

## CPP 27: Poster: Organic Electronics and Photovoltaics

Time: Wednesday 17:30–19:00

Location: Poster C

CPP 27.1 Wed 17:30 Poster C

**Charge carrier pair dissociation in polymer:PCBM blends studied using light induced electron spin resonance.** — ●TOM J. SAVENIJE<sup>1,2</sup>, ANDREAS SPERLICH<sup>1</sup>, HANNES KRAUS<sup>1</sup>, CARSTEN DEIBEL<sup>1</sup>, and VLADIMIR DYAKONOV<sup>1,3</sup> — <sup>1</sup>Experimental Physics VI, Physical Institute, Julius-Maximilians-University of Würzburg, D-97074 Würzburg — <sup>2</sup>Optoelectronic Materials Section, Department of Chemical Engineering, Delft University of Technology, Julianalaan 136, 2628 BL Delft, The Netherlands — <sup>3</sup>ZAE Bayern, Div. Functional Materials for Energy Technology, D-97074 Würzburg

Blends of conjugated poly alkylsubstituted-thiophenes or thienothiophenes with a soluble fullerene (PCBM) show promising photophysical properties for application as photoactive layers in photovoltaic devices. On excitation of the polymer, fast electron transfer from the donor to the PCBM occurs leading to a charge carrier pair. For efficient charge collection dissociation of this radical pair is required. However, in view of the low dielectric constant of the blend the mechanism of the dissociation process is still unclear. Using light-induced electron spin resonance measurements we show that the geminate radical pair remains in close proximity at temperatures below ca 40 K. At higher temperatures delocalization of the positive charge on the polymer occurs, leading to an effectively larger radical pair distance.

CPP 27.2 Wed 17:30 Poster C

**Analysis of solvent residuals in thin films of conducting polymers** — ●MARKUS SCHINDLER, ROBERT MEIER, and PETER MÜLLER-BUSCHBAUM — TU München, Physik-Department LS E13, James-Franck-Str. 1, 85747 Garching (Germany)

Since conducting polymers show widespread application possibilities, e.g. in organic solar cells and organic field effect transistors, it is a serious concern to investigate long-time stability and aging. Aging can be enhanced due to remaining solvent embedded in the polymer matrix of thin films. Remaining solvent affects the mobility of the polymers and results in an ongoing change in the microstructure, which is accompanied by changes in the electrical performance.

We investigated the remaining solvent in thin conducting polymer films with neutron reflectivity, utilising the contrast between protonated and deuterated solvents. In addition, we report surface analysis of different polymer blends based on versatile novel conducting polymers using atomic force microscopy. In these films a spatial resolved analysis concerning the solvent content is obtained with STXM measurements.

CPP 27.3 Wed 17:30 Poster C

**Determination of intermolecular transfer integrals from DFT calculations** — ●BJÖRN BAUMEIER and DENIS ANDRIENKO — Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

Theoretical studies of charge transport in organic conducting systems pose a unique challenge since they require multiscale schemes that combine quantum-chemical, molecular dynamics and kinetic Monte-Carlo calculations. The description of the mobility of electrons and holes in the hopping regime relies on the determination of intermolecular hopping rates in large scale morphologies. Using Marcus theory these rates can be calculated from intermolecular transfer integrals and on-site energies.

Here we present a detailed computational study on the accuracy and efficiency of density-functional theory based approaches to the determination of intermolecular transfer integrals. First, it is demonstrated how these can be obtained from quantum-chemistry calculations by forming the expectation value of a dimer Fock operator with frontier orbitals of two neighboring monomers based on a projective approach. We then consider the prototypical example of one pair out of a larger morphology of Tris(8-hydroxyquinolinato)aluminium (Alq3) and study the influence of computational parameters, e.g. the choice of basis sets, exchange-correlation functional, and convergence criteria, on the calculated transfer integrals. The respective accuracies and efficiencies are compared in order to derive an optimal strategy for future simulations based on the full morphology.

