constant of silicon would cause a reflection loss of $\approx 30\%$ at the front surface of the lens compared to $\approx 15\%$ in quartz. We have eliminated this reflection loss by antireflection coating the lens with an alumina loaded epoxy ($\epsilon_r=4.0$). A uniform epoxy thickness of $68\mu\text{m}$ ($=\lambda/4$ at 550 GHz) over the hemispherical lens is obtained by diamond machining the surface. The twin slot antenna has good directivity and a low impedance which is well matched to the rf impedance of the SIS junctions. The mixer circuit consists of two SIS junctions separated by a superconducting microstripline acting as the tuning inductance. The area of the tunnel junctions ranges between $0.56\text{-}1.56\ \mu\text{m}^2$, with a current density of $10,000\text{A}/\text{cm}^2$, and $R_{sg}/R_n=15$. Preliminary results indicate typical receiver noise temperatures ranging from 130 K to 160 K in the 500 to 600 GHz band. The spectral response of the mixer agrees well with the direct detector response obtained by a Fourier transform spectrometer. The measured input beam pattern is well collimated and has a Gaussian distribution. This receiver is being used for radio-astronomical observations aboard NASA's Kuiper Airborne Observatory.

This work was supported by NASA/JPL and NASA grant NAWG-107.

*N.G. Ugras and J. Zmuidzinas are with the Downs Laboratory of Physics, 320-47, California Institute of Technology, Pasadena, CA 91125.

**H.G. LeDuc is with the Jet Propulsion Laboratory, 302-231, Pasadena, CA 91109.