Passive Plasmonic Nanoantenna Arrays for High-Efficiency Optical-to-Terahertz Conversion

(Invited Talk)

Mona Jarrahi
University of California Los Angeles, e-mail: mjarrahi@ucla.edu

High power terahertz sources are essential components to realize high dynamic-range and broadband terahertz time domain spectroscopy (THz-TDS) and imaging systems. Photoconductive antennas are frequently used terahertz sources in THz-TDS systems. Photogenerated carriers inside a photoconductive substrate are swept to terahertz radiating elements with the help of an external bias voltage, inducing an ultrafast photocurrent that generates terahertz radiation. Developing photoconductive terahertz sources at telecommunication optical wavelengths (~1550 nm) is very desirable due to the existence of compact femtosecond fiber lasers. However, photoconductive semiconductors that are responsive to these wavelengths have low resistivity, which results in early thermal breakdown at high bias voltages. We recently introduced a telecommunication-compatible photoconductive terahertz source architecture that does not require an external bias voltage. The photogenerated carriers in this passive terahertz source are swept to an array of terahertz radiating nanoantennas by a built-in electric field formed between the nanoantennas and photoconductive substrate. As a result, the dark current is eliminated, and a more reliable operation is achieved. The photoconductive substrate is specifically grown to maximize the strength and overlap of the built-in electric field with the photogenerated carriers to provide high optical-to-terahertz conversion efficiencies. We have used this terahertz generation scheme to develop a fiber-coupled passive terahertz source that provides more than a 110 dB dynamic range over a 5 THz bandwidth while offering record-high conversion efficiencies compared to existing passive optical-to-terahertz converters.

1. D. Turan, P. K. Lu, N. T. Yardimci, Z. Liu, L. Luo, J.-M. Park, U. Nandi, J. Wang, S. Preu, M. Jarrahi, “Wavelength conversion through plasmon-coupled surface states,” *Nature Communications*, **12**, 12, 4641, 2021.
2. P. K. Lu, D. Turan, M. Jarrahi, “High-Power Terahertz Generation from Bias-Free Nanoantennas on Graded Composition InGaAs Structures,” *Optics Express*, **30**, 1584-1598, 2022.