

Psst! A whispering gallery for light boosts solar cells

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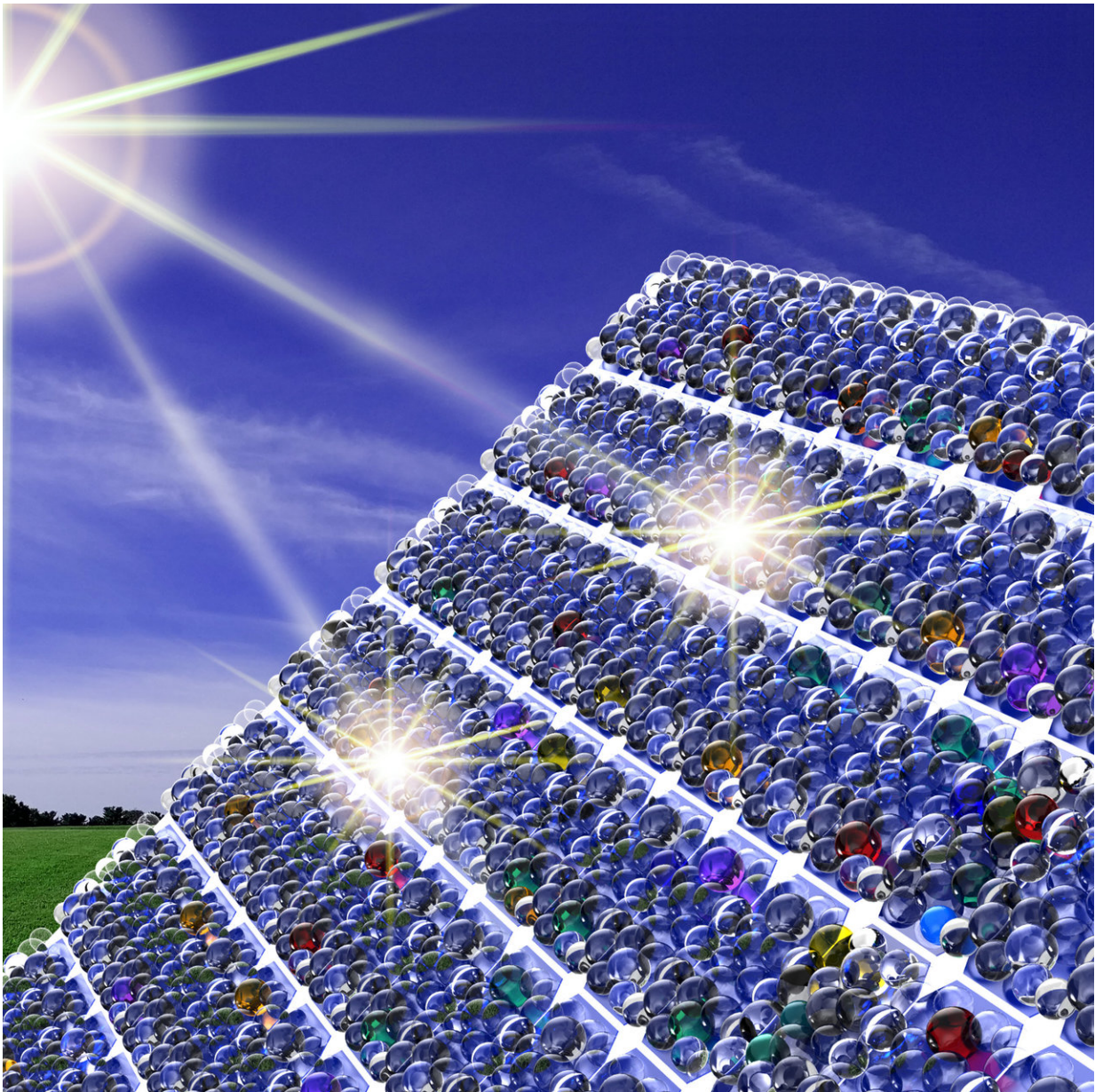


Illustration shows the nanoresonator coating, consisting of thousands of tiny glass beads, deposited on solar cells. The coating enhances both the absorption of sunlight and the amount of current produced by the solar cells. Credit: K. Dill, D. Ha, G. Holland/NIST

