

## SYOO 6 Poster

Zeit: Montag 18:00–20:00

Raum: Poster TU A

SYOO 6.1 Mo 18:00 Poster TU A

**White light emission from p-i-n OLEDs** — •GREGOR SCHWARTZ, KARSTEN FEHSE, KARSTEN WALZER, SEBASTIAN REINEKE, MARTIN PFEIFFER, and KARL LEO — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden

In the last several years, the development of new materials and device structures in the field of small molecule organic light emitting devices (OLEDs) have led to the demonstration of highly efficient single color devices. Therefore, as the next step, white OLEDs which combine multiple colors into one device are promising to become the future light sources for large area light emission, e.g. in display backlighting or illumination. We present first data on such devices that include two or three emission layers of different color into our well established p-i-n structure with electrically doped charge transport layers. We discuss their electro-optical properties like CIE color coordinates, color rendering and the important issue of power efficiency. Detailed studies on the charge carrier transport and balance are carried out to find optimum conditions both for electrical properties and color matching. We show that the white-point can be matched by following the three color approach. The aim of high power efficiency is followed by the preferred application of triplet emitters.

SYOO 6.2 Mo 18:00 Poster TU A

**Organic p-i-n homojunctions: Fundamental properties and application in red phosphorescent OLED** — •KENTARO HARADA<sup>1</sup>, ANSGAR G. WERNER<sup>2</sup>, OLAF KÜHL<sup>1</sup>, MARTIN PFEIFFER<sup>1</sup>, and KARL LEO<sup>1</sup> — <sup>1</sup>Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden, Germany — <sup>2</sup>Novald GmbH, Zellescher Weg 17, D-01069 Dresden, Germany

Organic light emitting diodes (OLEDs) have been currently broadly studied, and it has been shown that efficient luminescence can be achieved by heterostructures utilizing suitable organic materials as the charge transport and blocking layers. Recently, we have realized the first example of a stable and reproducible organic p-i-n homojunction using a phthalocyanine as the matrix. Here, the main challenge was the simultaneous n- and p-type doping of the same material. Using strong organic acceptors like perfluorinated tetracyanoquinodimethane (TCNQ) and metal-organic donors synthesized and handled in strict absence of oxygen, we show that several organic matrices can form p-i-n homojunctions with high built-in potentials: Using a porphyrine as the matrix, a built-in potential of around 1.2 V is achieved. The homojunctions show well-behaved diode characteristics with rectification ratios up to 10<sup>5</sup>. A homojunction composed of a phosphorescent metal-complex emits fairly intense red light under forward bias. We discuss the properties of these archetypal homojunction OLEDs with respect to the luminescence efficiency and current-voltage characteristics and compare the results with optimized heterostructure OLEDs.

SYOO 6.3 Mo 18:00 Poster TU A

**Highly efficient and long-living red p-i-n bottom emission OLEDs based on triplet emitter systems** — •RICO MEERHEIM, KARSTEN WALZER, MARTIN PFEIFFER, and KARL LEO — Institut für Angewandte Photophysik (IAPP), Technische Universität Dresden, George-Bähr Str. 1, D-01062 Dresden, Germany

We demonstrate the making of highly efficient red bottom emission OLEDs with doped transport layers and phosphorescent emitter materials for high quantum yield. In this contribution we will show how the lifetime of such devices can be increased. The p-i-n devices consist of doped transport layers, charge and exciton blockers, and a dilute emitter substance inside an appropriate emitter matrix. There exists an optimum ratio between the host and the emitter material which gives the best exciton transport and recombination. By omitting either the electron or hole blocking layer we prove the favoured electron conductivity of our emission layer. This is shown by strong exciton quenching due to charge carrier accumulation at the interface between hole transport and emission layer. More advantageous is a nearly ambipolar emission system to create a broad light generation zone. We achieve this by including a second doped emission layer (leading to a double emission structure) which has a preferably hole conductive matrix material. This approach enables us to increase the extrapolated device lifetime of similar OLEDs from 100000 hours to 180000 hours with nearly identical efficiencies and operating voltages. This can be explained by reduced number of charge

carriers arriving at the blockers.