CPP 27.4 Wed 17:30 Poster C

**Fabrication of hierarchically ordered crystalline titania**

**thin films** — ●MARTIN NIEDERMEIER<sup>1</sup>, GUNAR KAUNE<sup>1</sup>, MONIKA RAWOLLE<sup>1</sup>, VOLKER KÖRSTGENS<sup>1</sup>, MATTHIAS RUDERER<sup>1</sup>, JOCHEN S. GUTMANN<sup>2</sup>, and PETER MÜLLER-BUSCHBAUM<sup>1</sup> — <sup>1</sup>TU München, Physik-Department LS E13, James-Franck-Str. 1, D-85747 Garching (Germany) — <sup>2</sup>Max-Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz (Germany)

Thin films of nanostructured titania have received a lot of attention in various applications such as photovoltaics within the last years. Having a well defined morphology is crucial for the functionality and performance of these films because it defines the volume to surface ratio and thereby the surface being available for interface reactions. Increasing the total film thickness is a common approach in order to increase the surface area. The present work focuses on the fabrication of hierarchically structured titania thin films and their crystallinity. A layer-by-layer spin-coating approach is investigated. A solution based sol-gel process using diblock copolymers as a template to obtain nanocomposite films is followed by calcination to obtain crystalline titania structures. The obtained structures are investigated using several imaging techniques like SEM and AFM. The crystallinity and the thickness of the films are analyzed with XRD and XRR.

CPP 27.5 Wed 17:30 Poster C

**Controlling the morphology of thin titania films for applications in hybrid solar cells** — ●MONIKA RAWOLLE<sup>1</sup>, MATTHIAS A. RUDERER<sup>1</sup>, STEFAN PRAMS<sup>1</sup>, QI ZHONG<sup>1</sup>, MINE MEMESA<sup>2</sup>, JOCHEN S. GUTMANN<sup>2</sup>, and PETER MÜLLER-BUSCHBAUM<sup>1</sup> — <sup>1</sup>TU München, Physik-Department LS E13, James-Franck-Str. 1, D-85747 Garching (Germany) — <sup>2</sup>Max-Planck Institute for Polymer Research, Ackermannweg 10, D-55128 Mainz (Germany)

Nanostructured thin films of titania have a variety of applications. For applications in photovoltaics a high absorption coefficient and a large surface area are desirable. A sponge structure is a promising morphology for titania to meet these demands. Block copolymers can be used in a 'good-poor solvent pair' induced phase separation process coupled with sol-gel chemistry to create structured titania films in a reproducible way. We use the amphiphilic diblock copolymer Poly(dimethyl siloxane)-*block*-methyl methacrylate poly(ethylene oxide) [PDMS-*b*-MA(PEO)] as templating agent.[1] Different well defined mixing procedures of sol-gel components (Tetrahydrofuran, 2-Propanol, HCl and titania precursor in addition to the PDMS-*b*-MA(PEO)) of same weight fractions result in small changes in the morphology of the film. The thin films are prepared via spin-coating on silicon substrates. The surface structure is studied with SEM. Information on the morphology in the volume of the film is gained from GISAXS. The layer thickness and structure are studied with XRR, the optical properties with UV/Vis spectroscopy.

[1] G. Kaune et al., ACS Appl. Mater. Interfaces, in press

CPP 27.6 Wed 17:30 Poster C

**Performance of organic solar cells with a ferroelectric component** — ●KRZYSZTOF KACHEL, MATTHIAS RICHTER, SHINE PHILIP, IOANNA PALOUMPA, KLAUS MUELLER, and DIETER SCHMEISSER — Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, 03046 Cottbus, Germany

Charge dissociation and recombination are important factors for the efficiency of organic solar cells, even in blended systems of different polymers. As a new approach, the influence of additional blended ferroelectric nanoparticles on the solar cell performance is investigated. The ferroelectric dipole of the nanoparticle causes a local field, which could lead to a longer recombination time of the polaron pairs. As solar cell system we use bulk heterojunction cells or bilayer structures based on regioregular poly(3-hexylthiophene) (P3HT) as the donor and phenyl-C61-butyric acid methyl ester (PCBM) as the acceptor molecule. As ferroelectric additive we use the ferroelectric copolymer poly(vinylidene fluoride trifluoroethylene) (P(VDF-TrFE)) or BaTiO<sub>3</sub>. The copolymer is spincoated as ultrathin film of 20nm, whereas the BaTiO<sub>3</sub> is incorporated as nanodispersion into the donor-acceptor blend. We present the solar cell parameters for the different geometries and ferroelectric materials as a function of ferroelectric content and of the alignment of the ferroelectric dipoles after application of an external electric field.

