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# Reflection tuning via destructive interference in metasurface

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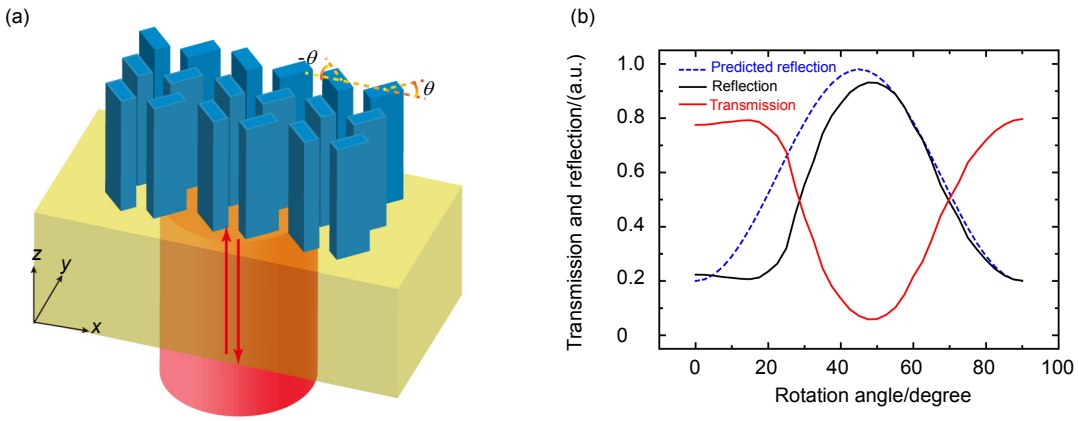


(a) Schematic of the metasurface. (b) The transmission and reflection of metasurface at various rotation angles.

Abstract: Reflection is one of basic optical phenomena, which has extensive applications in various optical systems, such as reflective mirror, laser cavity, coupler and lens. For these applications, the requirements are different. For instance, reflective mirror requires a high reflectivity but lens requires a high transmittance. Conventionally, reflection components mainly rely on the reflective coating. For the metal coating, the loss cannot be avoided, which limits its applications in high-power laser cavity and has low tunability in spectral response. For the dielectric coating, multi-layer design is required. It is not only sophisticated in design but also complicated in manufacturing, especially when the devices require different reflecivities. For the applications that require spectral filtering to reduce noise for particularly wavelengths or the spatial filtering for the special transmission mode, the design becomes even more difficult. Therefore, it is highly demanded to propose a feasible solution that can easily achieve the flexible control of reflection by a simple manufacturing process. It would be favorable for many devices if we can design a strategy that provides a large range of reflection tuning with a simple fabrication process. Metasurface is an array of scattering elements with sub-wavelength dimensions and periods, which can provide electromagnetic properties in demand. It is well-known for its capability of controlling light properties, such as wavefront, phase, and polarization. Furthermore, it is also favorable for industry as the fabrication process is compatible to the current semiconductor manufacturing. Hence, a single layer metasurface has great potential to replace traditional reflective components by a proper design. In this paper, we propose a new design of metasurface with just one single layer dielectric structure to tune the reflection of an interface by destructive interference in a subwavelength scale. By arranging the orientation of nano-antennas, the reflectivity tuning from 20% to 90% can be achieved at the wavelength of 1550 nm. Moreover, such reflectivity tuning of the designed metasurface works at the tunable wavelength from 1500 nm to 1600 nm. A design for the reflection without high diffraction orders is also proposed by a high refractive index silicon antenna on a low refractive index silica substrate, which can achieve about 0.1% ~ 98% reflection after optimization. It can achieve similar performance as the traditional bulky components without diffraction orders, while the design and fabrication are much more simple and flexible. The ultra-thin and tunable properties indicate the great potentials of this method to be applied in laser fabrication, optical communication and optical integration.

Keywords: metasurface; reflection; tunable; destructive interference

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