Moth eyes may hold key to more efficient solar cells

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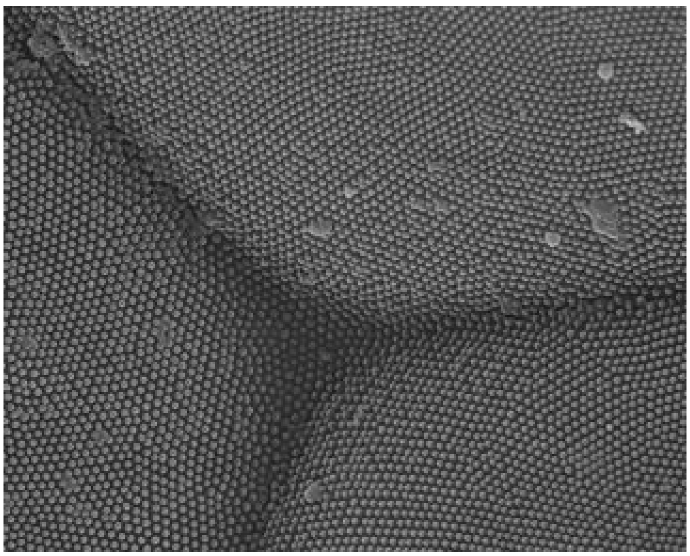
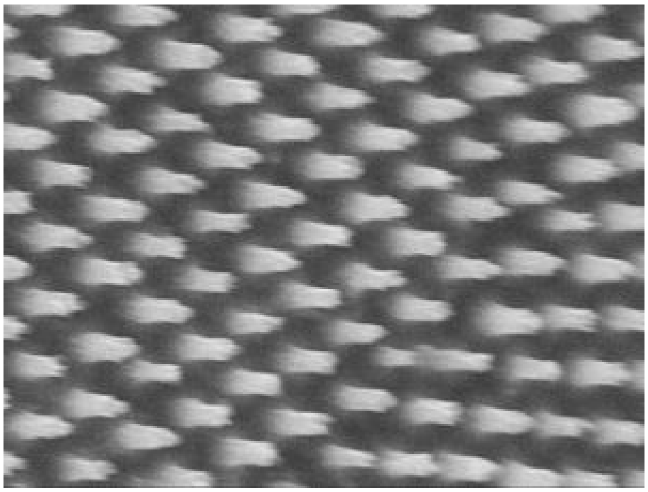


Picture of the structure of a moth eye. Credit: Peng Jiang

One of the difficulties with solar power is that solar cells are notoriously inefficient. Some of that inefficiency, says Peng Jiang, is due to the fact that silicon is reflective. Jiang, an assistant professor at the University of Florida, tells *PhysOrg.com* that there are “disadvantages to the anti-reflective coating currently used in solar cells.”

With a new process that looks to the structure of moth eyes for inspiration, Jiang hopes to address these disadvantages, improving the cost-efficiency of solar cells. “You want more of the sunlight absorbed, rather than reflected," he says. Jiang and his collaborators, Chih-Hung Sun at the University of Florida, and Bin Jiang at Portland State University, share the results of their work in *Applied Physics Letters*: "Broadband moth-eye antireflection coatings on silicon."



Silicon wafer with anti-reflection array, model after a moth eye. Credit: Peng Jiang

"Right now," Jiang explains, "the bluish anti-reflective coating you see on solar cells is not very efficient beyond a narrow range." He says that the wavelengths of light from the sun range from between 400 nm and 1400 nm. "Once you get below about 500 nm, and above 800 nm, reflection starts increasing." Jiang points out that the optimal efficiency for the current technology works with wavelengths of around 600 nm.

Looking at the way moth eyes are structured gave Jiang and his co-authors an idea. "Moth eyes are not very reflective," he points out. "We found our inspiration in nature, trying to mimic the natural nanostructure."

Moth eyes have orderly bumps on their corneas. Jiang refers to these bumps as “nipples.” The nipples are in an array that creates a situation in which almost no reflection exists. While it was most likely an evolutionary defense against nocturnal predators, it can be adapted for use in solar cells, creating a situation in which most of the light from the sun is absorbed and efficiently utilized instead of reflected uselessly.

Jiang says that a method of spin coating is used to create the effect. Nanoparticles in a liquid suspension are placed on a silicon wafer, similar to those used in solar cells. As the wafer is spun, the force created distributes the nanoparticles in the liquid. A sort of mask is created that can be used as a template. Etching is used to transfer the nanoparticle structure onto the silicon wafer beneath.

“It is self-assembling,” Jiang says of the nanoparticle arrangement. “All of the particles are the same size. It’s like when you put glass beads in a box and then shake it. All of the beads arrange themselves into an array pattern.”

In addition to being technologically easy, the process is also inexpensive. “In addition to the inefficiency, these are the two main disadvantages of the current solar cell anti-reflective coating,” Jiang explains. “It is difficult to make, and it is an expensive process.”

Jiang points out that this process creates less than two percent reflection. This is a vast improvement over the 35 to 40 percent reflection rate seen without the anti-reflection coating layers. “This simple, cheaper process is also much more efficient.”

The next step, Jiang says, is manufacturing. “We think it is ready now,” he says. “We are close to a start-up company that could use this process to make solar cells.” And he also hopes to improve upon the design. “Right now, this is done with single crystalline silicon wafers. We hope to extend the technology to work on multi-crystalline silicon, which is where solar cell technology is moving in the future."

"I don't see much trouble with it though," he continues. "Because of the simplicity of the process, there should be no reason it shouldn't work. There should be no limitation to expansion."