22nd International Symposium on Space Terahertz Technology, Tucson, 26-28 April 2011

Measure the beam wavefronts of a terahertz source

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Terahertz (THz) quantum cascade lasers (QCL) are one of the most promising THz sources as local oscillators (LO) for heterodyne receivers at super-THz frequencies. To effectively couple the radiation from a THz QCL to a lens-antenna-coupled THz mixer, which usually has a Gaussian beam pattern, understanding the beam pattern of the QCL is crucial. The beam pattern of a THz QCL with regard to the intensity has been studied extensively. However, the wavefront of the beam has never been measured. The latter can be more crucial for the use as a LO in a receiver because the mixer is a phase sensitive, coherent detector,

Here we propose a measurement technique for the phase front in the THz domain by adapting the Shack-Hartmann wavefront sensors (SH-WFS) in the optical wavelengths. SH-WFS can provide accurate measurements of the wavefronts of beams. It is made of a panel of lens array, which creates a spot field from the incident wavefront on the detection plane, located at the focus plane of the lenses. The wavefront of the beam can be reconstructed from the locations of the spots.

We start our experiment by using an array of holes (Hartmann mask) instead of the lens array. The diameter of each hole in our Hartmann mask is 1 mm and the separation between adjacent holes is 3 mm. The detection plane is located 10 mm behind the mask. The displacement of the intensity spots from the holes in the mask, measured at the detection plane, can indicate a distorted wavefront of the THz beam. To prove the measurement principle, we start with the beams generated by a gas laser operated at 2.5 THz. We also measured the beam through a Fresnel lens, which is expected to distort the wavefront. We observed the distorted wavefront from the deviations of spot positions from those in the mask.