NREL Highlights SCIENCE

Potential Benefits of Manmade Opals Demonstrated for First Time

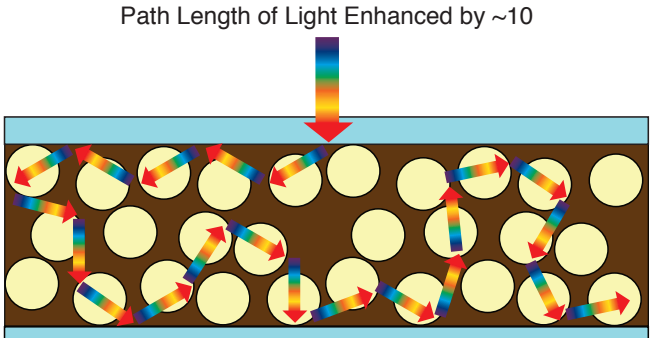
NREL experiments show that disordered inverse opals significantly scatter and trap near-infrared light, with possible impact on optoelectronic materials.

Inverse opals, familiar in the form of brilliantly colored opal gemstones, are a class of materials that has astounding optical properties. Scientists have been exploring the ability of inverse opals to manipulate light in the hopes of harnessing this capacity for advanced technologies such as displays, detectors, lasers, and photovoltaics. A research group at the National Renewable Energy Laboratory (NREL) discovered that man-made inverse opal films containing significant morphological disorder exhibit substantial light scattering, consequently trapping wavelengths in the near-infrared (NIR), which is important to a number of technologies. This discovery is the first experimental evidence to validate a 2005 theoretical model predicting the confinement of light in such structures, and it holds great promise for improving the performance of technologies that rely on careful light control. This breakthrough also makes possible optoelectronic technologies that use a range of low-cost molecular and semiconductor species that otherwise absorb light too weakly to be useful.

This work was sponsored by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, Division of Chemical Sciences, Biosciences, and Geosciences.

Technical Contact: Nathan Neale, *nathan.neale@nrel.gov*

Reference: N.R. Neale, B.G. Lee, S.H. Kang, and A.J. Frank. "Near-Infrared Light Trapping in Disordered Inverse Opals," *The Journal of Physical Chemistry C*, 2011, 115, 14341.



Schematic of light scattering within the disordered inverse opal structure showing a nearly tenfold increase in the path length, or the distance traveled by light, through the film. Illustration by Nathan Neale, NREL

Key Research Results

Achievement

The disordered inverse opal architecture validates the theoretical model that predicts the diffusion and confinement of light in such structures.

Key Result

Electrochemically deposited CdSe inverse opal films containing significant morphological disorder exhibit substantial light scattering and consequent NIR light trapping.

Potential Impact

This discovery holds promise for NIR light management in optoelectronic technologies, particularly those involving weakly absorbing molecular and semiconductor photomaterials.

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NATIONAL RENEWABLE ENERGY LABORATORY

15013 Denver West Parkway | Golden, CO 80401 | 303-275-3000 | www.nrel.gov

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NREL/FS-5900-53385 • July 2012