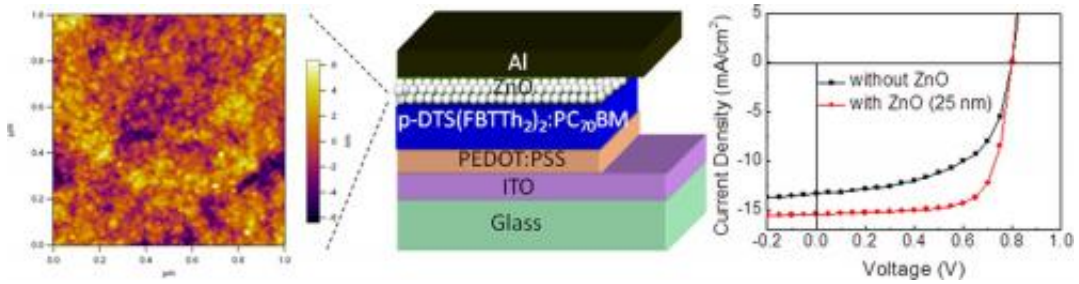
Small-molecule solar cells get 50% increase in efficiency with optical spacer

August 14 2013, by Lisa Zyga



(Left) A ZnO optical spacer viewed under an atomic force microscope. (Center) The device structure of the small-molecule solar cell. (Right) Solar cell performance with and without an optical spacer. Credit: Aung Ko Ko Kyaw, et al. ©2013 American Chemical Society

(Phys.org) —In the world of organic solar cells, polymer-based devices may currently be at the top, but other organic materials such as "small molecules" also prove to be promising. Although small-molecule organic solar cells currently have lower efficiencies than polymer solar cells, they are generally easier to fabricate and their efficiencies are improving.

In a new study, researchers have shown that they can increase the efficiency of one type of small-molecule organic solar cell from 6.02% to 8.94% simply by tuning the thickness of the active layer and inserting an optical spacer between the active layer and an electrode. The efficiency improvement demonstrates that small-molecule solar cells

have the potential to compete with their polymer counterparts, which have efficiencies approaching 10%.

The researchers, led by Alan J. Heeger at the University of California at Santa Barbara, have published their paper on the efficiency improvement in small-molecule solar cells in a recent issue of *Nano Letters*.

As the scientists explain in their paper, small-molecule organic solar cells have several advantages over organic polymer solar cells: relatively simple synthesis, high charge carrier mobility, similarly sized particles (monodispersity), and better reproducibility, among others. However, small-molecule solar cells have so far achieved top efficiencies of about 8%, lagging somewhat behind the best polymer devices.

By demonstrating how a few simple changes can increase the efficiency of one type of small-molecule organic solar cell by nearly 50%, the scientists here have shown that these devices still have the potential for vast improvements.

Tuning the thickness of the active layer and inserting a zinc oxide optical spacer between the active layer and metal electrode enable the active layer to harvest more light, increasing optical absorption. The insertion of the optical spacer places the active layer in a more favorable position within the optical electric field within the cell. As the scientists explained, the optical spacer contributes to increased light absorption in three ways: increasing the charge collection efficiency, serving as a blocking layer for holes, and reducing the recombination rate.

More information: Aung Ko Ko Kyaw, et al. "Improved Light Harvesting and Improved Efficiency by Insertion of an Optical Spacer (ZnO) in Solution-Processed Small-Molecule Solar Cells." *Nano Letters*. DOI: 10.1021/nl401758g