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Development of 1.9 THz Band Waveguide-type Hot-electron Bolometer Mixer Employing Superconducting NbTiN Microbridge

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Many spectral lines for rotational, rotation-vibration, and fine-structure transitions of gas species in the interstellar medium and planetary atmospheres lie in the millimeter to terahertz waveband. In this frequency band, heterodyne spectroscopy with high frequency resolution is a powerful tool for understanding of the basic physical (dynamics, densities, and temperatures) and chemical properties of planetary atmospheres and interstellar media such as dense molecular clouds and star-forming regions. Despite its scientific and observational importance, 1-10 THz band radio astronomy has long been unexplored because of the lack of good observing sites and the unavailability of highly sensitive heterodyne receivers in this frequency range. Against this background, the superconducting hot-electron bolometer (HEB) mixer is being developed as a next-generation heterodyne mixer for operation above 1 THz.

We are currently developing a waveguide-type HEB mixer employing a diagonal horn for the 1.8-2 THz band, in which the dimensions of a NbTiN micro-bridge fabricated using our *in situ* technique are optimized on the basis of our HEB mixer model. The optical system and waveguide probe that couple the input signal were designed with 3D electromagnetic-field simulators, GRASP and HFSS(TM). The probe feed was optimized to match the micro-bridge impedance. The chip width and thickness are 44 μm and 19 μm, respectively. We succeeded in fabricating experimental preproduction samples of these microscopic chips using dicing and MultiPrep polishing systems with a high yield ($>$90%). The observational targets for this frequency band are OH radicals, which are important pro-oxidants in the chemical-reaction network in the atmosphere of Earth and other planets ; [OI] and [CII] lines, which are the basic coolants of the interstellar medium; and other complex and high-J molecules.

In this conference, we will present the current developmental status of the newly designed 1.9 THz band waveguide-type HEB mixer receivers.

Keywords: Teraherz Astoronomy, Interstellar Medium, Planetary Atmosphere, Heterodyne Spectroscopy, Superconducting Detector