SYOO 6.4 Mo 18:00 Poster TU A

**Differential reflectance and photoluminescence study on highly ordered thin films: PtOEP on potassium bromide** — •THOMAS DIENEL, HOLGER PROEHL, KARL LEO, and TORSTEN FRITZ — Institut für Angewandte Photophysik, TU Dresden, Germany

The platinum-2,3,7,8,12,13,17,18-octaethylporphyrine (PtOEP) is one of the triplet emitting molecules used in organic electroluminescent devices like OLEDs. The interaction of long-living triplet-states of excited molecules reduces the number of radiative decays. To investigate effects like triplet-triplet-annihilation, we deposited ultra thin PtOEP films on potassium bromide (KBr) by means of organic molecular beam epitaxy (OMBE). In situ differential reflectance spectroscopy (DRS) and in situ photoluminescence (PL) were used to observe the spectral changes during the film growth. For the transparent substrate KBr, the DRS signal strongly resembles the absorption of the adsorbed molecules. The spectra of one monolayer PtOEP show a characteristic shape known for PtOEP molecules dissolved in trichloromethane. The phosphorescence of the PtOEP thin films, excited by a frequency-doubled Nd-YAG laser (532 nm), exhibits a new low energy feature [1], besides the well known triplet emission at around 650 nm. We used precipitation from PtOEP solutions to verify that the appearance of this new feature is indeed an aggregation effect.

[1] T. Diemel et al., J. Lum., *accepted for publication* (2004).

SYOO 6.5 Mo 18:00 Poster TU A

**High-efficiency p-i-n electrophosphorescent organic light-emitting diodes without blocking layers** — •GUFENG HE, KARSTEN WALZER, MARTIN PFEIFFER, and KARL LEO — IAPP, TU Dresden, D-01062 Dresden, Germany

By using high conductive p- and n-doped organic materials as charge injection layers in organic light-emitting diodes (OLEDs), low operating voltage and ultra-high power efficiency have been reached. It is also very important to simplify the manufacture process in production of OLEDs. Here we have successfully removed either hole-blocking layer (HBL) or electron-blocking layer or both in our double-emission layer (D-EML) OLEDs without efficiency loss and lifetime drop. The D-EML comprises two emission layers with ambipolar transport characteristics, both doped with the green phosphorescent dye tris(phenylpyridine)iridium [Ir(ppy)<sub>3</sub>]. An important feature of the D-EML structure is its self-balancing character being not based on abrupt barriers, but on rather smooth transitions between regions with different mobility for the charge carriers. Both electrons and holes are gradually slowed down in the emission layer, and are likely to recombine before reaching the high barrier to the corresponding blocking layers. Hence, the blocking layers are less critical in D-EML structure than in other structures. A power efficiency of 80 lm/W is obtained at 100 cd/m<sup>2</sup> without HBL.

SYOO 6.6 Mo 18:00 Poster TU A

**A highly efficient top emission organic light-emitting diode with gold as the top electrode** — •QIANG HUANG, KARSTEN WALZER, MARTIN PFEIFFER, and KARL LEO — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden

We demonstrate an efficient top-emitting organic light-emitting diode (OLED) with organic layers sandwiched between a highly reflective metal anode and a semi-transparent thin Au film as cathode. The device shows deep red color with external quantum efficiency of 4.5% at the luminance of 100cd/m<sup>2</sup>. To improve the electron injection from Au, an n-doped CuPc layer is used. The OLED exhibits superior current-voltage characteristics over a comparable bottom emission device with ITO as anode. Since the device uses doped transport layers, a luminance of 100cd/m<sup>2</sup> and 1000cd/m<sup>2</sup> can be reached already at voltages as low as 2.6V and 3.3V respectively. By further introducing of an organic layer such as Bphen above the top electrode, the efficiency of the device can be improved by around 50%.

