Real-Time Imaging of Terahertz Electric Field in Metallic Holes by EO Sampling Method

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We have demonstrated real-time imaging of terahertz (THz) electric field in metallic holes and observed temporal behavior of the electric field. The present study will help achieving a resolution of THz imaging better than the diffraction limit. This real-time terahertz imaging method has built-in deformation correction and THz field calibration. The method uses intense THz pulses and two different types of EO sampling methods. Using this system, we will be able to observe changes of THz near-field in real-time, and study various phenomena related to THz near-field.

In many applications of THz waves such as THz device development, information of the THz field is required. We have developed a real-time THz field profile measurement method and achieved real-time imaging of THz electric field in metallic holes. In this method, intense THz pulses are generated by a large-aperture photoconductive emitter irradiated by amplified femtosecond laser pulses. The field profile is observed using two types of EO sampling methods. In one method, transmission type EO sampling, probe light is transmitted through an EO crystal (ZnTe). In the other mehod, reflection type, the probe light is reflected by the EO crystal. In the reflection type method, a reflective layer composed of SiO_2 (150 nm) and Ge (300 nm) is deposited on the EO crystal to increase the reflectivity. By using a quarter-wave plate and a rotatable polarization analyzer, calibration curve of the THz field at each pixel of the image detector (CCD camera) can be obtained by simply observing the background images at several analyzer rotation angles [1]. In the figure, (a) drawing of the metal hole having a diameter of 1 mm and thickness of 0.5 mm, and (b) examples of time-resolved field profiles in this hole obtained using reflection type are shown. The measurement system was constructed using a LabVIEW program running on a PC. From the acquired CCD images, calibrated field profiles are calculated automatically. Our approach for the time-resolved study of THz near-field broadens the way to the investigation of vaious interesting phenomena of THz field around microscopic structures such as near-field enhancement.

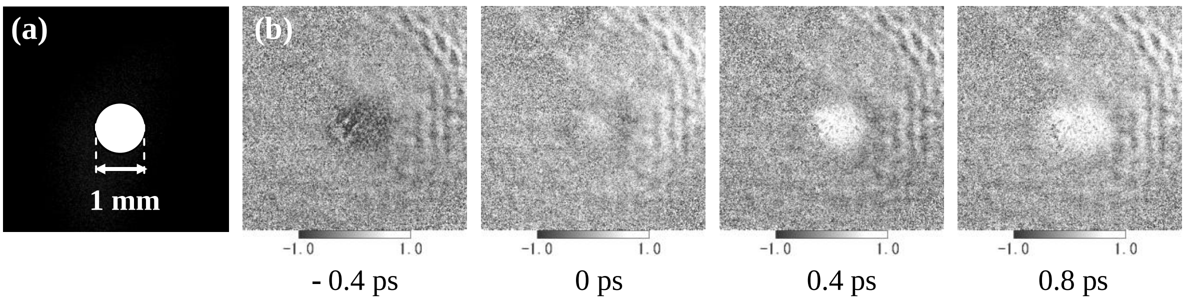

Figure. (a) Drawing of the metal hole showing the actual size. (b) Time-resolved field profiles of focused THz pulses observed using the real-time imaging method of reflection type. The scale denotes the electric field in kV/cm. In the picture above, we defined time zero by the time when the sign of the electric field changed from negative to positive.

[1] T. Hattori and M. Sakamoto, Appl. Phys. Lett. **90**, 261106 (2007).