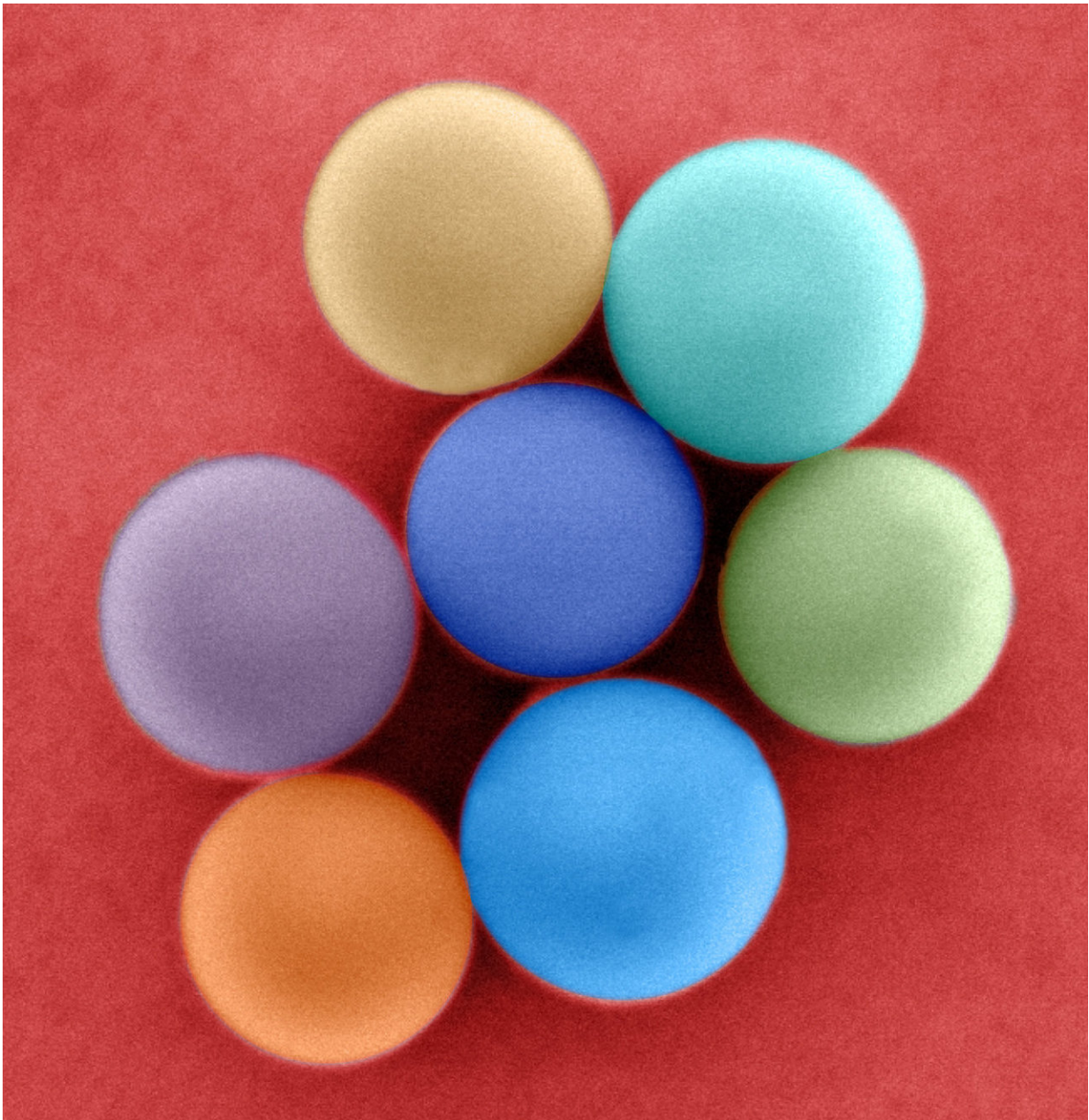
Trapping light with an optical version of a whispering gallery, researchers at the National Institute of Standards and Technology (NIST) have developed a nanoscale coating for solar cells that enables them to absorb about 20 percent more sunlight than uncoated devices. The coating, applied with a technique that could be incorporated into manufacturing, opens a new path for developing low-cost, high-efficiency solar cells with abundant, renewable and environmentally friendly materials.

The [coating](#) consists of thousands of tiny glass beads, only about one-hundredth the width of a human hair. When sunlight hits the coating, the [light](#) waves are steered around the nanoscale bead, similar to the way sound waves travel around a curved wall such as the dome in St. Paul's Cathedral in London. At such curved structures, known as acoustic whispering galleries, a person standing near one part of the wall easily hears a faint sound originating at any other part of the wall.

Whispering galleries for light were developed about a decade ago, but researchers have only recently explored their use in solar-cell coatings. In the experimental set up devised by a team including Dongheon Ha of NIST and the University of Maryland's NanoCenter, the light captured by the nanoresonator coating eventually leaks out and is absorbed by an underlying solar cell made of gallium arsenide.

Using a laser as a light source to excite individual nanoresonators in the coating, the team found that the coated solar cells absorbed, on average,

20 percent more visible light than bare cells. The measurements also revealed that the coated [cells](#) produced about 20 percent more current.



Artist's representation of glass beads of slightly different diameters (denoted by different colors) in the nanoresonator coating. Each bead acts as an optical whispering gallery, or resonator, for a slightly different wavelength of sunlight.

Credit: K. Dill, D. Ha/NIST

The study is the first to demonstrate the efficiency of the coatings using precision nanoscale measurements, said Ha. "Although calculations had suggested the coatings would enhance the [solar cells](#), we could not prove this was the case until we had developed the nanoscale measurement technologies that were needed," he noted.

This work was described in a recent issue of *Nanotechnology* by Ha, collaborator Yohan Yoon of NIST and Maryland's NanoCenter, and NIST physicist Nikolai Zhitenev.

The team also devised a rapid, less-costly method of applying the nanoresonator coating. Researchers had previously coated semiconductor material by dipping it in a tub of the nanoresonator solution. The dipping method takes time and coats both sides of the semiconductor even though only one side requires the treatment.

In the team's method, droplets of the nanoresonator solution are placed on just one side of the solar cell. A wire-wound metal rod is then pulled across the cell, spreading out the solution and forming a coating made of closely packed nanoresonators. This is the first time that researchers have applied the rod method, used for more than a century to coat material in a factory setting, to a [gallium arsenide](#) solar cell.

"This is an inexpensive process and is compatible with mass production," said Ha.

More information: Dongheon Ha et al, Nanoscale imaging of photocurrent enhancement by resonator array photovoltaic coatings, *Nanotechnology* (2018). [DOI: 10.1088/1361-6528/aaab0c](https://doi.org/10.1088/1361-6528/aaab0c)

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