PAPER

Monolithic light concentration by core–shell TiO_2 nanostructures templated by monodisperse polymer colloidal monolayers

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Abstract

Nanostructured dielectric overlayers can be used to increase light absorption in nanometer-thin films used for various optoelectronic applications. Here, the self-assembly of a close-packed monolayer of polystyrene nanospheres is used to template a core–shell polystyrene-TiO_2 light-concentrating monolithic structure. This is enabled by the growth of TiO_2 at temperatures below the polystyrene glass-transition temperature via atomic layer deposition. The result is a monolithic, tailorable nanostructured overlayer fabricated by simple chemical methods. The design of this monolith can be tailored to generate significant absorption increases in thin film light absorbers. Finite-difference, time domain simulations are used to explore the design polystyrene-TiO_2 core–shell monoliths that maximize light absorption in a 40 nm GaAs-on-Si substrate as a model for a photoconductive antenna THz emitter. An optimized core–shell monolith structure generated a greater than 60-fold increase of light absorption at a single wavelength in the GaAs layer of the simulated model device.

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