Combining high repetition subcycle MIR and THz pulses to study field-driven ultrafast phenomena

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Recent development of intense terahertz (THz) pulses has enabled electric-field-driven ultrafast control of fundamental excitations such as molecular vibrations, polarons, superconductors, charge density waves, etc [1,2,3]. Broadband mid-infrared (MIR) pulses can be used to understand transient properties of these phenomena in the frequency domain with the energy less than several ten to hundred meV. In this study, we developed a light source that subcycle MIR pulses and subcycle THz pulses were combined coaxially with retaining their broad bandwidth. The coaxial layout has advantages to simplify conventional pump-probe measurements, for example, using vacuum chambers.

We used a Ti:S-based optical parametric chirped pulse amplifier (OPCPA) with the repetition frequency of 4 MHz. Subcycle MIR pulses were generated by the optical rectification, where the fundamental pulses with the wavelength ranging from 660 nm to 940 nm and the pulse duration of 8.5 fs entered into a GaSe crystals [4]. Subcycle THz pulse were generated by the optical rectification, where a part of the pump beam of the OPCPA (the center wavelength of 1030 nm and the pulse duration of 300 fs) were incident into a BNA crystal [5]. A Germanium plate was used to combine the MIR and THz pulses coaxially.

Figure 1 shows the waveform of the electric field of the combined pulses measured by using photoconductive antenna with the probe beam of the fundamental wave of the OPCPA. We can see the fast modulation of the electric field of the MIR in the slowly varying field of the THz. The MIR retain broad bandwidth from 32 meV to 200 meV (-10 dB, not shown here). This light source is expected to be used to reveal ultrafast properties of fundamental excitations driven by THz electric field.

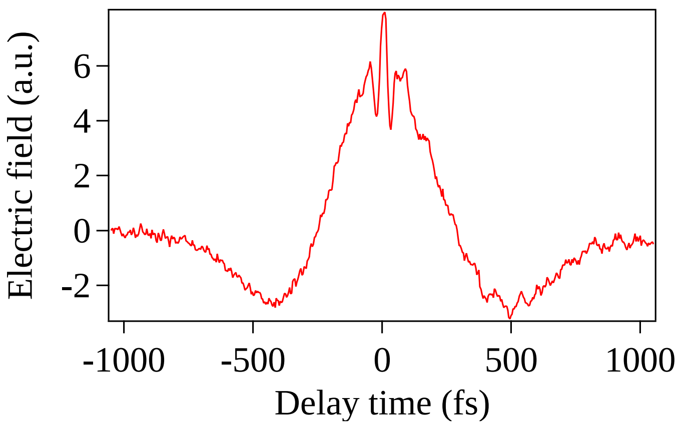

Fig. 1 Electric field waveform of the combined beam of MIR and THz pulses.

References:

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