Ph.D. Project Description

My Ph.D. thesis will be carried out at the Light Technology Institute (LTI) at the Karlsruhe Institute of Technology (KIT) in the emerging field of organic photovoltaics. We aim by focusing on photophysical processes within novel organic materials to gain a deeper understanding of the underlying microscopic mechanisms of light absorption and energy transfer, and therefore hopefully contribute to efficiency improved solar cell concepts. These elementary investigations will necessarily include broad applications of diverse advanced spectroscopy methods.

Within my thesis I will participate in two joint research projects involving the LTI. The first collaboration is with the Institute for Organic Chemistry (IOC) at the University of Ulm and the Centre for Solar Energy and Hydrogen Research Baden-Württemberg (ZSW). In this project we are engaged in the development of monolithic tandem solar cells based on polymer-fulleren active layers with soluble low band gap thiophenes. In organic photovoltaics tandem solar cells are supposed to attain the next step of power conversion efficiency and to raise the device performance to a new level. But this progress still needs a lot of effort in finding the right complementary materials with excellent properties for energy conversion and processibility. In order to meet these challenges the understanding of photophysical processes like light absorption, charge carrier transfer and recombination dynamics are of major interest. My work will consequently include the operation and installation of photoinduced absorption as well as photoluminescence spectroscopy (continuous wave and time dependent) and transient photocurrent measurements for material as well as device characterization. The second project is in the framework of the DFG priority program on “Elementary Processes of Organic Photovoltaics” with the Institute of Materials Science of Barcelona (ICMAB) and the Thin Film Technology (TFT) group at the KIT. Within this already established venture the film drying, molecular orientation and structure in high performance polymer solar cells is investigated and correlated with the optoelectronic properties. Besides the device preparation and standard characterization my main task will be the detailed optical spectroscopy comprising ellipsometry and electromodulation. Applying these techniques enables us to address the effects of molecular assembly and orientation of the absorbing chromophores on the resulting opotoelectronic properties of the active layer. Former research has already shown how morphology and structural issues influence the optoelectronic characteristics of the polymer films in an essential way.

Both projects tend to provide a comprehensive understanding of elementary processes determining the operation of polymer solar cells. On the basis of these investigations a systematic optimization of organic solar cell devices is likely to achieve.