Polarization Independent Perfect Reflect ion metasurface via Mie resonances in Dielectric Nanoclusters

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Manipulating electromagnetic behavior of light with nanostructures at subwavelength dimensions has been a constitute building blocks in many applications, for instance, optical sensor, photonics integrated circuit and solar cells. Noble metallic nanostructures are of high interest due to their ability to control the collective behavior of the free conduction electrons near the surface of the metal but were limited by inevitable ohmic losses, especially at optical wavelengths. Very recently, metasurfaces made of high refractive index dielectric materials, exhibiting high scattering efficiency and strong magnetic response throughout the visible and NIR regimes as an alternative to their metallic counterpart have stimulated increasing research.[1,2]

In this study, we present the perfect reflection metasurface in the near infrared range using silicon hexamer as the building block on the quartz substrate. A peak with 100% reflection was found in the numerical simulation using FDTD solutions. To make clear of the origin of the perfect reflection, we also simulate the scattering cross section and near field distribution of the silicon hexamer cell. We exploit the coherent interaction between the electric and magnetic dipolar resonances induced in the silicon hexamer. The results show that the perfect reflection comes from the collective magnetic dipole resonance of the hexamers.

To experimentally observe the presented perfect reflection, the dielectric metasurface was fabricated using a standard top-down nanofabrication approach with Electron Beam Lithography (EBL) and induced coupled plasma (ICP) etching on the quartz substrate. Then both transmission and reflection spectra are measured by home-made grating spectrometer. The measurement agrees well with the numerical simulation. Therefore, the perfect reflection and independent on the polarization properties enable dielectric metasurface based on silicon hexamer to become a superior magnetic-based resonance device in nanophotonics applications, such as optical sensor.

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[1] A. I. Kuznetsov, A. E. Miroshnichenko, M. L. Brongersma, Y. S. Kivshar, B. Luk'yanchuk. Science, **354**, 6314 (2016).
[2] I. Staude, J. Schilling. Nat. Photonics, **11**, 5 (2017).