Nano World: Black silicon for solar power

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Silicon surfaces rendered black by pits and bumps only nanometers or billionths of a meter large could in the future help make solar power cells more efficient.

Flat silicon surfaces are normally highly reflective. Scientists want to minimize reflection as much as possible when it comes to solar power cells made of silicon, because the more light they reflect, the less they convert to electricity. Often, anti-reflective coatings are used, which reduce the amount of average reflection in the wavelengths of light solar power cells use by 85 percent to 92 percent.

The novel treatment developed by researchers at the Technical University of Munich can cut the surface reflection silicon experiences by 95 percent to 98 percent across the wavelengths of light solar power cells use, making them black.

"The results are really good when it comes to preventing reflection. It is still speculative as to how much this can boost the efficiency of solar cells. I am optimistic that for traditional designs of solar cells, it could give a 15 to 20 percent improvement with respect to their present efficiency. The performance of some solar cells with novel design could be improved even more dramatically. However, I think we will need a bit of time to show this," said researcher Svetoslav Koynov, a physicist.

The researchers created nanometer pits and bumps on the silicon, which end up helping to absorb light. Prior techniques had developed such textures on silicon as well using plasma etching, but are complex,

difficult to work over large surfaces and can incur damage, making large-scale production of solar power cells with them a problem.

Koynov and his colleagues instead developed a simple and fast technique that creates these textures using wet chemical processes. Their method works regardless of the crystalline structure of the silicon, its thickness, or what extra chemical additives it possesses. The fact the technique is so flexible could mean it could work on silicon surfaces that cannot handle other kinds of anti-reflection treatments, such as the silicon thin films used in advanced hybrid solar cells, Koynov suggested.

First the researchers deposit grains of gold only nanometers large onto a flat silicon surface. Next the silicon between the areas covered by the clusters is etched away with a solution of hydrogen peroxide and hydrofluoric acid. The gold nanoparticles exhibit catalytic action, "behaving like drills into the surface," Koynov said. The areas covered by the gold form 50-to-100-nanometer-high pits on the surface while the silicon between the gold makes up the bumps. The nanoparticles are then removed with a solution of iodine and potassium iodide.

"This is a very easy way to get an extremely non-reflective silicon surface," said physicist Howard Branz at the National Renewable Energy Laboratory in Golden, Colo. "We've tried it and it works."

The researchers are currently attempting to establish an industrial partner to advance their method forward. "If we are able to establish a good connection with an industrial partner, I'd hope in one to three years we could go to market," Koynov said.

"This is an important breakthrough on an important problem," said theoretical physicist Alexander Efros at the Naval Research Laboratory in Washington. "It is clear this could find application for increasing the efficiency of solar cells."

Koynov cautioned the gold nanoparticles could react unfavorably with the semiconductors in solar cells. He added his team has experimented with using other metal nanoparticles as well, with some success.

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