SYOO 6.7 Mo 18:00 Poster TU A

**Daylight stability of organic light emitting diodes** — ●ROLAND SCHMECHEL<sup>1</sup>, GABI ANDRESS<sup>1</sup>, HEINZ VON SEGGERN<sup>1</sup>, HOLGER HEIL<sup>2</sup>, JÜRGEN STEIGER<sup>2</sup>, KLAUS BONRAD<sup>3</sup>, and RÜDIGER SPRENGARD<sup>3</sup> — <sup>1</sup>TU-Darmstadt, Institut für Materialwissenschaft, Petersenstr.23, D-64287 Darmstadt — <sup>2</sup>Covion Organic Semiconductors GmbH, D-65926 Frankfurt am Main, Germany — <sup>3</sup>SCHOTT AG, Div. Luminescence Technology, D-55014 Mainz, Germany

This work reports on the photo-degradation of organic light emitting diodes (OLEDs) due to exposure to visible and near-ultraviolet light. Such exposure affects strongly the device performance, e.g., the electroluminescence intensity and the device current decrease considerably, however, the photoluminescence remains unaffected. This photo-degradation was investigated on various production-relevant classes of high quality polymer semiconductors with different energy gaps, i.e. a yellowish-green polyphenylenevinylene derivative, a red polyfluorene derivative and a blue polyspiro derivative. It will be demonstrated that the action spectrum of the photo-degradation is strongly correlated with the fundamental absorption of the polymer itself. The ITO/polymer interface was identified as the interface where photo-degradation takes place, while the bulk of each layer (ITO or polymer) turned out to be insensitive to irradiation with visible or near-ultraviolet light. Further it is demonstrated that the photo-induced damage can be suppressed by inserting appropriate interlayer systems.

SYOO 6.8 Mo 18:00 Poster TU A

**Vacuum deposited composite films for luminescence conversion** — ●MARIETA LEVICHKOVA, JACKY ASSA, HARTMUT FRÖB, ROBERT GEHLHAAR, and KARL LEO — Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden, Germany

A possibility for PL conversion of blue-emitting diodes using vacuum deposited composite films on top is investigated. The layers consist of a host material (e.g. Alq3) doped with materials fluorescent in the yellow-red range. The LEDs are used as primary light source for excitation of the host molecules, upon which photon emission at lower energies occurs. The dopants are chosen to absorb in the emitting range of the host. The resulting PL spectra depend on dopant concentration as well as on the total composite film thickness. Chromaticity evaluations undoubtedly confirm that by optimization of the latter parameters, white emitting LEDs could be produced. The results are interpreted by Förster energy transfer between the organic macromolecules. The stability of the systems in dependence on composition is discussed.

SYOO 6.9 Mo 18:00 Poster TU A

**Laser Ablation for OLED Displays** — ●WIEBKE SARFERT<sup>1</sup>, DIRK BUCHHAUSER<sup>2</sup>, CHRISTOPH GAERDITZ<sup>1</sup>, CARSTEN TSCHAMBER<sup>1</sup>, ARVID HUNZE<sup>3</sup>, RALPH PAETZOLD<sup>3</sup>, KARSTEN HEUSER<sup>3</sup>, and ALBRECHT WINNACKER<sup>1</sup> — <sup>1</sup>Department of Materials Science VI, University of Erlangen-Nuremberg, Germany — <sup>2</sup>Department of Experimental Physics, University Freiberg, Germany — <sup>3</sup>Siemens AG, CT MM 1, Paul-Gossen-Str.100, 91052 Erlangen, Germany

Displays based on Organic Light-Emitting Devices (OLEDs) employing a passive matrix driving scheme suffer from the need to structure the metallic cathode into lines using an expensive and time-consuming lithographic process, which in addition may disturb the uniform deposition of the electroluminescent material.

