Silver Nanoparticles Give Polymer Solar Cells A Boost

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(PhysOrg.com) -- Small bits of metal may play a new role in solar power. Researchers at Ohio State University are experimenting with polymer semiconductors that absorb the sun's energy and generate electricity. The goal: lighter, cheaper, and more-flexible solar cells.

They have now discovered that adding tiny bits of silver to the plastic boosts the materials' electrical current generation.

Paul Berger, professor of electrical and computer engineering and professor of physics at Ohio State, led the team that reported the results online in the journal *Solar Energy Materials and Solar Cells*.

Berger and his team measured the amount of light absorbed and the current density -- the amount of electrical current generated per square centimeter -- generated by an experimental solar cell polymer with and without silver nano-particles.

Without silver, the material generated 6.2 milli-amps per square centimeter. With silver, it generated 7.0 -- an increase of almost 12 percent.

The small silver particles help the polymer capture a wider range of wavelengths of sunlight than would normally be possible, which in turn increases the current output, Berger explained.

He added that with further work, this technology could go a long way toward making polymer solar cells commercially viable.

“The light absorption of polymer solar cells is inadequate today,” he said. “The top-performing materials have an overall efficiency of about 5 percent. Even with the relatively low production cost of polymers compared to other solar cell materials, you’d still have to boost that efficiency to at least 10 percent to turn a profit. One way to do that would be to expand the range of wavelengths that they absorb. Current polymers only absorb a small portion of the incident sunlight.”

The new fabrication technique involves encasing each silver particle in an ultra-thin polymer layer -- a different polymer than the light-absorbing polymer that makes up the solar cell -- before depositing them below the light-absorbing polymer; the coating prevents the silver particles from clumping, but also allows them to self-assemble into a dense and regular mosaic pattern that Berger believes is key to enhancing the light absorption.

Even though the silver particles allow the material to produce 12 percent more electrical current, that improvement may not translate directly into a 12 percent increase in overall solar cell efficiency. Many factors effect efficiency, and some energy can be lost.

Still, the silver nanoparticles could boost the overall efficiency of virtually any kind of solar cell -- those made from polymers or other semiconductor materials. Berger and his colleagues are now studying other nanoparticle formulations that would increase that number further.

“By changing the organic coating, we could change the spacing of the particles and alter the size of each particle. By fine-tuning the mosaic pattern, we could move the enhanced absorption to different wavelengths, and thus get even more of an improvement. I think we can get several percent more,” he said.

The semiconductor polymer captures more light because the metal nanoparticles absorb light that would normally be wasted. This extra light energy excites electrons in the metal particles, creating electron waves called plasmons -- a cross between plasma and photons. The plasmons dance across the surface, depositing energy inside the solar cell that would otherwise be lost.

Researchers have been looking for a way to generate plasmons in solar cells without greatly increasing the difficulty and cost of manufacture. Given that his technique uses simple fabrication equipment at room temperature, and given that the silver particles self-assemble based only on the chemistry of the coating, Berger feels that any laboratory could easily make use of this finding.

“Not only do week seek better efficiency, but also lower costs too,” he added.

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