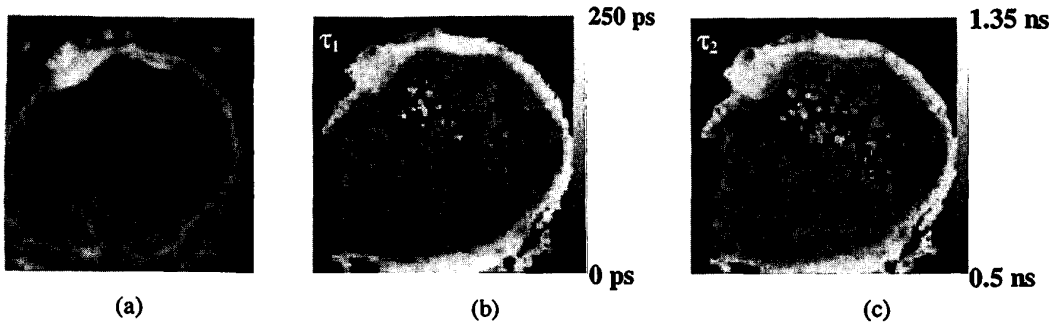

CFL1 Fig. 2. (a) Fluorescence microscope image with, (b) and (c), FLIM maps of short- (τ_1) and long-lived (τ_2) decay components of rat artery obtained using an all-solid-state diode-pumped FLIM system.

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CFL2 10:45 am

Mid-Infrared THz Imaging

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Application of far-infrared pulse in terahertz (THz) frequency range provides advantage in imaging of chemical and biological materials due to strong molecular resonance in the frequency range.[1,2] Two dimensional frame imaging of THz illumination is also possible as demonstrated recently.[3]

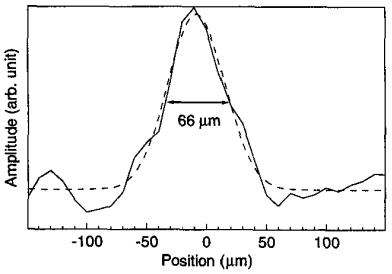
In this paper we report on THz imaging with a high spatial and temporal resolution using free-space electro-optic sampling technique in the mid-infrared frequency range. A spatial resolution of sub 70-μm is achieved. Our technique allows us to demonstrate the time-resolved THz transillumination for imaging of biological cells.

The ultrashort THz pulses are generated via nonresonant optical rectification in a ZnTe crystal with a thickness of 30 μm. The fundamental near infrared pulses of 15 fs are derived from a mode-locked Ti:sapphire laser. The generated THz pulse has a main spectral distribution around 10 THz and extends over 30 THz. For the free-space electro-optic sampling we use a 25 μm-ZnTe crystal (sensor). The use of this thin crystal provides us with a higher temporal resolution and avoids pulse distortion effect. Two pairs of paraboloidal mirrors are used to collimate and focus the THz beam.

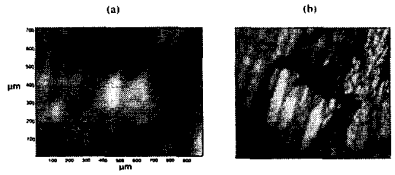
Figure 1 shows the electric field profile of the THz beam at the focal plane of the focusing paraboloidal mirror (f = 1.5″) for the sample, measured by moving a knife-edge across the spot. Assuming a Gaussian intensity distribution we derive a half beam waist of 33 μm of which value corresponds closely to the diffraction limit of the main spectral density. This beam waist promises potential for far-field THz imaging of microstructures.

We placed in the focal plane of the THz beam a fresh tissue of onion cells. The cell tissue has a thickness about 50 μm and the cell width was measured to be of 70 μm in average. This microcells filled mainly with water provides us with an excellent biological sample for a high resolution THz imaging. Figure 2(a) shows the two dimensional image of the onion cells obtained by scanning the cells laterally in the focal plane, in comparison to an optical microscope picture of comparable cell structure as shown in Fig. 2(b). The shape of the cells can be identified apparently. This image is achieved by plotting the transillumination amplitude of the THz pulses at a fixed time delay between the THz and probe pulse in the electro-optic sensor crystal. Thus the contrast in the image is given both by the attenuation of the THz amplitude due to water absorption in the cells and by the phase shift of the waveform in time due to structural differences between cells.

In conclusion, we presented the recent experimental results of mid-infrared THz imaging using broadband free-space THz electro-optic technique. Our results demonstrate the feasibility of THz imaging of biological tissue with a sub 70-micron spatial resolution and sub 100-fs temporal resolution.



CFL2 Fig. 1. The electric field distribution of the mid-infrared THz beam at the focal point of a paraboloidal mirror. The solid line is the measured data and the dashed line is a Gaussian fit.



CFL2 Fig. 2. (a) A transillumination imaging of onion cell tissue measured by time-domain mid-infrared THz pulses. (b) The optical microscope picture showing the comparable cell structure. The picture is taken on the same piece of tissue, but the area is not perfectly coincident to the scanning area of (a).

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CFL3 11:00 am

Real-time two-dimensional imaging through scattering media using 80-fs-gated parametric amplification

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In a previous work,[1] we have reported on point-to-point imaging in highly scattering medium using type-I parametric amplification in femtosecond regime. Although high-resolved two-dimensional imaging by type-II parametric amplification has been already shown in picosecond regime,[2] we demonstrate, in this paper, the feasability of this method for real-time two-dimensional imaging with 80-fs pulses. Because of the angular