DS 6: Organic Photovoltaics (SYOE 2)

Time: Monday 16:00–17:45 Location: H32

DS 6.1 Mon 16:00 H32

Exciton Diffusion length Measurements in Diindenoperylene Thin Films — •Tobias Roller, Dieter Kurrle, Philipp Neumann, and Jens Pflaum — 3. Physikalisches Institut, Universität Stuttgart

To accomplish large exciton diffusion lengths is a major task for the successful implementation of molecular thin films in organic photovoltaic cells. The exciton diffusion length determines the maximal useful thickness of the absorbing layer in excitonic photovoltaic (PV) cells, thus governing their internal quantum efficiency.

To analyse the exciton diffusion length in relation to the structural properties we have studied thin films of the organic semiconductor Diindenoperylene (DIP) prepared by MBE in HV at thicknesses up to 400nm. Due to its tapered ends this molecule provides long-range order in the direction normal to the surface of weakly-interacting substrates such as ITO. By XRD we were able to access the structural film parameters along the exciton diffusion path, namely their out-of-plane lattice spacing, crystallite size and average tilting angle. The exciton diffusion lengths were estimated from the spectral photocurrent of DIP PV-cells and, additionally, measured by quenched photoluminescence of Palladium Phthalocyanine capped DIP layers. The observed diffusion length in DIP exceeds 100nm for the thickest films and shows a direct correlation with the crystallite sizes along the surface normal. We will discuss these results and possible mechanisms of exciton trapping and annihilation with respect to the film structure of DIP.

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DS 6.2 Mon 16:15 H32

Efficient photon harvesting strategies in ZnPc/PPV/Fullerene solar cells — •Robert Koeppe[1], Pavel A. Troshin[2], Rimma N. Lyubovskaya[2], and N. Serdar Sariciftci[1] — [1]LIOS, Altenbergerstr. 69, A-4040 Linz, Austria — [2]Institute of Problems of Chemical Physics of RAS, Chernogolovka, Moscow region, 142432, Russia

A novel multicomponent organic solar cell architecture is suggested in order to expand the active layer absorption of organic solar cells by a combination of solution-processed bulk heterojunction polymer/fullerene cells with bilayer ZnPc/fullerene devices [1]. For this purpose, a blend of different fullerene derivatives with the conjugated polymer MDMO-PPV is spin-coated on an evaporated ZnPc film. Supramolecular complexation of the highly soluble pyrrolidinofullerene with ZnPc ensures a very efficient charge separation [2] and therefore a high contribution of the ZnPc to the overall photocurrent generation. This yields photovoltaic devices that demonstrate power conversion efficiencies above 2% and efficient photocurrent generation of up to 20% external quantum yield in the full range from 350 nm to 820 nm. [1] R. Koeppe et al., APL 87(24), 244102, [2] R. Koeppe et al., Full. Nanotub. Carb. Nanostruct. 14(2-3), 441-446

DS 6.3 Mon 16:30 H32

Efficient thin film organic solar cells containing low band gap oligothiophenes with tailored heterojunction level alignment — •R. Schüppel[1], K. Schmidt[2], C. Uhrich[1], K. Schulze[1], D. Wynands[1], J. L. Brédas[2], B. Männig[1], M. Pfeiffer[3], K. Leo[1], E. Brier[4], E. Reinold[4], and P. Bäuerle[4] — [1]Institut für Angewandte Photophysik, Technische Universität Dresden, Germany — [2]Georgia Institute of Technology, School of Chemistry and Biochemistry, Atlanta, Georgia, USA — [3]Heliatek GmbH Dresden, Germany — [4]Institut für Organische Chemie II und Neue Materialien, Universität Ulm, Germany

The recently demonstrated power conversion efficiency of 3.4% in a thin film solar cell (OSC), which utilized C_{60} as acceptor (A) and a new acceptor-substituted oligothiophene (OT) as donor (D) [1], stimulated us to study the energy (ET) and electron transfer (CT) taking place at this D/A heterojunction along a homologous series of these OT. The HOMO is tuned using different OT chain lengths, while the LUMO is essentially fixed by the acceptor-type end-groups (dicyano-vinylene). We study electron transfer at the heterojunction to C_{60} using photoinduced absorption. The observed transitions were unambiguously identified by TD-DFT calculations. With increasing the effective energy gap of the D/A pair, CT is eventually replaced by ET, which alters the OSC operation. Therefore, the optimum open circuit voltage between 1.0V-1.1V in our OSC has to be considered as a trade-off between an efficient charge separation and a maximized effective gap. [1] K. Schulze *et al.*, Adv. Mater. **18**, 2872 (2006)

DS 6.4 Mon 16:45 H32

Spin-Coated Hybrid Layers of Crystalline Silicon Nanoparticles and Semiconducting Polymers: Optical, Structural and Electronic Properties — •Roland Dietmüller[1], Robert Lechner[1], André R. Stegner[1], Rui N. Pereira[1], Martin S. Brandt[1], Heiko Thiem[2], Martin Trocha[2], Hartmut Wiggers[3], and Martin Stutzmann[1] — [1]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — [2]Degussa AG, Paul-Baumann-Str.1, 45764 Marl, Germany — [3]Universität Duisburg-Essen, Institute of Combustion and Gas Dynamics, Lotharstr. 1, 47048 Duisburg, Germany

Organic semiconductors have received a lot of attention for novel, low cost electronic applications (e.g. printable electronics). Silicon, in form of nanoparticles, could be incorporated in such organic devices to tailor their physical properties. For example, hybrid organic-inorganic solar cells could benefit from the solution processing of polymer semiconductors and from the high electron mobility of the non-toxic silicon.

