CONTROLLING THERMAL EMISSION AND OPTICAL ABSORPTION RESONANCES FROM NANOCYLINDER ARRAYS

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Understanding the absorption and thermal emission of electromagnetic radiation in nanostructured systems is a key issue in nanoscience and technology. Emission and absorption processes, closely connected from the well known Kirchhoff's law, are of considerable interest in very different applications. Tailoring the thermal emission is especially relevant for thermophotovoltaic (TPV) applications and for the design of efficient light and infrared sources.

In this work, we show that a simple subwavelength cylinder array can be tuned to present striking emission and absorption characteristics. This system, that resembles a nanowire toaster grille, presents two different kinds of emission/absorption resonances. Close to the Rayleigh anomalies, the diffractive coupling with the lattice periodicity [1,2] can generate coherent, quasi-monochromatic and highly directional, thermal emission/absorption even in absence of any material or surface plasmon/polariton resonance (SPR). These geometric resonances [3] lead to sharp peaks in the extinction spectra with characteristic Fano line shapes. Another kind of absorption resonances, with wider and symmetric line shapes, appears when the ma-
terial exhibits an absorption line or in the presence of localized SPRs. At the resonant wavelength, the emission is isotropic which may be important for TPV applications. We analytically derive the conditions for resonant emission/absorption as a function of the geometry and material's parameters. We will demonstrate that for s-polarization there is a theoretical limit of 50% of absorption. Interestingly, we will show that, for p-polarized light and an appropriate choice of parameters, an array of nano-cylinders can present perfect (100%) absorption. This study provides new tools for the nanoengineering of biological and chemical sensors based on nanoparticle arrays.

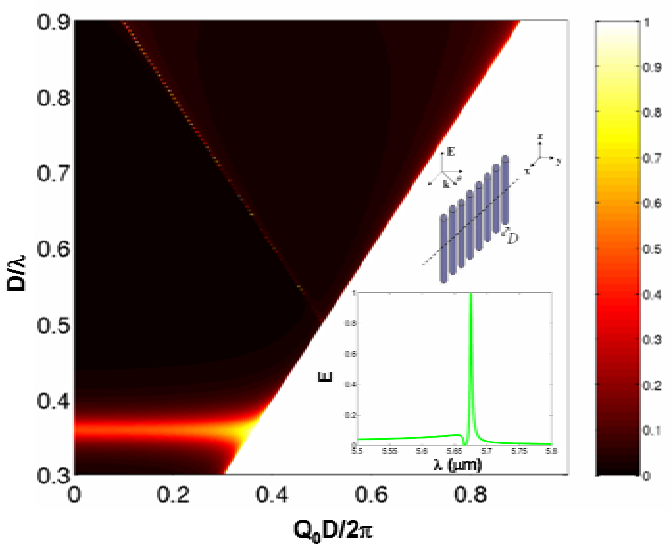

Fig. 1: Extinction spectrum in s-polarization in the plane D/ versus Q_0 (x-component of the incident wavevector), for an array of SiC nanocylinders with parameters : period D = 4.5 m and radii a=0.2 m. Around D/ =0.36 (l = 12.5 m), there is an isotropic extinction peak due to the absorption line of SiC. The inset shows the extinction spectrum, which exhibits a typical Fano line shape, for an incident angle =15° around the geometric resonance (close to Rayleigh frequency).

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[3] R. Gómez-Medina and J.J. Sáenz, *Phys. Rev. Lett.* **93**, 243602 (2004).