Development of Novel Terahertz Light Source Using Resonant Tunneling Diodes

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The realization of time-domain spectroscopy in the late 1980s [1] triggered a rapid expansion of research utilizing terahertz (THz) waves. The key to this advancement was the development of mode-locked THz pulse generation using femtosecond lasers. Various generation methods have been developed using photoconductive antennas, nonlinear optical crystals, semiconductor surfaces, and gas plasmas. In all of these methods, identical THz electric field waveforms can be generated repeatedly [2]. This property enables sampling of the electric field in the time domain, making THz time-domain spectroscopy possible. In the frequency domain, the spectrum of such a source forms a frequency comb with zero offset frequency and evenly spaced longitudinal modes located at integer multiples of the repetition frequency [3]. Currently, the generation of such THz frequency comb inevitably relies on photonics technologies employing expensive femtosecond lasers. However, our recent research has revealed a promising path toward realizing equivalent sources based on compact semiconductor electronic devices, specifically resonant tunneling diodes (RTDs) [4,5]. In this talk, I will present recent progress on the development of novel THz RTD oscillators, including mode-locked oscillation [6], frequency comb generation [7,8], broadband generation [9] and time-domain measurement techniques [10,11]. I will also discuss future prospects for this technology.

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