We present an alternative approach for structuring the cathode using pulsed laser ablation of fine lines of the top metal layers following their deposition. A setup capable of handling 6" substrates using a frequency-doubled Nd:YAG laser is introduced and explained.

First experiments give promising results regarding the electrical separation of the cathode lines while no detrimental effects on performance and lifetime of laser-structured devices are observed.

SYOO 6.10 Mo 18:00 Poster TU A

**Charge Transport in Organic LEDs** — ●CARSTEN TSCHAMBER<sup>1</sup>, WIEBKE SARFERT<sup>1</sup>, DIRK BUCHHAUSER<sup>2</sup>, CHRISTOPH GÄRDITZ<sup>1</sup>, OLIVER WEISS<sup>3</sup>, ARVID HUNZE<sup>4</sup>, KARSTEN HEUSER<sup>4</sup>, RALPH PÄTZOLD<sup>4</sup>, DMITRY POPLAVSKY<sup>5</sup> und ALBRECHT WINNACKER<sup>1</sup> — <sup>1</sup>Department of Materials Science VI, University of Erlangen-Nuremberg, Germany — <sup>2</sup>Department of Experimental Physics, University of Freiberg, Germany — <sup>3</sup>Department of Materials Science, TU Darmstadt, Germany — <sup>4</sup>Siemens AG, CT MM 1, Paul-Gossen-Str. 100, 91052 Erlangen, Germany — <sup>5</sup>OSRAM Opto Semiconductors Inc., 3870 North First Street, San Jose, CA 95134, USA

The mobilities of charge carriers in Organic Light-Emitting Devices (OLEDs) are among the most important material parameters since they not only define the location of the recombination zone but also heavily influence various performance aspects including efficiency and lifetime.

Here we report on two methods for determining hole and electron mobilities in various polymeric OLED materials: transient dark injection current (DI) and transient electroluminescence (EL). Utilising these techniques we have obtained mobility data for a range of polymers which, when combined with steady-state current-voltage and luminance characteristics, provide detailed insight into electronic processes in current light-emitting materials. Furthermore, a closer look at these data allows us to draw conclusions regarding carrier trapping and to identify a correlation between trap distributions and mobilities.

Finally, we explore ways to systematically modify the mobilities of one or both charge carriers in order to improve OLED performances.

SYOO 6.11 Mo 18:00 Poster TU A

**Designing color filters for highly efficient full-color OLED displays** — ●DIRK BUCHHAUSER<sup>1</sup>, CHRISTOPH GAERDITZ<sup>2</sup>, CARSTEN TSCHAMBER<sup>2</sup>, WIEBKE SARFERT<sup>2</sup>, RALPH PAETZOLD<sup>3</sup>, KARSTEN HEUSER<sup>3</sup>, ARVID HUNZE<sup>3</sup>, WOLFGANG ROGLER<sup>3</sup>, and JÜRGEN RÜDIGER NIKLAS<sup>1</sup> — <sup>1</sup>Department of Experimental Physics, University of Freiberg, Germany — <sup>2</sup>Department of Materials Science VI, University of Erlangen-Nuremberg, Germany — <sup>3</sup>Siemens AG, CT MM 1, Paul-Gossen-Str. 100, 91052 Erlangen, Germany

The application of organic light emitting diodes (OLEDs) within full-color displays provides brilliant colors, high contrasts and high luminance. By using RGB color filters, the transmission spectra can be adapted to the emissive spectra of the polymer in order to achieve the best efficiency.

We show the modeling of an optimized and efficient color filter setup for OLEDs to tune the color for different broad band emitter polymers for display application. This results in a color filter setup which is able to provide a wide color gamut for video and picture applications.

