Light Technology Institute
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The Optoelectronics Group at the Light Technology Institute (LTI) of the Universität Karlsruhe (TH) has placed emphasis on the fabrication and characterisation of organic semiconductor devices (OLEDs, solar cells, photodetectors, lasers) five years ago. Approaches for both liquid phase processed polymers and vacuum processed molecules were followed deliberately in order to combine the advantages of both techniques.

For the fabrication of organic solar cells and OLEDs at the LTI a clean room of 150sqm with a glovebox-cluster (4 boxes, N_2, cleanroom class 100 inside the boxes) containing analytical balance, fridge, spincoater, doctor blade, vacuum oven, UV-cure and connected high vacuum chambers are available. The vacuum chambers give the opportunity to evaporate metals and organic materials. Dielectrics can be deposited with an electron beam and ITO layers are fabricated by RF-magnetron-sputtering. A supplementary organic molecule purification system by gradient vacuum sublimation has been established. For the characterization under inert atmosphere a spectrally monitored solar simulator and an automated measuring unit for OLEDs and photodetectors are available. Furthermore the LTI is equipped with SEM, AFM, profiler and lithogaphy workplaces inside the cleanroom. The affiliated Testhouse for Light Technical Equipment provides advanced spectral characterization equipment. Moreover wide experience in the field of time and spatially resolved laser spectroscropy for the characterisation of organic materials is given. A substantial and continuous growing pool of self-programmed simulation software for optical and electrical device properties in organic semiconductor devices has been developed.
The work group is embedded amongst others in the excellence-cluster “Center for Functional Nanostructures” (CFN) as well as the Karlsruhe Institute of Technology (KIT) and thus is part of an interdisciplinary network of Karlsruhe based researchers from physics, chemistry, material science and engineering. A logistic advantage of this network is the access to many technical facilities at different institutes (e.g. high resolution SEM, TEM, FIB, …).

In the past, solar cells were build both from the liquid phase and under vacuum, characterized and optimized at the LTI. Special attention was paid to the improvement of cathodes and carrier-transport-layers for organic semiconductor devices [Colsmann et al, SPIE Proc. **6192**, 6192-95 (2006)]. Thereby electrically doped organic semiconductors played a key role. The combination of liquid phase processes and vacuum techniques allow for the fabrication of improved polymer cells with evaporated electron-transport layers. An enhancement of the electron extraction was achieved by an intermixed system of absorber and electron transport materials as well [Colsmann et al, APL in preparation]. On the basis of the investigations on charge carrier transport layers and the optimization of single cell process parameters tandem solar cells comprising subcells of polymers and small molecules in different architectures were manufactured and characterized [Colsmann et al, Appl. Phys. Lett. **89**, 203506 (2006)].
Thermal influences on the solar cells were investigated in connection with morphological analysis to develop a better understanding for the structural processes in bulk heterojunction solar cells.
The simultanously realised studies on the closely related field of photodetectors [Punke et al, Appl. Phys. Lett. **91**, 071118 (2007)] connected with sounded simulations of their optical and electrical properties [C. Gärtner et al., Journ. of Appl. Phys. **101**, 023107 (2007)] are stimulating.

Our group strongly works towards efficient all-printable organic solar cells in cooperation with industry, chemists, process engineers and groups with experiences in piloting. This includes, but is not limited to, upscaling and the realization of ITO-free contacts.