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Ultrafast imaging of nonlinear terahertz pulse transmission in semiconductors

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Terahertz pulse spectroscopy has been widely used for probing the optical properties and ultrafast carrier dynamics of materials in the far-infrared region of the spectrum. Recently, sources of intense terahertz (THz) pulses with peak fields higher than 100 kV/cm have allowed researchers to explore ultrafast nonlinear THz dynamics in materials, such as THz-pulse-induced intervalley scattering in semiconductors. Here, we use a gated intensified CCD camera and full-field electro-optic imaging with femtosecond laser pulses to directly observe dipole electric fields arising from shift currents induced by intense THz pulses in n-doped InGaAs. Voltage pulses generated by the THz-pulse-induced shift currents are also measured directly on a high speed oscilloscope. The polarization of the shift current with respect to that of the THz pump beam is determined. The simultaneous measurement of both the induced dipole and transmitted THz pulse allows for sub-picosecond resolution imaging of nonlinear THz dynamics in semiconductors.

Primary author: SHARUM, Haille (University of Alberta)

Co-authors: AYESHESHIM, Ayesheshim (University of Alberta); PURSCHKE, David (University of Alberta); HEGMANN, Frank (University of Alberta)

Presenter: SHARUM, Haille (University of Alberta)

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