Additionally we use simulations to calculate emitter spectra for a full color display with color filters, which allows driving all single RGB pixels with the same current to reach the CIE whitepoint (0.33/0.33). "Tailoring" the emission spectra to the color filters in such a way will also result in longer lifetimes due to efficiency improvement.

SYOO 6.12 Mo 18:00 Poster TU A

**Light Extraction via Guided Leaky Modes in Organic Light Emitting Devices** — ●NILS REINKE, ANDREAS OPITZ, and WOLFGANG BRÜTTING — Experimentalphysik IV, Universität Augsburg, 86135 Augsburg, Germany

Conventionally, a large fraction of the light generated in organic light emitting devices is trapped inside the device and lost due to internal total reflection and side emission or absorption by the organic layers. The latter process can be suppressed by implementing periodic corrugations (i.e. distributed feedback gratings) to scatter out light guided in the organic.

In this work, devices were fabricated consisting of an organic multilayer system sandwiched between two metallic electrodes. In these devices the metal film on the substrate can enhance the leakage of guided modes into the substrate. Consequently, light can be effectively extracted. The influences of thickness variations on the emission characteristics of the devices were studied both experimentally and theoretically.

Simultaneously, the two reflecting electrodes form a microcavity and the emitted light is spectrally filtered, giving prospects for laser resonator applications.

SYOO 6.13 Mo 18:00 Poster TU A

**Multilayer OLED based on derivatives of perylene** — ●STEPHAN BENNING<sup>1</sup>, MARCUS LAUHOF<sup>1</sup>, HEINZ LANGHALS<sup>2</sup>, HARALD BOCK<sup>3</sup>, and HEINZ KITZEROW<sup>1</sup> — <sup>1</sup>University of Paderborn, Warburger Str. 100, 33098 Paderborn — <sup>2</sup>Department of Chemistry, LMU University Munich, Butenandtstr. 13, D-81377 Munich — <sup>3</sup>Centre de Recherche Paul Pascal, CNRS, Université Bordeaux I, Avenue A. Schweitzer, F-33600 Pessac

Recently, we presented single layer organic light emitting diodes with perylene-3,4,9,10-tetracarboxylic-acid ethylester (PeC2). A brightness up to 100 Cd/m<sup>2</sup> was achieved which is comparable to a notebook panel [1]. Here, efforts to improve the efficiency by additional layers are described. TPD is used as hole transporting layer and N,N'-bis(1-hexylheptyl)-3,4,9,10-perylene-bis-(dicarboximide) as an electron conducting layer. The latter compound (also known as S-13) is a convenient standard for the determination of fluorescence quantum efficiencies [2]. A device containing three organic layers with the layer sequence ITO / TPD / PeC2

/ S-13 / Al shows a brightness of 400 Cd/m<sup>2</sup>. We speculate that both, PeC2 and S-13, contribute to the emission.

[1] Th. Hassheider, S. A. Benning, H.-S. Kitzerow, M.-F. Achard, H. Bock, *Angewandte Chemie International Edition*, Vol. 40, No. 11, 2060-2063, 2001 [2] H. Langhals, J. Karolin, L. B.-A. Johansson, *J. Chem. Soc., Faraday Trans.*, Vol. 94, 2919-2922, 1998

SYOO 6.14 Mo 18:00 Poster TU A

**Charge injection layers for inverted organic light-emitting diodes** — •MICHAEL KRÖGER, THOMAS DOBBERTIN, JENS MEYER, TORSTEN RABE, HENNING KRAUTWALD, EIKE BECKER, THOMAS RIEDL, HANS-HERMANN JOHANNES, and WOLFGANG KOWALSKY — Technische Universität Braunschweig, Institut für Hochfrequenztechnik

In this work charge injection layers for highly efficient inverted organic light-emitting diodes are discussed. Organic light emitting diodes (OLED) are expected to be a future technology for display applications. Single products employing the OLED-technology have been already introduced to the market. For the a generation of OLED-displays, which have to compete with established display-technologies, thin-film-transistors will be integrated onto the display-substrate itself. This involves the development of top-emitting organic light emitting diodes. Considering conventional bottom-emitting OLEDs a reversed deposition sequence results in such devices, speaking of inverted organic light emitting diodes (IOLED).

