



PAPER

Monolithic light concentration by core-shell TiO₂ nanostructures templated by monodisperse polymer colloidal monolayers

Rachel Cherry^{3,1}, Joseph Joel Muhanga^{3,1}, Hamed Mehrabi², Samuel K Conlin¹ and Robert H Coridan^{1,2}

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rcoridan@uark.edu

¹ Department of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR 72701, United States of America

² Materials Science and Engineering Program, University of Arkansas, Fayetteville, AR 72701, United States of America

³ Equal contributors.

Robert H Coridan <https://orcid.org/0000-0003-1916-4446> want to submit my research for publication.

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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-TiO₂ light-concentrating monolithic structure. This is enabled by the growth of TiO₂ 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-TiO₂ 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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