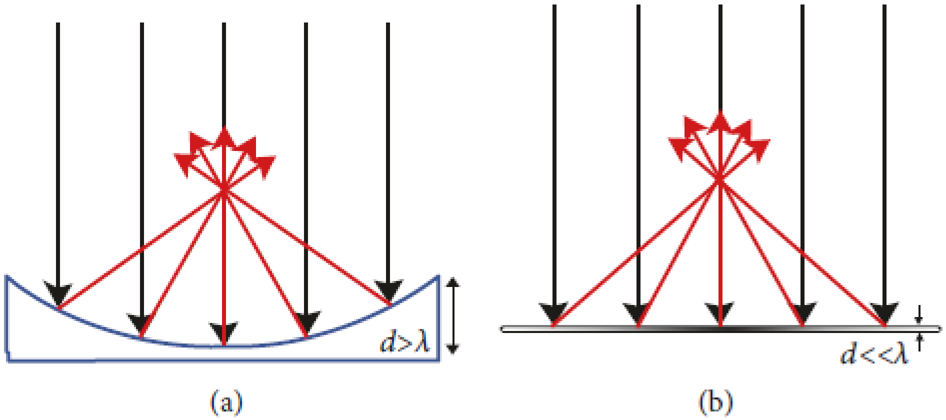
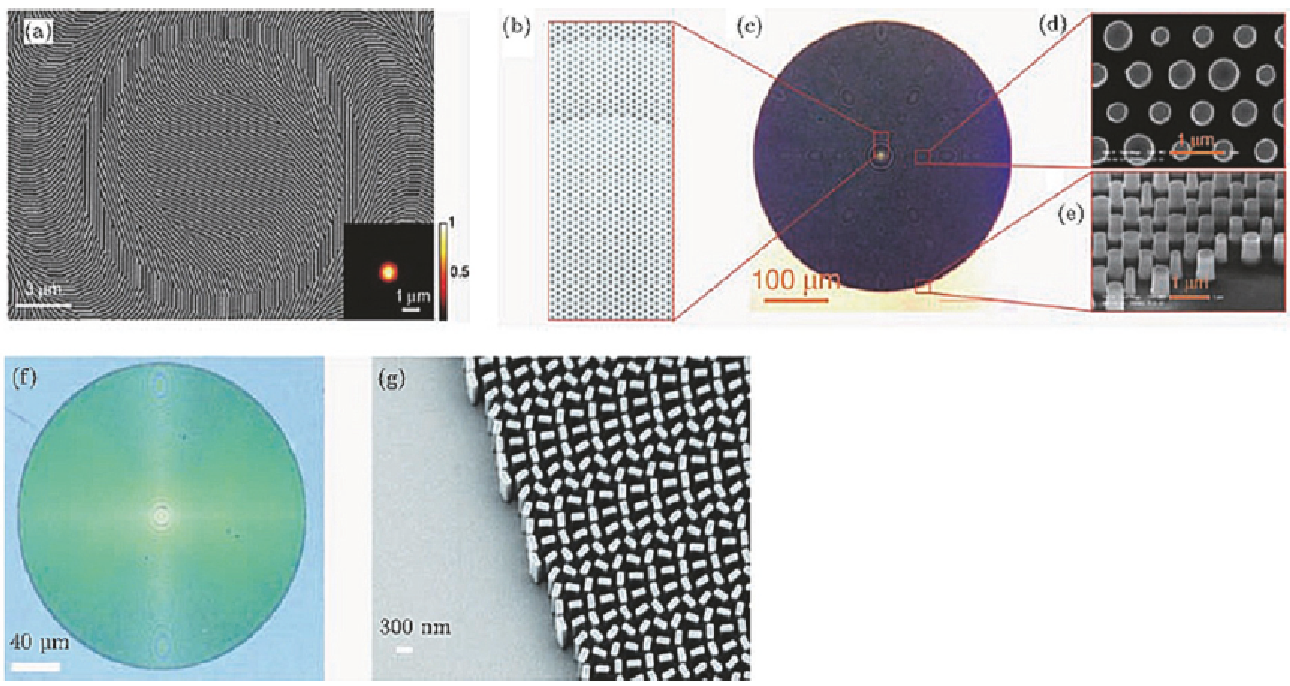
[Two-Dimensional Optical Metasurfaces: From Plasmons to Dielectrics]

Metasurfaces, kinds of planar ultrathin metamaterials, are able to modify the polarization, phase, and amplitude of physical fields of optical light by designed periodic subwavelength structures, attracting great interest in recent years. Based on the different type of the material, optical metasurfaces can be separated in two categories by the materials: one is metal and the other is dielectric. Metal metasurfaces rely on the surface plasma oscillations of subwavelength metal particles. Nevertheless, the loss caused by the metal structures has been a trouble, especially for devices working in transmit modes. The dielectric metasurfaces are based on the Faraday-Tyndall scattering of high-index dielectric light scattering particles. By reasonably designing the relevant parameters of the unit structure such as the size, direction, and shape, different functions of metasurfaces can realize and bring a wide range of applications. This article focuses on the metasurface concepts such as anomalous reflections and refractions and the working principle of different types of metasurfaces. Here, we briefly review the progress in developing optical over past few years and look
into the near future.



Metasurface prism’s convergence effect. (a) Conventional optical device. (b) Metasurface prisms.

Experiments of Figure show that the prism can focus incident light. The gradient metasurface prism thickness is much smaller than the wavelength (approximately λ/20) and all electromagnetic waves can be reflected and focused at the focal point.Therefore, with nearly 100% operating efficiency, it has important application value in the flat antenna.



(a) All-media gradient metasurface lens. (b)-(e) High numerical aperture lenses; (f)-(g) visible light lenses.

When the incident light wavelength is about 500 nm, the focusing efficiency of the lens reaches 70%. In 2015, Faraon et al. of California Institute of Technology designed a high numerical aperture lens with
a round silicon column. The lens achieves 82% focusing efficiency at the 1550 nm communication wavelength. The microstructure is shown in Figures (b)–(e). The circular silicon column has a high degree of rotational symmetry, so the designed lens is polarization-independent. The height of the silicon pillar is close to 1μm, the aspect ratio is relatively large, and the processing difficulty is also great. Although the proposal of dielectric metasurface is expected to solve the problem of plasmonic metasurface loss, the efficiency of the imaging lens designed in the visible light band is still limited, especially when the wavelength is 500 nm. As shown in Figures (f) and (g), the designed lens consists of a chloro-oxy dielectric rod and a glass substrate. A low loss medium material with smooth surface and high refractive index is used to solve the problem of material selection in visible band.

For more information: https://doi.org/10.1155/2019/2329168