Highly efficient IOLEDs can be prepared by the introduction of charge injection layers, lowering the driving voltage and balancing the charge carrier distribution. The polymeric or doped small-molecule hole- and electron-transporting layers compared here show a high conductivity and great stability. Maximum efficiencies of 59.2 cd/A and 21.2 lm/W employing an inert silver cathode and a sputtered indium-tin-oxide (ITO) anode have been achieved.

SYOO 6.15 Mo 18:00 Poster TU A

**Spin selective electroluminescence from conjugated polymers in strong magnetic fields: implications for singlet-triplet ratios** — •M. REUFER<sup>1</sup>, M. WALTER<sup>1</sup>, J. M. LUPTON<sup>1</sup>, J. FELD-MANN<sup>1</sup>, A. B. HUMMEL<sup>2</sup>, J. KOLB<sup>2</sup>, H. ROSKOS<sup>2</sup>, and U. SCHERF<sup>3</sup> — <sup>1</sup>Photonics and Optoelectronics Group, Department of Physics and CeNS, Ludwig-Maximilians-Universität München — <sup>2</sup>Physikalisches Institut, Johann Wolfgang Goethe Universität Frankfurt am Main — <sup>3</sup>Fachbereich Chemie, Universität Wuppertal, Gauss-Str. 20, 42097 Wuppertal

Electroluminescence in conjugated polymers has attracted wide interest for applications in display devices. The efficiency of these materials is strongly affected by the spin statistics governing charge carrier recombination. We recently developed a technique to allow triplet excitons to be visualised directly by enabling strong, spatially localised spin-orbit coupling, which permits room temperature phosphorescence. Using this phosphorescence signature, we can directly probe the singlet to triplet ratio in organic light emitting diodes under strong magnetic fields. We observe a substantial negative magnetoresistance of up to 20 % at 8 T, while the singlet to triplet ratio of the emission is only weakly affected by the magnetic field and saturates above 1 T. This demonstrates that the magnetic field is not able to hybridise the two spin states or lead to spin alignment in the recombinant state, thus implying a substantial exchange splitting within the exciton precursor. In the absence of a strong spin mixing channel, device efficiencies above the spin statistical limit of 25 % appear improbable.

SYOO 6.16 Mo 18:00 Poster TU A

**Influence of the device geometry on the efficiency of polymer solar cells** — •THOMAS KIETZKE, CHUNHONG YIN, and DIETER NEHER — Institut für Physik, Physik weicher Materie, Am neuen Palais 10, 14469 Potsdam

Polymer based solar cells offer the potential for large area flexible devices. However, currently the efficiencies are still lower than the values obtained for their inorganic counterparts. We present the results of investigations on solar cells based on semiconducting polymers in different geometries (blend, layered, nanostructured) and with different cathode materials (Ca, TiOx). External quantum efficiencies exceeding 30 % could be reached by blending a soluble PPV derivative with a cyano substituted PPV as the electron acceptor. We show how the different preparation techniques influence the device efficiency and present an approach based on a nanostructured layer how to improve efficiencies in future.

References:

Yu, G., Gao, J., Hummelen, J. C., Wudl, F., Heeger, A. J. *Polymer Photovoltaic Cells - Enhanced Efficiencies Via a Network of Internal Donor-Acceptor Heterojunctions*. *Science* 270, 1789-1791 (1995).

Kietzke, T., Landfester K., Neher D. et. al. Novel approaches to polymer blends based on polymer nanoparticles. *Nature Materials* 2, 408-412 (2003).

