Low-Cost Nano-Patterning Process Makes Millions of Holes in Silver Film, Boosting Light-Capturing Qualities of Solar Cells

NREL's breakthrough process creates nanoholes that trap sunlight so that more photons can be converted into electricity; the millions of holes create surface plasmons that account for the unusually high transmission in the silver films.

Any sunlight that reflects off of a solar cell is wasted potential energy. Historically, the search for a technology that effectively traps sunlight has been arduous, threatening to slow progress in developing ever more efficient solar cells.

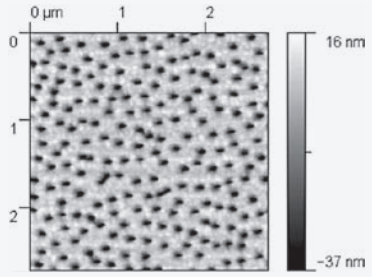
NREL researchers have demonstrated a simple, low-cost way to pattern nano-sized holes in thin silver films in order to trap light waves and boost the transmission of photons into usable energy.

Using a colloidal nanolithography method, the researchers employed latex beads and standard vapor deposition of silver to pattern nano-sized holes into the film. The result is a disordered array of tiny holes forming a novel transparent conductive electrode in the solar cells. With this method, the extraordinarily high transmission of photons is actually greater than the area of the holes.

A follow-up analysis of the electrodes found that surface plasmons, which are surface oscillations of conduction electrons trapping light waves near the surface, are responsible for the unusually high transmission in the films. The surface plasmons focus incoming light near the surface, which causes a sharp spike in optical absorption in the active layer of the solar cell.

The nano-patterned silver film should prove useful as a transparent electrode in newer solar cell technologies, such as organic solar cells. It also has the advantage of providing a transparent conductive electrode not made of indium, which is relatively rare and costs around $1,000 a kilogram.

Reference: Thomas H. Reilly III, Robert C. Tenent, Teresa M. Barnes, Kathy L. Rowlen, and Jao van de Lagemaat. Controlling the Optical Properties of Plasmonic Disordered Nanohole Silver Films. ACS Nano, Vol 4 No.2, 615-624. Published online January 29, 2010.



Key Research Results

Achievement

NREL researchers patterned millions of nano-sized holes into thin silver films using latex beads suspended in a liquid solution.

Result

The millions of nano-sized holes boost the films' light-management properties, capturing potential solar energy that would otherwise be wasted. Each hole can better capture a wavelength of light—similar to how a brick wall captures sunlight better than a smooth granite finish.

Potential Impact

This breakthrough could lead to more efficient solar cells; that is, cells in which a higher percentage of photons can be converted directly into energy for electricity.

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