Modulation of THz fields in semiconductors

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With the ever-increasing demand for faster microprocessors, there comes the need to characterize materials at such ultrafast speeds. In addition, with ever-decreasing size of these microprocessors, the electric field used could reach very high values. In this paper, we will describe our recent studies on characterizing the THz response of semiconductors at > 100 kV/cm electric fields. We will show that incoherent effects, such as intravalley scattering, would result in significant modulation of the input electric field, resulting in high-frequency generation and harmonic generation.

High-field carrier transport dynamics at terahertz (THz) frequencies in semiconductors can lead to numerous ultrafast phenomena, such as THz pulse self-phase modulation, intense THz field induced impact ionization, as well as dynamic Bloch oscillations driven by ultra-high THz frequencies [1-3]. In the nonresonant regime, carriers can be efficiently accelerated by the intense THz field, resulting in high ponderomotive energy that is proportional to the square of the peak field and inversely proportional to the square of the THz frequency [4]. In this work, we perform nonlinear THz-TDS measurement of InGaAs thin film using an intense THz source generated from an interdigitated ZnSe large-aperture photoconductive antenna (LAPCA), which can generate intense, asymmetric quasi-half-cycle THz pulses with low median frequency of approximately 0.2 THz [1]. With the same peak field, the ponderomotive potential is thus much higher than other higher frequency THz sources via, for example, optical rectification [1,5]. At high fields, we observe strong THz transmission bleaching, THz phase modulation as well as the generation of high frequency components (Fig. 1).

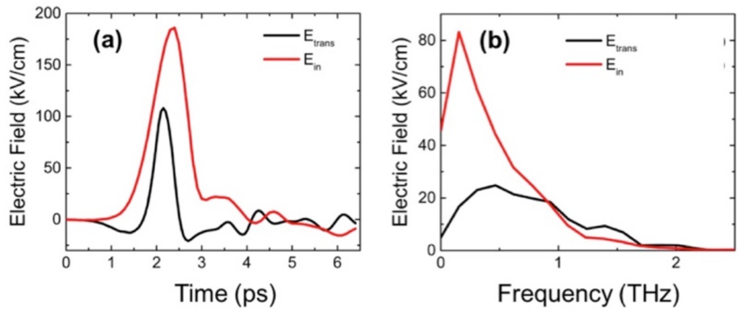

Fig. 1. (a). Incident and transmitted THz waveform through InGaAs, (b) corresponding spectra

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