EFFICIENT SOLAR LIGHT HARVESTING DEVICE BASED ON MULTILAYER PHOTONIC CRYSTAL FILMS

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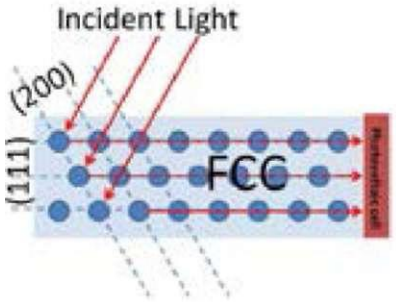
Introduction.

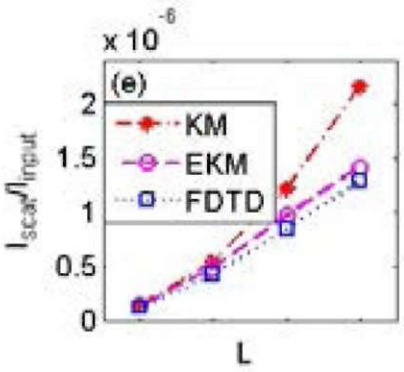
We fabricate, characterize and calculate photonic-colloidal crystals. We propose to use wave guiding properties of photonic crystal films [1] to concentrate large amount of sunlight onto a small area of solar photovoltaic (PV) cells.

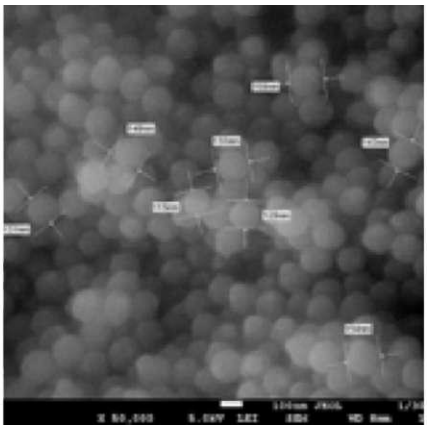
Methodology and results.

1) Fabrication: We have improved crystal films growth technology based on self-assembling of nanoparticle colloids into crystal structures. Improvements included better-quality synthesis reactions that result in better colloidal solutions (more optimal charge on each nanoparticle and higher level of homogeneity in size distribution) and better technologies of colloidal crystal growth.

2) Calculations and numerical simulations of diffraction: We have studied different methods for computation of optical diffraction on photonic crystals. By comparing different methods, in particular with the exact FDTD method, we have shown that Extended Kinematic Method [2] is computationally inexpensive method that allows calculating diffraction efficiency for large macroscopic system with very high precision. Using this method we have calculated diffraction efficiency on single photonic crystal film and on combination of several films in the regime optimal for concentration of large amount of sunlight onto a small area of solar photovoltaic (PV) cells. We have found the combination of several films that allowed concentration of wide band of sun light.







References.

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2. A. Tikhonov, N. Kornienko, J. Zhang, L. Wang, S.A. Asher; Reflectivity enhanced 2D dielectric particle array monolayer diffraction, J. Nanophotonics, 6, 063509, (2012).
3. A. Tikhonov, R. D. Coalson, and S. A. Asher, "Light diffraction from colloidal crystals with low dielectric constant modulation: simulations using single-scattering theory" Physical Review B 77, 235404, (2008).