Colloquium

Department of Physics, Temple University

High-power, high-resolution terahertz-spectroscopy technologies and their applications

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A terahertz beam is an electromagnetic wave with a frequency between millimeter-wave and infrared frequencies, typically from 100 GHz to 3 THz, sharing the properties of both radio frequencies (RF) and optical beams. Similar to an RF signal, it can penetrate rather deeply into a non-metallic and non-polar material. Similar to an optical beam, it is also highly directional and can be steered or manipulated by optical components, such as lenses, beam splitters, reflectors, and beam-polarizers. Since a large number of molecules' resonance frequencies, especially rotational modes, lie within terahertz frequencies, terahertz spectroscopy is a highly useful tool for scientific investigation and for identification of unknown or hidden materials. For example, the technology is useful for detection and identification of illicit drugs, counterfeit medicines, hidden chemicals, explosives and even hidden nuclear materials. Unfortunately, at present terahertz spectroscopy is largely underutilized, and it is mostly being used in a laboratory environment. This is in part, but largely, due to the fact that no portable, high-power, high-resolution spectrometer is currently available. We have therefore been developing a number of high-power terahertz sources and high-power, high-resolution terahertz spectrometers – both time-domain and frequency-domain terahertz spectrometers. Recently, we demonstrated two different types of terahertz sources: one is a wideband terahertz source and the other is a frequency-tunable terahertz source. These portable terahertz sources are capable of producing a high-power (> 3 mW), wideband (0.1 – 3 THz) terahertz beam, or a high-power (> 1 mW), narrow, tunable terahertz beam over the frequency range from 0.07 – 3 THz. In addition, we have demonstrated three different types of terahertz detectors: a detector based on a metal-semiconductor, field-effect transistor (MESFET) technology, an electro-optic (EO) detector, and an ultra-sensitivity detector based on quantum-dot technology, for which the sensitivities in terms of noise equivalent power (NEP) are 10^{-9} W/(Hz)$^{1/2}$, 10^{-13} W/(Hz)$^{1/2}$ and 10^{-21} W/(Hz)$^{1/2}$, respectively. Recently, with these terahertz sources and detectors, we have constructed a high-power, high-resolution terahertz spectrometer, and carried out various experiments to understand the resonance spectra of water vapor, chemicals and ionized air. In addition, we have constructed a modified terahertz spectrometer for standoff detection applications.

Monday, 3:00-4:00pm, Feb. 16, 2015.

SERC, Room 110

Refreshments served at 2:45pm