CPP 27.7 Wed 17:30 Poster C

**Spectroscopic investigations of P3HT/PCBM films for organic BHJ solar cells** — ●SHINE PHILIP, MATTHIAS RICHTER, DANIEL FRIEDRICH, IOANNA PALOUMPA, KLAUS MUELLER, and DIETER SCHMEISSER — Brandenburg University of Technology Cottbus, Applied Physics and Sensors, K.-Wachsmann-Allee 17, 03046 Cottbus, Germany

Investigations of the electronic structure and composition of regioregular poly(3-hexylthiophene) (P3HT) and phenyl-C<sub>61</sub>-butyric acid methyl ester (PCBM) based films using Near Edge X-Ray Absorption Fine Structure (NEXAFS) are presented. The measurements were performed at the U49/2-PGM2 beam line of BESSY II, Berlin recording TEY (total electron yield) and TFY (total fluorescence yield) data. Samples prepared by spin coating a mixture of P3HT dissolved in chloroform and PCBM dissolved in chlorobenzene onto ITO (indium tin oxide) coated glass slides were analyzed. Upon measuring the pure P3HT and PCBM, all reported excitations were observed, whereas the blended system is a weighted superposition of the related peaks. Analyzing the data we calculate the composition of the mixture. We also show angular dependent NEXAFS measurements of the P3HT/PCBM blend in order to measure the orientation and distribution of the P3HT polymer. Additionally, we show a new approach for organic solar cell application. BaTiO<sub>3</sub> nanoparticles were incorporated as nanodispersion into the donor-acceptor blend or the ferroelectric copolymer poly(vinylidene fluoride trifluoroethylene) (P(VDF-TrFE)) was spincoated as an ultrathin film below the blend.

CPP 27.8 Wed 17:30 Poster C

**Preparation and Characterisation of thin Polymeric Films to be used as Gate Dielectrics in Organic Field Effect Transistors** — ●JAN HARTEL, CHRISTOPHER KEIL, and DERCK SCHLETTWEIN — Institute of Applied Physics, Justus-Liebig-University Giessen, Germany. email:schlettwein@uni-giessen.de

Thin insulating polymer layers are of interest as gate dielectrics for all-organic field effect transistors (OFET). In our structures a DC resistance above 100 GΩ cm was typically reached. In this study, we performed impedance spectroscopy to characterize the dielectric properties of polymer films. A well-defined area of silver was Ar<sup>+</sup>-sputter-deposited onto glass. Subsequently different one-component or two-component polymer resins were deposited by spin-coating in a thickness of 6 - 100 μm. These layers were cured according to the respective technical process suggested by the supplier or optimized according to device performance. To complete the measurement structure a second silver layer of equal geometry was deposited on top of the polymer. The dielectric properties of the different films at different preparation conditions and different film thickness were characterized in this capacitor structure. The response to an AC voltage of 0.5 V in the frequency range of 100 Hz to 1 MHz was analyzed to determine the dielectric permittivity. Characteristics expected for an ideal capacitor were obtained for a number of samples and details of the Nyquist plot were compared to commercial capacitors. Samples down to the 5 μm range preserved the dielectric characteristics of bulk samples. The applicability of these films in OFET structures is discussed.

