OSS08-2008-000055

Abstract for an Invited Paper
for the OSS08 Meeting of
the American Physical Society

Terahertz Time-Domain Spectroscopy and its Applications

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The terahertz (THz) or far-infrared region of the electromagnetic spectrum (1 THz $\leftrightarrow$ 300 μm $\leftrightarrow$ 33.3 cm^{-1} $\leftrightarrow$ 4.1 meV $\leftrightarrow$ 47.6 K) corresponds to many fundamental excitations in solids and molecules. Despite the importance of this part of the spectrum, it has remained difficult to access because of the lack of convenient coherent sources and sensitive detectors. Over the past several years, a new approach has been developed based on the dramatic advances in the production of ultrafast optical pulses from modelocked lasers. In this scheme, the femtosecond laser pulses are used to produce and detect far-IR radiation with controlled electric-field waveforms through the use of either a photoconductor or a nonlinear crystal. This may be considered as the extension of electronics, providing signal generators and oscilloscopes of electrical transients of THz frequencies/sub-picosecond time resolution. In this talk I will introduce this new method known as the THz time-domain spectroscopy. I will then discuss some of its applications including imaging, far-IR spectroscopy, and particularly, probing charge transport in various materials.