

Crystallites of α -sexithiophene in bilayer small molecule organic solar cells double efficiency

Researchers from the NanoSYD center at Mads Clausen Institute of the University of Southern Denmark have applied 3D crystal formations of popular small molecule used in organic solar cells, to develop a device with 100% higher efficiency than the devices with a flat morphology.

Solar cells are a renewable energy technology, used for direct conversion of light into electricity. Organic solar cells, addressed in this study, are of a special interest due to their low cost, low weight, and mechanical flexibility. But they are inefficient – almost a half of the absorbed light energy is never converted into electrical power, mainly because their nanoscale ordering is not sufficiently lined up to enable the charges to exit the cell.

When the light energy is absorbed by the organic solar cell, electrons are excited to higher energy levels producing a strongly bound pair of an electron and its positively charged counterpart – a hole. In order to convert the energy of such a pair – called exciton – into electricity, the charges need to completely separate on the interface between two different semiconducting materials. In case they succeed, they need to make their way to electrodes before recombination when their energy is lost.

The efficiency of charge separation, as well as the charge transfer is improved in the devices fabricated at the NanoSYD, where one of the organic semiconductors – α -sexithiophene – forms nanocrystalline structures. However, in crystals formed by the elongated molecules of α -sexithiophene, the charge transport is strongly dependent on the direction. A crystal consistent of lying molecules conducts charges the best in the vertical direction, while a crystal of standing molecules – in horizontal.

Crystals consisting of standing molecules facilitate an efficient charge separation at the interface and enhance vertical charge transport. Such a configuration is favored in solar cell devices. The NanoSYD researchers have demonstrated that by careful control of deposition conditions, lying molecule crystals can be obtained directly during the fabrication process. The sufficient amount of lying molecule crystals was formed in order to reach an efficiency enhancement of 100% in comparison to the device consisting of the same amounts of materials deposited in a conventional way.