Transmission and reflection features of all-dielectrics metasurfaces with electric and magnetic resonances

100-word abstract:

In this work we study reflection and transmission features of silicon metasurfaces composed of silicon nanocubes, applying a semi-analytical multipole method. Using this approach, the role of different Cartesian multipoles, excited in the nanocubes, in the modification of light transmission and reflection metasurface properties is analyzed. The so-called lattice anapole affect, where the light transmits through the metasurface almost without amplitude and phase perturbations, was found and explained by destructive interference between scattered waves generated by dipole and quadrupole multipoles of metasurface’s nanoparticles. Transmission and reflection properties of metasurfaces composed of silicon nanocones are also investigated.

250-word abstract:

In this work we study transmission and reflection features of silicon metasufaces using the developed multipole decomposition approach. We analyze the optical properties of periodic metasurfaces based on silicon nanocubes and nanocones with different lattice constants. The comparison of transmission and reflection spectra calculated using multipole approach and direct numerical calculations are in the excellent agreement.

 Applying the developed multipole analysis, we can identify and explain different reflection and transmission features including the so-called lattice anapole effect where the light transmits through the metasurface almost without amplitude and phase perturbations. Multipole interference providing the realization of generalized Kerker-type effect can be also studied and described. In addition, the mutual multipole coupling, leading to the intriguing features in the transmission/reflection spectra, is demonstrated as well. The properties of silicon metasurface based on non-symmetric conical meta-atoms are also investigated; we show that multipole decomposition differs for illumination from top and bottom side of nanostructure, however, the transmission spectrum remains unchanged.

Summarizing, it has been demonstrated that the multipole analysis can explain the origins of the reflection and transmission features from the multipole point of view. Obtained results could be used for development and optimization of new optical devices, including flat filters, sensors, switchers etc.