Silicon lens antenna for linear array THz antenna detectors

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Introduction:

Antenna structure has been developed for uncooled THz detection [1]. An antenna coupled detector on a substrate is effectively coupled with dielectric lens antenna to improve the detector performance [2]. Evaluation of the power-flow-density distribution focused with a dilectric lens is necessary for designing the configuration composed of the dielectric lens and antenna-coupled detectors. In this research, we study the power-flow-density irradiated by a Si-lens on eight-element-array antenna detectors at frequency 1 THz with the ray tracing method combined with Fresnel's transmission.

Model for simulation of a Si-lens:

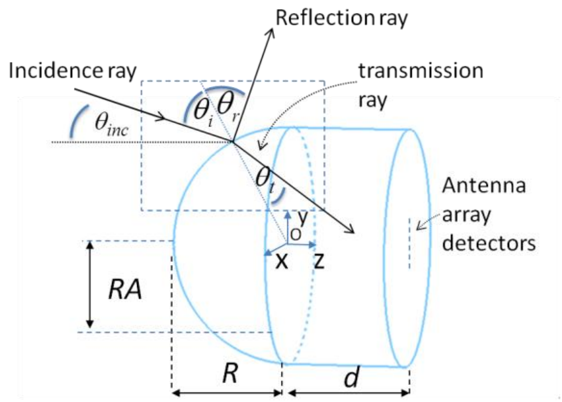

Fig. 1 Schematic of incidence, reflection, and transmission of rays around the boundary of air to the Si-lens antenna.

Figure 1 is a schematic of the dielectric lens antenna used in this research. The dielectric lens antenna is constructed with Silicon (ε_r=11.7). The dielectric lens antenna is a hemispherical antenna with the radius of the lens (R), the radius of the aperture (RA), and cylinder extension (d) are 3 mm, 2 mm, and 1.2 mm, respectively. The radiation coming into the Si-lens is varied by the inclined angle of its direction (θ_{inc}). Eight-element antenna detectors are arranged on the edge surface of the extended cylinder.

Focus position:

The focus length for each position of array detectors are determined by finding the largest number of rays in the square area with size 0.087 mm x 0.087 mm which is the square of wavelength in Silicon of 1 THz radiation. The focus lengths are distributed between 1.03 mm and 1.11 mm for the eight positions, and hence we took their average as the focus length of the antenna array. Figure 2 shows the distance of focus measured from the center on the plane vertical to z-axis as a function the inclined angle of input rays. The distance increases as the inclined angle increases. Figure 2 shows the changes of the distances is increasing linearly.

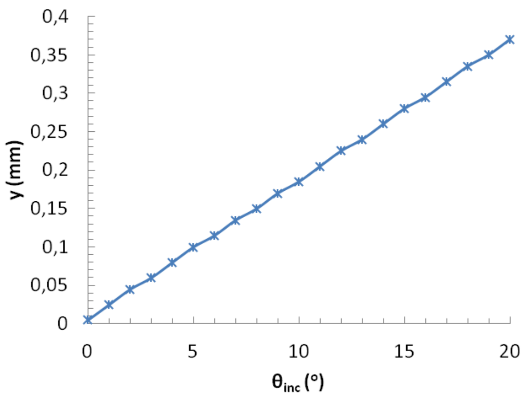

Fig. 2 Focus distance in the vertical axis as a function of the inclined angle of input rays calculated with the ray-tracing method

In this paper, we will present size of focusing as a function of z-axis. The size of focusing is calculated by analyzing spot diagram distribution with their transmittances. The size of focusing is represented by radii of circles on the x-y plane which contain some percentages of power as a function of extended length (d) on the z-axis in the extended Si-lens.

References

[1] N. Hiromoto et al, 61st JSAP Spring Meeting 2014, Mar. 17-20, **18p-E17-18** (2014) (in Japanese)
[2] M. F. Formanek *et al*, Applied Physics Letters **94**, 021113 (2009)