SYOO 6.17 Mo 18:00 Poster TU A

**Effects of solvent and annealing on the improved performance of solar cells based on poly(3-hexylthiophene):fullerene** — •MAHER AL-IBRAHIM<sup>1</sup>, STEFFI SENSFUSS<sup>2</sup>, GERHARD GOBSCH<sup>3</sup>, and OLIVER AMBACHER<sup>1</sup> — <sup>1</sup>Ilmenau Technical University, Center for Micro- and Nanotechnologies, Gustav-Kirchhoff-Str. 7, D-98693 Ilmenau, Germany — <sup>2</sup>TITK Institute, Department of Functional Polymer Systems, Breitscheidstr.97, D-07407 Rudolstadt, Germany — <sup>3</sup>Ilmenau Technical University, Institute of Physik, Weimarer Str. 32, D-98693 Ilmenau, Germany

Polymer solar cells based on poly(3-hexylthiophene):[6,6]-phenyl-C61-butyric acid methyl ester (P3HT:PCBM) were fabricated using two different solvents. P3HT:PCBM films casted from chlorobenzene solution absorb more red light than the films casted from chloroform solution. After thermal annealing, the films casted from chloroform show higher absorption than the films casted from chlorobenzene. Solar cells made from P3HT:PCBM chlorobenzene solution show no change in the white light power conversion efficiency (2.2%) after annealing. Solar cells processed from P3HT:PCBM chloroform solution show a white light power conversion efficiency of 1.5% without thermal annealing and 3.4% after the thermal annealing.

SYOO 6.18 Mo 18:00 Poster TU A

**Thin film photovoltaic cells of DIP/CuPc and DIP/F<sub>16</sub>CuPc bilayers and mixed layers** — •PHILIPP NEUMANN and JENS PFLAUM — 3. Physikalisches Institut, Universität Stuttgart, Germany

Wavelength dependent photocurrent measurements on DIP/CuPc and DIP/F<sub>16</sub>CuPc photovoltaic (PV) cells are presented and correlated to their structural properties obtained by x-ray diffraction. The choice of material is motivated by their complementary absorption regions over a broad spectral range and by the high degree of structural order. The molecular bilayer and mixed layer, each of them between 100 – 300 nm thick, were prepared by thermal evaporation of the organic compounds under vacuum (10<sup>-8</sup> mbar). As bottom contact ITO covered glass and as top contact a thin transparent Ag layer were used. Whereas for the organic bilayer cells the individual optical properties of the layers yield a symbatic behavior of the photocurrent, for the mixed layer PV-cells, pronounced deviations in the optical absorption and in the spectral photocurrent were observed. Taking into account the increase of the effective interface region, we discuss this result in context of the respective energy levels of DIP, CuPc and F<sub>16</sub>CuPc and of the possible formation of a hetero-charge transfer complex.

SYOO 6.19 Mo 18:00 Poster TU A

**Charge transport and recombination in bulk heterojunction plastic solar cells** — •A. J. MOZER<sup>1</sup>, N. S. SARICIFTCI<sup>1</sup>, M. WESTERLING<sup>2</sup>, R. ÖSTERBACKA<sup>2</sup>, and G. JUSKA<sup>3</sup> — <sup>1</sup>Linz Institute for Organic Solar Cells (LIOS) Johannes Kepler University Linz, Austria — <sup>2</sup>Department of Physics, Åbo Akademi University, Turku, Finland — <sup>3</sup>Department of Solid State Electronics, Vilnius University, Lithuania

The high quantum yield of charge generation within the interpenetrating network of the electron donating conjugated polymer and the electron accepting fullerene derivative (bulk heterojunction) is a prerequisite for fabrication of efficient photovoltaic cells, yet the charge collection efficiency depends on the mobility and lifetime of the charge carriers. The charge carrier mobility and recombination in the blend of MDMO-PPV/PCBM are studied simultaneously using the novel photoinduced charge carrier extraction by a linearly increasing voltage (photo-CELIV). In this technique, the charge carriers are photogenerated by a strongly absorbed laser flash, and extracted by the application of a reverse bias voltage pulse after an adjustable delay time (tdel). From the maximum of the extraction current pulse, the mobility is calculated, and from the number of the extracted charge carriers at various tdel, the recombination is studied. The photo-CELIV transients have been recorded as a function of the light intensity (charge carrier concentration), delay time and applied electric field at various temperatures, and the results indicate that the observed delay time-dependent mobility is related to a time dependent energy relaxation of the charge carriers into deeper traps.

