Plasmonics Enabled Advances in Photoconductive Terahertz Radiation Sources

(Invited Paper)

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***Abstract*—We present an overview of recent advances in photoconductive terahertz sources that utilize plasmonic nanostructures to significantly enhance optical-to-terahertz power conversion efficiency by enhancing light-matter interaction at nanoscale. We show that the impact of the plasmonic nanostructures on enhancing the optical-to-terahertz conversion efficiency of photoconductive terahertz sources is universal and can be employed in various types of photoconductive source designs under various operational settings.**

I. INTRODUCTION

In spite of the considerable progress in terahertz technology, practical feasibility of many exciting applications of terahertz systems is still bound by the low power, poor efficiency, and bulky nature of existing terahertz sources. Photoconduction is one of the most promising and commonly used means of terahertz generation, due to availability of high power, wavelength tunable, and compact optical sources with pulsed and continuous-wave operation required for broadband and narrowband terahertz generation, respectively [1, 2]. Here, we present an overview of recent advances in photoconductive terahertz sources that utilize plasmonic nanostructures to significantly enhance optical-to-terahertz power conversion efficiency by enhancing light-matter interaction at nanoscale.

II. RESULTS

Utilizing plasmonic nanostructures in a photoconductive source allows concentrating a larger fraction of the incident pump photons within nanoscale distances from the contact electrodes. By reducing the average transport path of photocarriers to the contact electrodes, the ultrafast photocurrent that drives the terahertz antenna is significantly enhanced and the optical-to-terahertz power conversion efficiency is increased considerably [3-7]. This enhancement mechanism has been widely used in various photoconductive terahertz sources with a variety of device architectures and in various operational settings, demonstrating significant optical-to-terahertz conversion efficiency enhancements [5-11]. We demonstrate that use of two-dimensional and three-dimensional plasmonic nanostructures leads to 2 orders-of-magnitude and 3 orders-of-magnitude enhancement in the optical to terahertz conversion efficiency of photoconductive sources, respectively, offering record-high optical-to-terahertz conversion efficiencies as high as 7.5% [8]. We show that the significant performance enhancement offered by plasmonic nanostructures can be utilized to achieve record-high terahertz power levels (milliwatt power levels) in both continuous-wave and pulsed operation at optical pump wavelengths ranging from 800-1550 nm [9-11].

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