Improving organic tandem solar cells based on water-processed nanoparticles by quantitative 3D nanoimaging - DTU Orbit (09/12/2018)

Organic solar cells have great potential for upscaling due to roll-to-roll processing and a low energy payback time, making them an attractive sustainable energy source for the future. Active layers coated with water-dispersible Landfester particles enable greater control of the layer formation and easier access to the printing industry, which has reduced the use of organic solvents since the 1980s. Through ptychographic X-ray computed tomography (PXCT), we image quantitatively a roll-to-roll coated photovoltaic tandem stack consisting of one bulk heterojunction active layer and one Landfester particle active layer. We extract the layered morphology with structural and density information including the porosity present in the various layers and the silver electrode with high resolution in 3D. The Landfester particle layer is found to have an undesired morphology with negatively correlated top- and bottom interfaces, wide thickness distribution and only partial surface coverage causing electric short circuits through the layer. By top coating a polymer material onto the Landfester nanoparticles we eliminate the structural defects of the layer such as porosity and roughness, and achieve the increased performance larger than 1 V expected for a tandem cell. This study highlights that quantitative imaging of weakly scattering stacked layers of organic materials has become feasible by PXCT, and that this information cannot be obtained by other methods. In the present study, this technique specifically reveals the need to improve the coatability and layer formation of Landfester nanoparticles, thus allowing improved solar cells to be produced.

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