CPP 27.9 Wed 17:30 Poster C

**Influence of Packing Motives on Charge Carrier Mobility in Perylene Tetracarboxydiimide Derivatives** — ●FALK MAY<sup>1</sup>, VALENTINA MARCON<sup>2</sup>, and DENIS ANDRIENKO<sup>1</sup> — <sup>1</sup>Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany — <sup>2</sup>Center of Smart Interfaces, Petersenstr. 32, 64287 Darmstadt, Germany

Disclotic mesophases are known for their ability to self-assemble into columnar structures and can serve as semiconducting molecular wires. Charge carrier mobility along these wires strongly depends on molecular packing which is controlled by intermolecular interactions.

In this work we compare the influence of side chains on the packing motives of perylene tetracarboxydiimide (PDI) derivatives. Two different (alkyl and glycol) side chains are considered. We first establish how the packing of side chains affects the molecular orientation within the columns using molecular dynamics. Then, using the high temperature non-adiabatic limit of Marcus theory for hopping rates and solving the rate equation for charge transport, we analyze the link between the secondary structure and charge carrier mobility [1]. This analysis eventually provides a pathway to rational design of columnar assemblies of PDI derivatives with high charge mobilities.

[1]V.Marcon et al., J. Am. Chem. Soc., 131, 2009

CPP 27.10 Wed 17:30 Poster C

**Crystallization induced phase separation in a double crystalline donor-acceptor diblock copolymer** — ●PETER KOHN<sup>1</sup>, MICHAEL SOMMER<sup>2</sup>, MUKUNDAN THELAKKAT<sup>2</sup>, and THOMAS THURN-ALBRECHT<sup>1</sup> — <sup>1</sup>Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany — <sup>2</sup>Angewandte Funktionspolymere, Makromolekulare Chemie I, Universität Bayreuth, 95440 Bayreuth, Germany

A high density of donor-acceptor interfaces ensuring nanoscale domains is of major importance for bulk hetero-junction organic solar cells. Fully functionalized block copolymers consisting of donor- and acceptor-subchains are an attractive class of materials as they inherently carry the desired heterogeneity on the molecular level. We studied the structure formation in a poly(3-hexyl thiophene-b-*perylene acrylate*) diblock copolymer by temperature dependent small- and wide-angle X-ray scattering. At high temperatures the block copolymer is in the disordered, non-microphase separated state. During cooling separate crystallization of both blocks induces a donor-acceptor phase separation. The resulting morphology of donor- and acceptor crystals separated on the nanoscale demonstrates the potential applicability of this class of materials for organic solar cell devices.

CPP 27.11 Wed 17:30 Poster C

**Mobility Measurements of aza-BODIPY for Organic Solar Cells** — ●MORITZ HEIN, ROLAND GRESSER, TORBEN MENKE, KARL LEO, and MORITZ RIEDE — Inst. f. Angewandte Photophysik, Dresden, Deutschland

For organic electronics applications, e.g. organic solar cells, new appropriate materials, in particular with high charge carrier mobilities are crucial. This contribution focuses on the promising absorber material class of aza-BODIPY. A series of this new donor material, with four different substituents and increased molecular rigidity has been analyzed in respect of mobility. Depending on the electron donor strength of the substituents, the HOMO (highest occupied molecular orbital) energy of the materials can be tuned from 5.1 eV to 5.7 eV. Structural modification, increasing the rigidity of the molecule and extending the planar pi-conjugated system lead to a better molecular orbital overlap of two adjacent molecules in the crystal structure. We investigate the influence of this structure variation on the mobility. Two different methods are used: field effect transistor (OFET) and space charge limited current (SCLC) measurements. A comparison of the mobilities of the different materials and techniques is presented. Furthermore, the film morphology has a huge influence on the mobility. To study this, the effect of heating the substrate during evaporation is used.

CPP 27.12 Wed 17:30 Poster C

**Breakdown of perturbative weak coupling approaches for the biomolecular energy transfer** — ●PETER NALBACH and MICHAEL THORWART — Freiburg Institute for Advanced Studies (FRIAS), Albert-Ludwigs-Universität Freiburg, Albertstraße 19, 79104 Freiburg, Germany

We show that the biomolecular exciton dynamics under the influence of slow polarization fluctuations in the solvent cannot be described by approaches which are perturbative in the system-bath coupling. For this, we compare results for the decoherence rate of the exciton dynamics of a resumed perturbation theory with numerically exact real-time path-integral results. We find up to one order in magnitude difference in the decoherence rate for realistically slow solvent environments even in the weak coupling regime, while both results coincide for fast environmental noise. This shows explicitly the nonperturbative influence of the bioenvironmental fluctuations and might render current perturbative approaches to biomolecular exciton transport questionable.

