Nanoparticles and nanoimaging for organic solar cells - DTU Orbit (08/11/2017)

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Solar energy is one of the few energy sources with the potential to power humanity in a future scenario where fossil fuels are not attractive due to their effect on the global climate or fossil fuels have been depleted all together. Organic photovoltaics is a promising technology for solar harvesting due to its potential for scalable roll-to-roll production and low manufacturing cost. However, the technology is faced with several obstacles which have to be overcome such as low efficiency and stability. Some of the issues are related to nano structures and device morphology. This dissertation is devoted to studying organic photovolatics on the micro to nanometer scale, in particular photoactive Landfester particles. The ultimate goal is to increase the performance of Landfester particle layers so they can become a viable alternative to photoactive layers cast from organic solvent. Transition to a water based ink would provide a production environment without toxic fumes from organic solvents and the nanoparticle structure would provide additional morphological control. The first part of the dissertation maps photodegradation in active layers cast from organic solvents. Reduction in degradation rates is quantified for mixed electron donor and acceptor material. The spatial distribution of photodegradation in an electron donor material is mapped and the degradation is found to be homogeneous at the sub-micron length scale. The second and third part is devoted to studying the nano structures in photoactive Landfester nanoparticles. The dispersed particles are characterized by size, internal structure and crystallinity. Crystal orientation and spatial distribution of materials are quantified for cast layers of Landfester particles. A layer of particles is also investigated in a tandem solar cell and compared to other layers in the structure using Tomographic 3D mapping. The fourth part presents a projection alignment algorithm for tomographic methods. It works by estimating projection movement through iterative logic using projection distance minimization. It is tested on simulated datasets and results in decreased angular displacements and increased spatial resolution. Further development of the algorithm could therefore be used to increase spatial resolution for characterization of organic photovoltaics and computed tomography in general.

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