Development of a 30 THz Heterodyne Receiver Based on a Hot-Electron-Bolometer Mixer

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We present new Hot-Electron-Bolometer (HEB) mixers designed for mid-IR spectroscopy targeting astrophysical and geophysical observations where high sensitivity and spectral resolution are required. The mixers are made of an ultrathin NbN film deposited on GaAs substrates. Two entirely different types of the devices have been fabricated. The first type is based on a direct radiation coupling concept and the mixing devices are shaped as squares of 5×5 μm^2 (which corresponds to the diffraction limit at the chosen wavelength) and 10×10 μm^2 (which was used to establish a possible influence of the contact pads on the radiation absorption). The second type utilizes a spiral antenna designed with HFSS. The fabrication and layout of the devices as well as the performance comparison will be presented.

During the experiments, the HEB mixer was installed on the cold plate of a LHe cryostat. A germanium window and an extended semi-spherical germanium lens are used to couple the radiation. The cryostat is equipped with a germanium optical filter of thickness 0.5 mm and with a center wavelength of 10.6 mμ.

The incident power absorption is measured by using the isothermal method. As a Local Oscillator, a 10.6 micrometers line of a CO_2 gas laser is used. We further characterize the frequency response of the spiral antenna with a FIR-spectrometer. The noise characteristics of the mixers are determined from a room temperature cold load and a heated black body at ~600 K as a hot load.