CPP 27.13 Wed 17:30 Poster C

**Proton Transport in Self-Assembling Organic Compounds** — ●MANUEL SCHRADER and DENIS ANDRIENKO — Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz

Organic phosphonic acid derivatives are promising materials as proton-conducting electrolytes in water-free proton exchange membrane fuel cells. In this work atomistic molecular dynamics simulations of phosphonic-acid functionalized organic conjugated compounds have been carried out. In order to conduct simulations, force fields for these molecules have been developed with the aid of first-principle calculations. In the simulations supramolecular self-assembly in columnar structures and formation of hydrogen bond networks leading to proton transport could be observed.

CPP 27.14 Wed 17:30 Poster C

**Imaging the ageing dynamics of polymer solar cells** — ●MARCO SEELAND, RÖSCH ROLAND, and HOPPE HARALD — Institute of Physics, Ilmenau University of Technology, Weimarer Str. 32, 98673 Ilmenau, Germany

Nowadays, many attempts are existing on the route towards higher power conversion efficiencies in polymer solar cells. In addition, the lifetimes of such devices play a key role for the market entry as commercial products. To investigate the timescale of degradation processes, we applied long-time stability measurements with devices stored in the dark and under illumination and compare the results with luminescence images. The application of those techniques allows us to investigate the ageing dynamics in our devices consisting of an interpenetrating network of P3HT and PCBM, sandwiched between the ITO/PEDOT:PSS and aluminium electrode.

CPP 27.15 Wed 17:30 Poster C

**Temperature dependent photoinduced absorption measurements on oligothiophene derivatives** — ●CHRISTIAN KÖRNER<sup>1</sup>, HANNAH ZIEHLKE<sup>1</sup>, KARL LEO<sup>1</sup>, ROLAND FITZNER<sup>2</sup>, EGON REINOLD<sup>2</sup>, PETER BÄUERLE<sup>2</sup>, and MORITZ RIEDE<sup>1</sup> — <sup>1</sup>Institut für Angewandte Photophysik, Technische Universität Dresden — <sup>2</sup>Institut für Organische Chemie II und Neue Materialien, Universität Ulm

Oligothiophenes are among the most promising small molecules for use in organic photovoltaic devices (OPV). The current efficiency world record of 6.1% on an area of >2cm<sup>2</sup> is based on using an oligothiophene derivative as one of the absorber materials. Notwithstanding this success, the underlying processes e.g. for charge generation at the donor-acceptor heterointerface are still subject of intense discussions.

By small variations of the molecule structure we are able to systematically tune the electrical and optical properties of these molecules. The energy levels which are mainly determined by the backbone length and the terminating end groups are supposed to strongly correlate with energy and charge transfer processes like the initial charge separation step at the donor-acceptor heterojunction in OPV.

Here we present temperature dependent PIA measurements of dicyanovinyl end-capped oligothiophenes with various backbone lengths. The nature and recombination dynamics of the long living triplet excitons and cations present in optically excited oligothiophene single layers and in mixed layers with the acceptor C<sub>60</sub> are determined and compared.

CPP 27.16 Wed 17:30 Poster C

**Substituted Perylene Diimides as Electron Acceptors in Organic Solar Cells: Suppressing aggregate and formation to increase device efficiency** — ●VALENTIN KAMM, IAN A. HOWARD, CHEN LI, KLAUS MÜLLEN, and FRÉDÉRIC LAQUAI — Max-Planck-Institut für Polymerforschung, Mainz, Deutschland

Perylene diimide (PDI) is a promising candidate as electron acceptor material for high open circuit voltage organic solar cells. Its strong absorption in the visible region combined with high electron mobility in the solid state renders it a potential alternative to the weakly absorbing PCBM that is typically used in state-of-the-art organic solar cells. However, PDI molecules tend to aggregate and form intermolecular excited states that can act as exciton traps. These traps effectively limit the diffusion of excitons to the interface where charge separation occurs and thus strongly reduce the charge generation efficiency in bulk heterojunction solar cells.

