# Antireflection–Coated Silicon Lenses for Low–Noise 400 – 1040 GHz Quasioptical SIS Mixers

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A significant improvement in the optical efficiency of quasioptical SIS mixers can be obtained by using a substrate lens made with a high dielectric constant material such as silicon ($\epsilon = 11.5$), along with a suitable antireflection coating. The large dielectric constant of the substrate lens increases the forward coupling efficiency of the integrated antenna, to around 90% for a twin–slot on silicon. However, an antireflection coating is needed to avoid a 30% reflection loss at the lens surface. This coating must satisfy several important constraints: (1) The coating material must have the correct dielectric constant ($\epsilon \approx 3.4$); (2) The material must adhere well to the lens and be cryogenically recyclable; and (3) The coating thickness should be controlled to an accuracy of a few microns. Ugras, Zmuidzinas, and LeDuc (1994) showed that suitable coatings could be made using alumina-loaded epoxy that is diamond–machined to the correct thickness, and demonstrated results in the 500–600 GHz band. Since then, we have employed this technique with all-niobium SIS mixers in the 400–850 GHz band (Gaidis *et al.* 1996), and with a 1042 GHz SIS mixer using niobium junctions and an aluminum tuning circuit (Bin *et al.* 1996). We will describe measurements of the frequency response, noise temperature, and antenna pattern and polarization. In our experience, the coatings are very rugged and reliable. These mixers have been used over the past two years for astronomical observations aboard NASA's Kuiper Airborne Observatory.

## References

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