We have investigated the optical properties, in particular absorption spectra, of spin-coated layers of crystalline silicon nanoparticles, semiconducting π-conjugated polymers like poly(3-hexylthiophene-2,5-diyl) (P3HT), [6,6]-phenyl C-61-butyric acid methyl ester (PCBM) or poly[(9,9-dioctylfluorene-2,7-diyl)-co-bithiophene] (F8T2) and mixed layers of polymers and silicon nanoparticles. To further characterize the spin-coated layers, atomic force and optical microscopy has been employed. Also, the electrical properties of sandwich-like structures of polymers and crystalline silicon nanoparticles are discussed.

DS 6.5 Mon 17:00 H32

Preparation and Characterization of Colloidal ZnO:Al Nanoparticles for Organic-Inorganic Hybrid Solar Cells — Jan Friedmann[1,2], Daniel Rauh[1,2], Volker Lorrmann[1,2], Carsten Deibel[2], Vladmir Dyakonov[1,2], and •Ingo Riedel[1] — [1]Functional Materials for Energy Technology, ZAE Bayern e.V., Am Hubland, D97074 Würzburg, Germany — [2]Experimental Physics VI, Faculty of Physics and Astronomy, Julius-Maximilians University of Würzburg, Am Hubland, D97074 Würzburg, Germany

Colloidal nanoparticles of non-capped ZnO:Al have been wet-chemically synthesized as functional materials for novel hybrid device concepts related to organic photovoltaics. The nanoparticles were characterized by means of optical spectroscopy, current-voltage characterization and magnetic resonance techniques. The material was found to fulfil the requirements to become a fullerene substitute in polymer-based organic solar cells and/or to serve as a wave guiding n-conducting buffer layer between the light absorber and the back-reflecting metal electrode. We fabricated polymer-fullerene bulk heterojunction solar cells with and without ZnO:Al layer. The effects of improved light absorption and enhanced selectivity of the metal electrode are discriminated by optical simulations and electrical interface characterization.

DS 6.6 Mon 17:15 H32

Nanomorphology of Poly[3-alkylthiophene] based Polymer/Fullerene Bulk Heterojunction Solar Cells — •Harald Hoppe[1], Le Huong Nguyen[2], Tobias Erb[1], Serap Günes[2], Gerhard Gobsch[1], and N. Serdar Sariciftci[2] — [1]Institute of Physics, Ilmenau Technical University, Weimarer Str. 32, 98693 Ilmenau, Germany — [2]Physical Chemistry - LIOS, Johannes Kepler University Linz, Altenbergerstr. 69, 4040 Linz, Austria

We report on nanomorphology evolution within poly[3-alkylthiophene]/[6,6]-phenyl C61-butyric acid methyl ester (P3AT/PCBM) blends upon film formation and subsequent thermal annealing. In detail, the influence of the P3AT side chain length on the extend of the polymer/fullerene phase separation is discussed for butyl, hexyl, octyl, decyl and dodecyl side groups. We apply atomic force microscopy (AFM), X-ray diffraction and optical spectroscopy to understand the underlying processes. Photovoltaic devices based on the different P3ATs have been processed and optimised. In conclusion a correlation between the achieved solar cell performance and the corresponding nanomorphology is drawn.

DS 6.7 Mon 17:30 H32

Inkjet Printing of Polymer based Solar Cells — •Claudia Klepek, Pavel Schilinsky, Stelios Choulis, and Christoph Brabec — Konarka Technologies GmbH, Nürnberg, Germany

A variety of approaches have been used to deposit organic semiconductors based on the nature of those materials. The commonly applied technique is the solution-processed deposition. Due to the low-cost roll-to-roll production, the printing technologies are attracting more and more attention. Inkjet printing is very promising because the polymer devices can be fabricated very easily in terms of no-mask patterning. We report an organic photovoltaic device depositing the photoactive layer, comprising P3HT blended with the fullerene PC61BM in a solvent mixture, by a piezoelectric inkjet printing system. We compared two P3HTs differing in the molecular weight distribution (MW). A lower MW of the P3HT has been suited for inkjet printing since the latency time until gelification of the solution occurs is longer. The device performance and limitation of an IJ printed cell were well-investigated and remarkable losses in the short circuit current have been assessed. Among other things, losses in the short circuit current can be attributed to the low deposition temperature for comparatively high-boiling solvents. The drying rate affects the device performance significantly. The morphology and surface roughness of IJ printed films have been examined by atomic force microscopy. The roughness has been controlled by a careful selection of organic solvents. Due to an adapted solvent mixture the short circuit current and the efficiency have been improved.