Combining high repetition subcycle MIR and THz pulses to study field-driven phenomena in condensed matters

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Due to the recent technological innovation of intense terahertz (THz) pulses, ultrafast control of fundamental excitations such as molecular vibrations, polarons, superconductors, charge density waves, etc. using THz electric fields have been extensively studied [1,2,3]. These field-driven phenomena show rich spectra in the mid-infrared (MIR) range so that broader MIR pulses are desired to study ultrafast response of electrons in various materials. In this study, we combined subcycle MIR pulses and THz pulses coaxially with retaining their broad bandwidth. The coaxial layout enables to simplify optical setup which contributes to measure dynamical properties of not only conventional optical measurements but also surface measurements in vacuum chambers.

We used a Ti:S-based optical parametric chirped pulse amplifier (OPCPA) with the high repetition of 4 MHz. We have already developed subcycle MIR pulses [4] by using a GaSe crystal and optical rectification of the fundamental pulses with the wavelength range from 660 nm to 940 nm, pulse duration of 8 fs. To generate THz, we split a part of the pump beam of the OPCPA which has the center wavelength of 1030 nm, pulse duration of 300 fs, pulse energy of 5 uJ. Optical rectification with BNA crystal [4] was used to obtain THz pulses. To combine THz and MIR coaxially, we used a Ge beam splitter.

Figure 1 shows the waveforms of the electric field of THz and MIR, respectively, measured at a same point. The measured bandwidth were 1 THz for the THz pulses and 30 THz for the MIR pulses. We succeeded in retaining subcycle bandwidth for the MIR after combining with THz with coaxial layout.

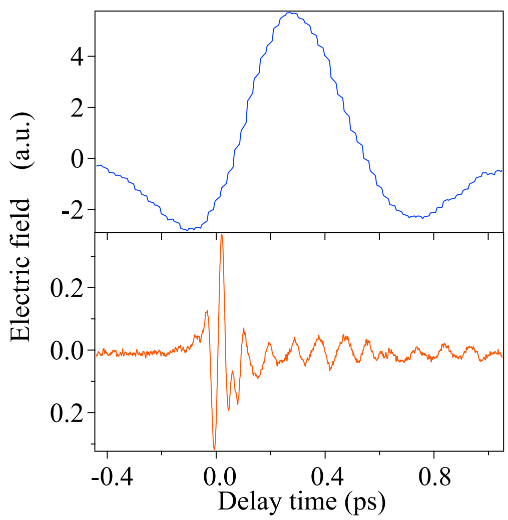

Fig. 1 THz electric field waveform (blue line) and MIR electric field waveform (orange line).

References:

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