We investigate the effect of different bulky side groups attached to the terminal and to the bay positions of PDI molecules on the formation of aggregates by time-resolved optical spectroscopy. In particular transient photoluminescence and transient absorption spectroscopy are used to study, whether the increased spacing between the PDI molecules, caused by the bulky side groups, can prevent aggregation and intermolecular excited state formation leading to more efficient exciton transport. Furthermore, we correlate the photophysical properties of these materials with the efficiency of bulk heterojunction organic solar cells.

CPP 27.17 Wed 17:30 Poster C

**Time-resolved luminescence spectroscopy of biomimetic, self-assembling porphyrins** — ●JONAS CONRADT<sup>1,2</sup>, HENDRIK KUHN<sup>1</sup>, PETER MAREK<sup>3</sup>, MANUEL REINHARD<sup>2,5</sup>, OLIVER LÖSCH<sup>5</sup>, ALEXANDER COLSMANN<sup>2,5</sup>, ULI LEMMER<sup>2,5</sup>, TEODOR SILVIU BALABAN<sup>3,4</sup>, and HEINZ KALT<sup>1,2</sup> — <sup>1</sup>Karlsruhe Institute of Technology (KIT), Institute for Applied Physics (AP), Karlsruhe, Germany — <sup>2</sup>Karlsruhe Institute of Technology (KIT), Center for Functional Nanostructures

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Self-assembling porphyrins represent a promising candidate in order to mimic natural bacteriochlorophylls, the light-harvesting system found in photosynthetic bacteria exhibiting chlorosomes. Such biomimetic porphyrins with a central zinc or magnesium atom show interesting photophysical properties. We performed time-resolved spectroscopy on these porphyrins in order to investigate the properties of monomers as well as self-assembled aggregates. An improved fitting algorithm is developed to identify more reliable the decay-associated spectra and the corresponding decay times. The large extinction coefficient of the porphyrins makes them an interesting candidate for photovoltaic application. They can help to improve the external quantum efficiency of hybrid and dye-sensitized solar cells. Their photovoltaic suitability is investigated.

CPP 27.18 Wed 17:30 Poster C

**Morphological degradation of fullerene polymer solar cells** — ●VIDA TURKOVIC, CHETAN RAJ SINGH, SEBASTIAN ENGMANN, MAIK BÄRENKLAU, ROLAND RÖSCH, GERHARD GOBSCH, and HARALD HOPPE — Ilmenau University of Technology, Weimarer Straße 32, Ilmenau 98693

Typical acceptor materials such as fullerene derivatives tend to diffuse and finally agglomerate in blends with polymeric donors, depending on the chemical structure of the donor. This process eventually leads to a morphological destruction of the organic solar cells. The changes in the blend morphology of the thin films accelerate when thermally annealed at increased temperatures. Tapping-mode atomic force microscopy (AFM) measurements provide deeper insight into the nano and micrometer scale of the phase separation observable on the surface of the film. Furthermore, to prove the coarsening of phase separation on various length scales, optical microscopy, UV-Vis, photoluminescence and spectral ellipsometry measurements were conducted. Of special interest is tracking down the formation of fullerene aggregates and correlation of their growth in time.

