Light Scattering By Subwavelength Arrays of Silicon Nanowires

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Abstract

The study of light scattering by optically resonant nanostructures is a field of growing interest as a result of the rapid progress in nanophotonics in the last decade. Contrary to their plasmonic counterparts, high-index dielectric structures exhibit low optical losses and different structures allowing engineering and control of near-field effects and far-field scattering show great promise as building elements of new devices and metamaterials. The possibility of controlling the spectral position of different resonant frequencies with different materials and geometries is being intensely explored and it has been shown that highly directional scattering can be achieved when electric and magnetic dipole resonances are excited simultaneously1 or with structures combining metallic and dielectric materials[2].

In this work we use the Wave Optics Module of COMSOL Multiphysics® to analyze infrared scattering by subwavelength arrays of cylindrical silicon nanowires, within the electromagnetic waves frequency domain (ewfd) framework. The geometry of the problem is composed by the array of cylindrical nanowires and a spherical perfectly matched layer. We shine an infrared polarized plane wave over the array and calculate the scattered electric field for different values of the wavelength and the scattering and absorption cross sections.

We show that, in contrast with the case of a single nanowire, the array gives rise to different resonance frequencies which depend on the incidence direction of the light. We also study the dependence of the resonances peaks and their spectral positions on the number of nanowires in the array, the geometric parameters of the system, and light polarization axis.