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标题: Scalable Microstructured Photoconductive Terahertz Emitters
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摘要: The development of scalable emitters for pulsed broadband terahertz (THz) radiation is reviewed. Their large active area in the 1 - 100 mm(2) range allows for using the full power of state-of-the-art femtosecond lasers for excitation of charge carriers. Large fields for acceleration of the photogenerated carriers are achieved at moderate voltages by interdigitated electrodes. This results in efficient emission of single-cycle THz waves. THz field amplitudes in the range of 300 V/cm and 17 kV/cm are reached for excitation with 10 nJ pulses from Ti:sapphire oscillators and for excitation with 5 mu J pulses from amplified lasers, respectively. The corresponding efficiencies for conversion of near-infrared to THz radiation are 2.5 x 10(-4) (oscillator excitation) and 2 x 10(-3) (amplifier excitation). In this article the principle of operation of scalable emitters is explained and different technical realizations are described. We demonstrate that the scalable concept provides freedom for designing optimized antenna patterns for different polarization modes. In particular emitters for linearly, radially and azimuthally polarized radiation are discussed. The success story of photoconductive THz emitters is closely linked to the development of mode-locked Ti:sapphire lasers. GaAs is an ideal photoconductive material for THz emitters excited with Ti:sapphire lasers, which are widely used in research laboratories. For many applications, especially in industrial environments, however, fiber-based lasers are strongly preferred due to their lower cost, compactness and extremely stable operation. Designing photoconductive emitters on InGaAs materials, which have a low enough energy gap for excitation with fiber lasers, is challenging due to the electrical properties of the materials. We discuss why the challenges are even larger for microstructured THz emitters as compared to conventional photoconductive antennas and present first results of emitters suitable for excitation with ytterbium-based fiber lasers. Furthermore an alternative concept, namely the lateral photo-Dember emitter, is presented. Due to the strong THz output scalable emitters are well suited for THz systems with fast data acquisition. Here the application of scalable emitters in THz spectrometers without mechanical delay stages, providing THz spectra with 1 GHz spectral resolution and a signal-to-noise ratio of 37 dB within 1 s, is presented. Finally a few highlight experiments with radiation from scalable THz emitters are reviewed. This includes a brief discussion of near-field microscopy experiments as well as an overview over gain studies of quantum-cascade lasers.
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