

Near IR sensitization of polymer/fullerene solar cells: Controlling the morphology and transport in ternary blends

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Goals

This research proposal aims to investigate and develop a novel approach to sensitize polymer/fullerene bulk heterojunction solar cells in the near infrared (NIR) by blending a third, NIR absorbing component, into the otherwise binary polymer/fullerene system. The project will focus on three major activities:

Synthesis:

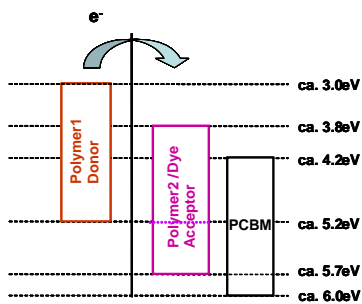
A series of suitable polymers with wide as well as narrow band gaps will be synthesized, whereas the low band gap polymers will be used as NIR sensitizers.

Morphology:

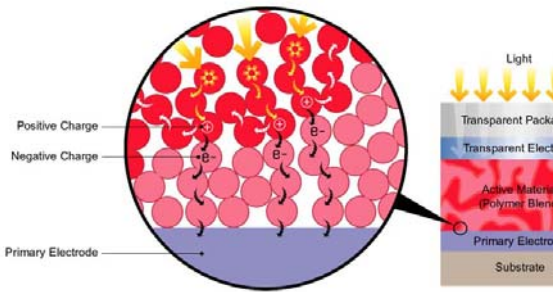
Determination of the Hansen solubility parameters for the various polymers and fullerenes to predict chemical compatibility and morphology formation. Development of suitable solvent systems is planned as well as morphology assessment for ternary blends.

Transport:

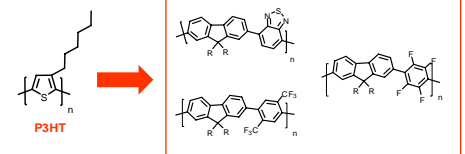
Characterization of the electronic transport properties of ternary blends



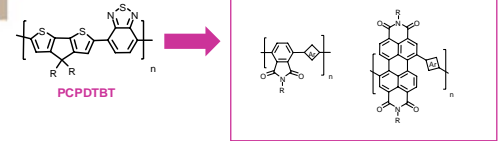
Energy level diagram for the envisaged ternary blends



Schematic of a Photovoltaic Cell showing the Bulk Heterojunction Morphology and the Mechanism of Charge Transfer and Transport



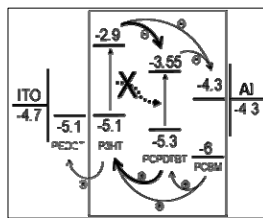
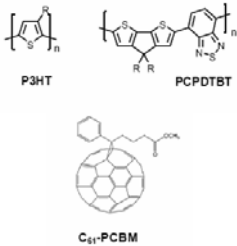
Chemical structures of the envisaged polymer component 1 (sensitizer) R = alkyl chain (octyl, dodecyl, etc.)



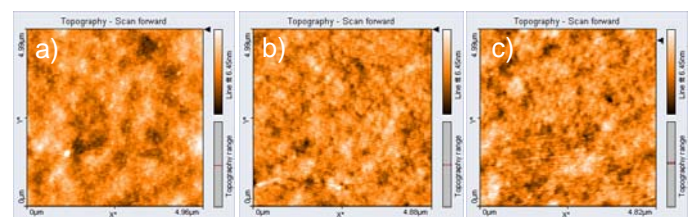
Chemical structures of the envisaged polymer component 2 (sensitizer) Ar = aryl moiety (thienylene, bithiophene, etc.)

Preliminary work

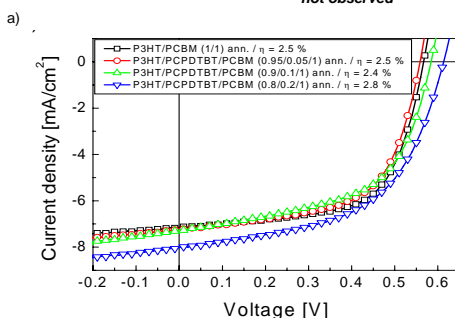
Koppe et al. demonstrated a generally applicable approach to enhance the spectral response of wide bandgap blends like P3HT/PCBM by blending them with a low band gap polymer (PCPDTBT)



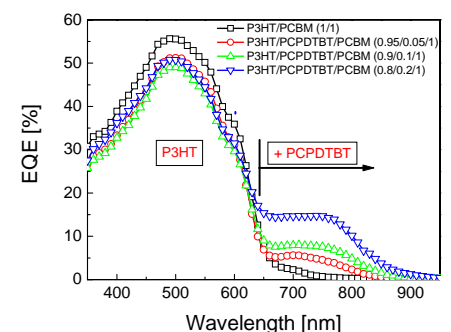
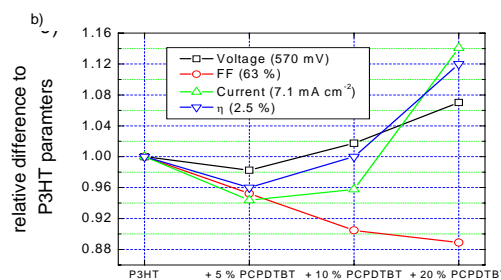
Energy levels [eV] of electrodes and semiconductors used in ternary blends. Curved arrows indicate allowed charge transfer reactions in the ternary blend. The dashed arrow indicates possible energy transfer, which is not observed



Contact mode atomic force microscopy surface scans of thermally annealed films of (a) PCPDTBT/PCBM (1/1), (b) P3HT/PCPDTBT/PCBM (0.8/0.2/1) and (c) P3HT/PCBM (1/1).



a) Current density - voltage (jV)-characteristics of thermally annealed P3HT/PCBM devices, pristine and blended with 3 different PCPDTBT ratios. b) Relative change of the device parameters with increasing PCPDTBT content. The performance of pristine P3HT/PCBM was chosen as reference and set to 100%. All other device data were normalized to that reference



EQE spectra of pristine P3HT/PCBM (open squares) and of P3HT/PCBM with 5 w-% (open circles), 10 w-% (open up triangles) and 20 w-% (open down triangles) PCPDTBT