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Recent progress on plasmonic metasurfaces

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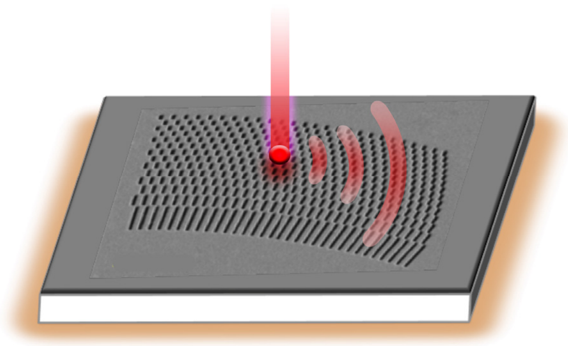

Plasmonic metasurfaces for light manipulation.

Abstract: Conventional optical systems (lenses, wave-plates and holograms) shape the wavefront of light within the range of an optical path that is much larger than the wavelength of light. The control of amplitude, phase and polarization of light depends on the dynamic optical path difference accumulated through the reflection, refraction and diffraction. Recently, planar ultrathin optical components have attracted tremendous attention by removing such traditional limitations. Among the competitive technologies, plasmonics is a promising field that enables the unique property of nanoscale confinement of electromagnetic fields. Plasmonic devices based on the manipulation of surface plasmons (SPs), a collective charge oscillation at metal/dielectric interfaces, have provided a confined environment for the full manipulation of light, and it is not surprising that this unique property of SPs has received considerable attentions. Meanwhile, engineered planar nanostructures, also named as metasurfaces, allow us to harness the light more smartly than any conventional ways. So far, a huge number of unprecedented optical components have been attained by the use of metasurfaces. As a result, plasmonic metasurfaces have become a whole new discipline within nanophotonics, because it can be perceived as a bridge connecting both electronics and optics, opening up opportunities for new and exciting applications.

In this paper, we mainly review the recent progress of plasmonic metasurfaces with respect to wavefront shaping of free space and localized optical fields. In general, applications of wavefront control usually require a space-gradient phase distribution ignoring the amplitude modulation. Herein, we introduce a novel design of holographic interface that can simultaneously realize the full control of several fundamental properties of light, i.e. amplitude, phase and polarization. Intuitively, one can exploit the metasurface for the generation of cylinder vector beams and the detection of orbit angular momentum of vortex beams. Based on the unidirectional coupling plasmonic metasurfaces, a spin-sensitive extraordinary transmission has also been discovered in a broadband range. As for the manipulation of localized surface plasmons, a variety of applications, such as Cosine-Gaussian beam, non-diffractive Airy beam and Weber beam, are verified experimentally. A theoretical contribution of in-plane Fourier transform is reported and it will pave a new avenue for integrating photonic metadevices. Though surface plasmons have attained significant potentials in various areas, the shortcomings of inherent Ohmic loss and low efficiency still exist. The improvement concerning these major issues is in urgent need of developing advanced plasmonic devices. Finally, we discuss current challenges and future development in the field of metasurfaces.

Keywords: surface plasmon polaritons; metasurfaces; wavefront shaping
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See page 289 for full paper.