CPP 27.19 Wed 17:30 Poster C

**Influence of electron transport on the efficiency of polymer-based solar cells** — ●VIKTOR KUXHAUS<sup>1</sup>, FRANK JAISER<sup>1</sup>, DIETER NEHER<sup>1</sup>, and FRANK VOGES<sup>2</sup> — <sup>1</sup>Institute of Physics and Astronomy, University Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany — <sup>2</sup>Merck KGaA, 64271 Darmstadt, Germany

Recently, we showed that the mobility of electrons in polymer-based solar cells has a large influence on the overall performance of such devices [1]. Here, we investigate the correlation between electron mobility and charge generation efficiency in organic bilayer solar cells for a series of electron transporting materials (ETMs) with comparable HOMO and LUMO levels. The electron mobility was measured by transient electroluminescence. Here, a thin M3EH-PPV was used as a sensing layer. The interface between M3EH-PPV and ETM acted as a recombination zone of electrons transported through the ETM layer and holes that are blocked at the interface. Therefore, the electron mobility can easily be determined from the onset of M3EH-PPV emission which is spectrally well separated from the ETM emission. To determine the charge generation efficiency, the different ETMs were combined in bilayer solar cell with PFB as donor.

[1] M. Schubert, R. Steyrlleuthner, S. Bange, A. Sellinger, D. Neher, pss(a), DOI: 10.1002/200925312

CPP 27.20 Wed 17:30 Poster C

**Organic magnetoresistance effect in unipolar and bipolar devices of conjugated polymers** — ●THOMAS MANICKE, FRANK JAISER, SERGEY BAGNICH, and DIETER NEHER — Institut für Physik und Astronomie, Universität Potsdam, Potsdam, Deutschland

For the last few years, several origins of the organic magnetoresistance (OMaR) effect have been discussed. There are three main models to describe this effect, namely the polaron pair, bipolaron and excitonic model. The bipolaron model is mutually exclusive to the other two models and predicts an OMaR effect also for unipolar currents.

We present the results of measurements of the OMaR in unipolar and bipolar devices. Experiments were performed both on a hole-conducting polymer (MEH-PPV) and an electron-conducting polymer (F8BT). We also tested the influence of the cathode material in

electron-only devices on the OMaR. The results of these experiments suggest that the bipolaron model is not suited to explain this intriguing effect consistently for all device configurations.

CPP 27.21 Wed 17:30 Poster C

**Charge Generation and Recombination in Dye-sensitized Solar Cells** — ●MICHAEL MEISTER, HENRIKE WONNEBERGER, CHEN LI, KLAUS MÜLLEN, and FRÉDÉRIC LAQUAI — Max-Planck-Institute for Polymer Research, Mainz, Germany

Charge recombination is one of the efficiency limiting processes in bulk heterojunction and dye-sensitized organic solar cells. To determine the presence of charges and the dynamics of charge generation and recombination photoinduced absorption spectroscopy (PIA) and transient absorption spectroscopy (TAS) are particularly useful techniques, since most of the investigated states are non-emissive. These methods allow to investigate all important mechanisms that lead to photocurrent generation beginning with the excitation of the dye, followed by charge transfer to a metal oxide semiconductor and regeneration of the dye by an electrolyte or an organic solid state hole conductor. In this study, we present spectroscopic experiments on dye-doped titanium dioxide films using novel all-organic perylene monoimide dyes as sensitizer with and without solid state hole conductor and on real device structures. We correlate the observed charge generation and recombination dynamics with the device efficiency to understand the relation between dye-structure, photophysics and device performance.

CPP 27.22 Wed 17:30 Poster C

**Band bending at interfaces between polymers and electrodes** — ●ILJA LANGE — Universität Potsdam, Institut für Physik und Astronomie, Karl-Liebknecht-Strasse 24/25, 14476 Potsdam-Golm

There is an ongoing discussion on whether band bending is present in organic semiconductors near metallic contacts and how it affects device properties. Here, we present Kelvin Probe studies on various polymers coated with different thickness on the well known polymeric anode poly(3,4-ethylenedioxythiophene): poly(styrenesulfonate) (PEDOT:PSS). Band bending was detected for poly(3-hexylthiophene) (P3HT), poly{3-hexylthiophene-co-[1,4-(2,2-dithienyl)-5,5-2,3,5,6-tetrafluorbenzene]} (P3HTTFT), poly[2,5-dimethoxy-1,4-phenylene-1,2-ethylenylene-2-methoxy-5-(2-ethylhexyloxy)-(1,4-phenylene-1,2-ethylenylene)] (M3EH-PPV) and poly[2-methoxy-5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene] (MEH-PPV). The experimental results can be well fitted with a model that explicitly takes into account a Gaussian density of transport sites [1]. This analysis is based on iterative numerical solution of the carrier density according to Fermi statistics and the one-dimensional Poisson equation. By comparing these results with measurements on films of the same materials on different metals, a consistent picture of band bending in conjugated polymers is developed.

