Argonne National Lab Ups Solar Efficiency via Luminescent Solar Concentrators

By Jeanne Roberts on September 29, 2011

For years, the goal of solar energy has been to extract as much energy as possible from each solar cell, which effectively lowers the cost of the technology as a whole.

Once solar energy can deliver a certain number of kilowatt hours from a certain type of solar technology, photovoltaic or concentrating, for example, it reaches "grid parity." That is, its cost becomes comparable to more traditional sources of energy like coal, oil, natural gas and nuclear.

At Argonne National Laboratory, scientists are re-examining an idea which has been around for about three decades in non-commercial form. They are using luminescent solar concentrators, or LSCs, thin film plastics treated with phosphorescent dyes that capture light rays, change them to a different wavelength, and then concentrate them along the outer edges of the film.

The research is being conducted by Postdoctoral Fellow Chris Giebink and Group Leader Chemist Gary Wiederrecht, both of Argonne Laboratory, which is one of a system of facilities and laboratories managed by the U.S. Department of Energy, or DOE.

The two are collaborating with Michael Wasielewski, a faculty professor of chemistry at Northwestern University and the Director of Argonne's Solar Energy Research (ANSER) Center, which is one of 46 Energy Frontier Research Centers set up in 2009 and supported by the DOE's Office of Science.

The LSCs act as "flat funnels" (Giebink's description), collecting an abundance of light waves over their surfaces. These light waves, or particles, are then redirected and emitted only at the edges, which serves to concentrate the energy.

The process takes advantage of an optical microcavity effect, in this case layers of nanoscale thin film which produce a resonance-shifting state in which light "fails to recognize its source" – a process that reduces reabsorption. This is the state of amnesia alluded to in most reprises of the release.

In fact, the plastic and dyes work as a waveguide, with dyes trapping electrons and exciting them. When the electrons return to their normal charge state, having "forgotten" how they got where they are, they are released into the sheet, where they get stuck and bounce around until they find their way to the surface, where solar cells are lined up along the edge to absorb them.

"If light forgets how it came in," Wiederrecht explains, "It is less likely to get reabsorbed or scattered out."

But the technique involves more than redirection, or misdirection. In fact, the scientists are shifting the frequency of the light "by the theoretical potential for this intensification", Giebink explains. The effect is called a Stokes shift, and the potential, at least for fluorescent luminescent concentrators, can be more than one hundred suns, which is considered high.

So far, however, the shift hasn't panned out in more efficient solar cells, largely because the light is getting lost in the slabs, victim of either reabsorption or dissipation. The same problem is inherent in all SCs, including PSCs (plasmonic solar cells).

PSCs hope to solve this with a photonic waveguide. The Argonne group plans to analyze the LSC in two dimensions, which scientists hope will reveal a greater propensity toward resonance-shifting via optimum dye layers or compositions and/or glass thicknesses.

Source: http://www.energyboom.com/yes/argonne-national-lab-ups-solar-efficiency-luminescent-solar-concentrators?utm_source=Argonne+Today+Internal+and+External+List&utm_campaign=123336858e-1100930&utm_medium=email