Abstract:
The use of ultrashort terahertz pulses has facilitated terahertz spectroscopy of a wide range of physical, chemical and biological samples, and has enabled time-resolved measurements in which the terahertz pulse is used to probe dynamical responses to an optical excitation pulse. In almost all cases reported to date, the THz pulses have had rather low energy, field amplitude, and average power. This has slowed the development of nonlinear THz optics and spectroscopy as well as THz signal processing, spectroscopic imaging and screening, and other applications.

Using an extremely effective terahertz radiation generation scheme pioneered by Hebling et al., we obtained the highest energy tabletop terahertz source to date. By using strong THz radiation we have demonstrated nonlinear effects in semiconductors such as saturated absorption, intervalley scattering, self-phase modulation and impact ionization.

These effects can be monitored time and frequency resolved using a novel THz-pump/THz probe scheme in the absence of band-to-band excitation. Our data show the effect of highly accelerated carriers and the strong coupling of the electronic system to the lattice on the picosecond timescale.