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PHOTONIK SEMINAR

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Plasmonic Terahertz Optoelectronics

Although unique potentials of terahertz waves for chemical identification, material characterization, biological sensing, and medical imaging have been recognized for quite a while, the relatively poor performance, higher costs, and bulky nature of current terahertz systems continue to impede their deployment in field settings. In this talk, I will describe some of our recent results on developing new terahertz electronic/optoelectronic components and imaging/spectrometry architectures to mitigate performance limitations of existing terahertz systems. In specific, I will introduce new designs of high-performance photoconductive terahertz sources that utilize plasmonic nanoantennas to offer record-high optical-to-terahertz conversion efficiencies – demonstrating more than three orders of magnitude increase compared to the state of the art. I will describe that the unique capabilities of these plasmonic nanoantennas can be further extended to develop terahertz detectors and heterodyne spectrometers with quantum-level detection sensitivities over a broad terahertz bandwidth at room temperatures, which has not been possible through existing technologies. I will also present a terahertz time-domain imaging system based on a plasmonic photoconductive terahertz focal-plane array, which provides ultrafast-time-resolved and frequency-resolved amplitude and phase information of the imaged object with an imaging speed that exceeds 16 fps. The rich information provided by the terahertz focal-plane array allows super-resolving both shape and depth information of imaged objects with a lateral/depth resolution as small as 60/10 □m and an effective number of pixels exceeding 1-kilo-pixels. These plasmonic antennas and device architectures are optimized for operation at telecommunication wavelengths, where very high power, narrow linewidth, wavelength tunable, compact and cost-effective optical sources are commercially available. Therefore, our results pave the way to compact and low-cost terahertz sources, detectors, spectrometers, and imaging systems that could offer numerous opportunities for e.g., medical imaging and diagnostics, atmospheric sensing, pharmaceutical quality control, and security screening systems.

Monday, 30th October 2023, 11:00h c.t.

Seminarraum 387 (CBEG02) - Institut für Photonik
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