[1] J.C. Blakesley and N.C. Greenham, J. Appl. Phys. 106, 034507 (2009)

CPP 27.23 Wed 17:30 Poster C

**Encapsulation of thin fluorescent polymer films with graphenes** — ●PHILIPP LANGE<sup>1</sup>, MARTIN DORN<sup>1</sup>, NIKOLAI SEVERIN<sup>1</sup>, DAVID VANDEN BOUT<sup>2</sup>, and JÜRGEN P. RABE<sup>1</sup> — <sup>1</sup>Humboldt-Universität zu Berlin, Department of Physics, Newtonstr. 15, 12489 Berlin, Germany — <sup>2</sup>The University of Texas at Austin, Department of Biochemistry and Chemistry, Austin, Texas 78712, USA

Conjugated polymers are widely used as active layers in organic electronics. While they exhibit a high potential for new device concepts and low cost fabrication, they suffer from fast degradation under ambient conditions due to reactions with oxygen and moisture. To achieve reliable and long time operation, commercial organic devices are protected with multilayer encapsulation techniques. Graphene has recently been attracting increasing interest due to its remarkable mechanical, optical and electronic properties, which qualifies it for potential application in future electronic devices. This work addresses the question in how far graphenes deposited on top of a thin organic film can protect it sufficiently from degradation by moisture and oxygen. The polymer films are produced by spincoating on mica after which a graphene layer is deposited by mechanical exfoliation. The degradation of the polymer films is investigated with fluorescence microscopy. Our results indicate a substantial reduction in the degradation of organic material covered by graphene and suggest that graphenes can function simultaneously as transparent electrodes and encapsulation layers in future electronic devices.

CPP 27.24 Wed 17:30 Poster C

**Kombination von photothermischer Ablenkungsspektroskopie und Spektralellipsometrie zur Bestimmung der Subbandgap-Absorption in Polymersolarzellen** — ●FELIX HERRMANN, MARTIN PRESSELT, ROLAND RÖSCH, SEBASTIAN ENGMANN, MAIK BÄRENKLAU, SVIATOSLAV SHOKHOVETS, HARALD HOPPE und GERHARD GOBSCH — Fachgebiet Experimental Physik I, Institut für Physik & Institut für Micro- und Nanotechnologie, Technische Universität Ilmenau, Weimarer Str. 32, 98693 Ilmenau, Deutschland

In dieser Arbeit wird die photothermische Ablenkungsspektroskopie (PDS) zur Bestimmung des Absorptionskoeffizienten im Subbandgapbereich von verschiedenen Schichten in Polymersolarzellen angewandt.

Die Erwärmung der Probe bei Bestrahlung mit monochromatischem Licht bewirkt eine Verringerung des Brechungsindex des Perfluorhexans, in welchem sich die Probe bei der Messung befindet. Diese Verringerung wird durch die Ablenkung eines He-Ne-Laserstrahls detektiert. Die Methode zeichnet sich durch eine hohe Empfindlichkeit aus.

Die Auswertung des PDS-Signals erfolgt mit Hilfe der aus der Ellipsometrie gewonnenen Schichtdicken und Absorptionskoeffizienten oberhalb der Absorptionskante. Diese Kombination von PDS und Spektralellipsometrie ermöglicht die Bestimmung der Absorptionskoeffizienten verschiedener Schichten von NIR bis UV. In diesem Beitrag werden Ergebnisse für den Subbandgapbereich von P3HT-PCBM bulk heterojunction Solarzellen vorgestellt und diskutiert.