Flexible, Thermal Isolating and Low-loss Rectangular Dielectric Waveguide for THz Superconducting Receivers

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Abstract—The dielectric waveguide is a potential transmission line in Terahertz (THz) applications for its low-loss. A new application of the rectangular dielectric waveguide (RDW) for a THz superconducting receiver system for radio astronomy is investigated and demonstrated for the first time. The RDW can propagate the solid THz source, functioning as pumping signal (local oscillator), to superconductor–insulator–superconductor (SIS) mixer and prevent heat into the cryostat. A series of the RDWs with different lengths were fabricated and measured in cryostat and room temperature, respectively. According to the measured results at 3.4 K environment, the attenuation constant of the RDW is 0.034±0.012 dB/mm, operating in 240-300 GHz. For a comparison, the measured attenuation constant of the RDW in room temperature is 0.069±0.020 dB/mm. An E-bend and a twist based on a 118-mm RDW were also measured in both 3.4 K and 300 K environments. The measured DSB system noise temperature is 99.9±19.1 K over 240-300 GHz. Comparing to traditional pumping signal feeding schemes, this approach well outperforms the traditional ones in feeding flexibility, insertion loss, and thermal isolation for cryostat.

The flexible, thermal isolated and low-loss RDW can be widely applied for the single beam SIS mixer superconducting receivers and THz vector filed measurement instrumentations. Moreover, the RDW can be widely used in the multi-beam superconducting receivers for radio astronomy.