Charge Separation at the Donor-Acceptor Heterojunction in Organic Solar Cells: A Photoinduced Absorption Study

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Organic solar cells have attracted much interest in recent years. Apart from being an alternative energy source and approaching the stage of commercialisation, organic solar cells pose many interesting questions on the fundamental physics of organic semiconductors.

The central process in solar cells is the creation of free charge carriers. In Silicon-based photovoltaics free charge carriers are directly generated by the absorption of photons. However, in organic semiconductors the absorption of photons creates strongly bound excitions, which are unlikely to dissociate in pristine materials. The key for an efficient generation of free charge carriers lies here in the heterojunction of two materials with different electron affinities and ionisation potentials. However, the exact requirements for and processes taking place during exciton separation and the steps to get free charge carriers are still intensively discussed.

The effects taking place at the heterojunction can be investigated with photoinduced absorption (PIA). Here, we present a homologous series of acceptor-substituted oligothiophene as electron donor in combination with the fullerene C_{60} as electron acceptor in vacuum deposited films.
This allows for a systematic study of the energy and electron transfer at the heterojunction. The oligothiophenes show a gradual change in the energy energies as function of the chain length. Additionally, side chains that were originally supposed to only influence the film morphology were found to have strong influence on the transfer processes. These experiments show that very subtle structural changes in the molecular structure can have significant influence on the charge separation and eventually on the solar cell performance.