Multiwavelength THz Metasurfaces under the Circularly-polarized Incidence

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In this paper, a novel single-layer dual-wavelength metasurface unit cell has been proposed, which can operate independently at two arbitrary terahertz (THz) wavelengths with a circularly polarized illumination. Multiwavelength metasurfaces based on the proposed meta-atom have been numerically studied and experimentally verified. The experimental results agree well with the simulation results and the design goals.

Metasurfaces are two-dimensional counterparts of metamaterials for manipulating the phase fronts of electromagnetic waves and lights. Typically, most of the reported metasurfaces are designed to work optimally at a single wavelength, and the extension of metasurfaces to operate at multi-wavelengths has remained a challenge due to the dispersion nature. In this study, we propose a novel single-layer meta-atom that could be used to work independently at two THz wavelengths under a circularly-polarized incidence. Figure 1 illustrates the general schematic of the proposed dual-wavelength meta-atom structure, which is composed of a patterned aluminum layer placed on a silicon substrate. The patterned aluminum layer consists of an outer double-slot structure and a bar structure centered in an inner circular hole. The 2π geometric phase, or Pancharatnam-Berry phase profiles at two THz wavelengths can be achieved by rotating the double-slot structure (for the larger wavelength) and the bar structure (for the smaller wavelength), respectively. Besides the dual-wavelength functionality, the proposed single-layer structure features the continuous phase control and easy fabrication. Several dual-wavelength metalenses and beam deflectors are both numerically studied and experimentally validated, the experimental results of which are consistent with the simulation results and the design goals. In addition, a four-wavelength metalens is also demonstrated by multiplexing two designs of the proposed structure. The presented structures could pave a new avenue for achieving multi-functional and multiwavelength metasurface devices.

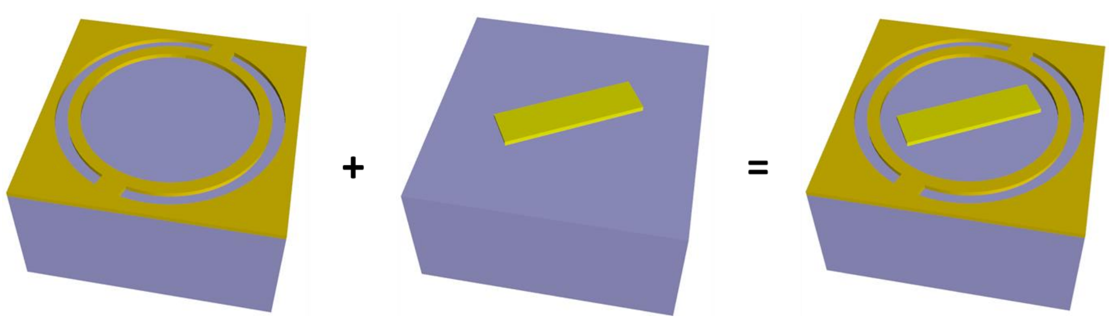

Figure 1. The general schematic of the proposed multi-wavelength metasurface meta-atom.