

HL 40: Joint Session: Organic Semiconductors III: Aggregation and Nanostructures

Time: Tuesday 14:00–15:15

Location: ZEU 222

HL 40.1 Tue 14:00 ZEU 222

Substituted Perylene Diimides as Electron Acceptors in Organic Solar Cells: Suppressing Aggregate Formation to Increase Device Efficiency — ●VALENTIN KAMM, GLAUCO BATTAGLIARIN, IAN A. HOWARD, MICHAEL HANSEN, HANS W. SPIESS, ALEXEY MAVRINSKIY, WOJCIECH PISULA, CHEN LI, KLAUS MÜLLEN, and FRÉDÉRIC LAQUAI — Max-Planck-Institut für Polymerforschung, Mainz, Deutschland

Perylene diimide (PDI) is a promising electron acceptor material for high open circuit voltage bulk heterojunction organic solar cells. However, many PDI molecules have the drawback of strong aggregation leading to intermolecular excited state formation that results in exciton trapping. These traps can effectively limit the diffusion of excitons to the interface where charge separation occurs and thus strongly reduce the charge generation efficiency. In this contribution we study the influence of substitution of PDI molecules with side groups attached to the terminal and to the perylene core positions on the formation of aggregates. In particular transient photoluminescence and absorption spectroscopy are used to probe the impact of aggregation on the dynamics of charge generation and recombination in bulk heterojunction solar cells. Besides, AFM, x-ray and solid state NMR techniques are used to get further insight into the solid state morphology of polymer:PDI blends on different length scales. Finally, we correlate the photophysical properties of the PDI derivatives with the efficiency of bulk heterojunction organic solar cells and present unprecedented efficiencies from polymer:PDI solar cells.

HL 40.2 Tue 14:15 ZEU 222

Near-field spectroscopic mapping of the nanoscale phase separation of low band-gap polymer:fullerene blend film — ●XIAO WANG¹, HAMED AZIMI², HANS-GEORG MACK¹, MAURO MORANA², HANS-JOACHIM EGELHAUF³, ALFRED J. MEIXNER¹, and DAI ZHANG¹ — ¹Institute of Physical and Theoretical Chemistry, Auf der Morgenstelle 18, University of Tübingen, Germany — ²Konarka Austria F&E GmbH, Linz, Austria — ³Konarka Technologies GmbH, Nürnberg, Germany

We present the study of the influences of the additive 1,8-octanedithiol (ODT) on the nanometer scale morphology and local photophysics properties of low band-gap polymer blends, PCPDTBT and PCBM. Near-Field spectroscopic mapping provides the possibility to obtain simultaneously morphology and spectroscopic (photoluminescence and Raman) information correlated with high spatial resolution.[1] We observe the phase separations of the PCPDTBT:PCBM blend film induced by ODT by the dramatically increased PL emission from PCPDTBT that was originally largely quenched, by the fluctuations of spectral features at different locations of the sample surface, by the fibril-shaped topographic features evolve to spherical bumps. The correlations between the local photo physics properties and the morphology of the blend film with/without ODT at both the micrometer and nanometer scales were revealed by the confocal and high-resolution near-field spectroscopic mapping technique. 1.Wang, X.; Zhang, D.; Braun, K.; Egelhaaf, H. J.; Brabec, C. J.; Meixner, A. J. *Adv. Funct. Mater.* 2010, 20, (3), 492-499.

HL 40.3 Tue 14:30 ZEU 222

High Crystallinity and Nature of Crystal-Crystal Phase Transformations in Regioregular Poly(3-hexylthiophene) — ●OVIDIU F. PASCUI^{1,3}, RUTH LOHWASSER², MICHAEL SOMMER², MUKUNDAN THELAKKAT², THOMAS THURN-ALBRECHT¹, and KAY SAALWÄCHTER¹ — ¹Institut für Physik, Martin-Luther-Univ. Halle-Wittenberg, Halle, Germany — ²Makromolekulare Chemie I, Universität Bayreuth, Germany — ³Experimentelle Physik III, TU Dort-

mund, Germany

Molecular weight and stereoregularity affect the morphology and the crystallinity of conjugated polymers and are thus of pivotal relevance for the mobility of charge carriers in electro-optical device applications. We use ¹³C solid-state NMR to determine the crystallinity and details on crystal-crystal phase transformations in regioregular head-to-tail poly(3-hexylthiophene) of well-defined molecular weight and demonstrate that the crystallinity was previously severely underestimated. Typical crystallinities are at least around 37% for the lowest molecular weights and as high as about 64% upon increasing MW, corresponding to a corrected maximum value for the reference melting enthalpy of $\Delta H_m \approx 37$ J/g for use in DSC experiments. Using one- and two-dimensional NMR, we observe that the crystal-crystal phase transition between a 3D- and a 2D-ordered crystalline phase at around 60°C entails a structural disordering process of the alkyl side chains, while not affecting the backbones. The formation of the 3D-ordered phase is kinetically suppressed at higher molecular weights.

see: O. F. Pascui et al., *Macromolecules* **43**, 9401 (2010).

HL 40.4 Tue 14:45 ZEU 222

Self-Assembled Ultralong Organic Semiconducting Nano/Microwires — JULIA LAMBRECHT, ●TOBAT P. I. SARAGI, and JOSEF SALBECK — Macromolecular Chemistry and Molecular Materials (mmCmm), Department of Mathematics and Science and Center for Interdisciplinary Nanostructure Science and Technology (CINSaT), University of Kassel, Heinrich-Plett-Strasse 40, D 34132 Kassel, Germany

We report on the simple process in fabrication of spiro-substituted perylene diimide nano/microwires (NMWs) by using self-assembly approach, namely drying under solvent atmosphere. This method results in a controllable number of NMWs on the substrate, which enables us to fabricate single NMW electronic device. Furthermore, we are able to control the growth direction of NMWs by using a structured substrate. An aspect ratio as high as ~9200 can be obtained in our experiment and the longest wire is determined to be 5.5 mm. The resistivity of the single NMW is characterized and the value is in the range of 100 Ohm m and 10000 ohm m.

HL 40.5 Tue 15:00 ZEU 222

Plasmonic enhancement of light absorption in organic semiconductors using silver nanowire arrays — ●MATTHIAS HANDLOSER¹, RICKY DUNBAR², PHILIPP ALTPETER², LUKAS SCHMIDT-MENDE², and ACHIM HARTSCHUH¹ — ¹Department Chemie and CeNS, Ludwig-Maximilians-Universität, München, Germany — ²Department Physik and CeNS, Ludwig-Maximilians-Universität, München, Germany

Plasmonics can be used to improve light absorption in photovoltaic devices, permitting a considerable reduction in the physical thickness of absorber layers, and yielding new options for solar-cell design [1]. We investigated arrays of aligned silver nanowires embedded in different organic polymers via confocal microscopy in combination with Time Correlated Single Photon Counting (TCSPC) and Pump-Probe techniques. The wires had a length of 10 μ m, a height of 20 nm, and variable widths and spacings. Thin films of different organic semiconductors were then deposited onto these arrays. Plasmon modes were excited through one and two photon absorption between 500 to 900 nm and photoluminescence maps and transients of the arrays were recorded. We observed a clear correlation between photoluminescence intensity, lifetime and nanowire spacing. We analyzed our data to distinguish between absorption and radiative rate enhancement and energy transfer to the metal followed by quenching. [1] H.A.Atwater, A.Polman, *Nature Materials* **9**, 205 (2010)