SYOO 6.20 Mo 18:00 Poster TU A

**Porous Films from Layer-by-Layer Deposition of TiO<sub>2</sub> Nanoparticles and Polyelectrolytes for Photovoltaic Applications** — •KERSTIN SCHULZE<sup>1,2</sup> and STEFAN KIRSTEIN<sup>1</sup> — <sup>1</sup>Institut für Physik, Humboldt-Universität zu Berlin — <sup>2</sup>Hahn-Meitner Institut, Berlin

Dye-sensitized solar cells (DSSCs) are based on photoinduced charge separation at a TiO<sub>2</sub> surface. Staining of the surface with dye molecules is used to shift the absorption from the UV to the visible spectrum. For sufficient absorption of light a very rough and highly porous TiO<sub>2</sub> surface is desired. In this work we report on the preparation and characterization of thin porous films of TiO<sub>2</sub> by alternate adsorption of TiO<sub>2</sub> nanoparticles and various polyelectrolytes from aqueous solutions. It is demonstrated that the adsorption process is independent of electrostatic forces and due to a sol-gel process. The resulting films are growing linearly with the deposition cycles and show high surface roughness, as analyzed by AFM measurements. The current transport through the films is investigated by measuring the current voltage characteristics of ITO/TiO<sub>2</sub>/Au structures. Almost ideal thin film Schottky diodes are obtained whereas the parameters were only slightly affected by annealing of the TiO<sub>2</sub> films at a temperature of 400 °C. First demonstration samples of DSSCs made of these films are presented.

SYOO 6.21 Mo 18:00 Poster TU A

**Organic thin-film photovoltaic cells based on low gap thiophene oligomers** — •CHRISTIAN UHRICH<sup>1</sup>, RICO SCHÜPPEL<sup>1</sup>, ANETTE PETRICH<sup>1</sup>, DR. MARTIN PFEIFFER<sup>1</sup>, PROF. DR. KARL LEO<sup>1</sup> and PROF. DR. PETER BÄUERLE<sup>2</sup> — <sup>1</sup>Institut für Angewandte Photophysik, Technische Universität Dresden, 01062 Dresden — <sup>2</sup>Abteilung Organische Chemie II und Sektion Massenspektrometrie, Universität Ulm, 89081 Ulm

The best polymeric solar cells reported so far are based on a so called bulk heterojunction of polythiophene as a donor and a soluble fullerene derivative as an acceptor. However, these cells still suffer from an unsatisfying photovoltage typically below 0.6V. Here, we show that we can achieve higher photovoltages using a new thiophene based oligomer comprising electron withdrawing groups that increase both the ionization energy and even more strongly the electron affinity of the compound. The new material is tested in MIP-type cells using a photoactive heterojunction to separate the excitons generated in the oligomer and a p-doped wide-gap transport layer. First solar cells show an open-circuit-voltage of above 0.8 V, fill factors around 50 % and a broad spectral sensitivity band starting at 650nm. The dynamics of excitons and photogenerated charge carriers in the photoactive layers is studied by photoinduced absorption spectroscopy (PIA) and time-resolved fluorescence spectroscopy. Solar cells based on such thiophene oligomers have the potential of high power efficiencies up to 3 % and are promising candidates for stacked PIN-type organic solar cells tailored to the sun-spectrum.

SYOO 6.22 Mo 18:00 Poster TU A

**New materials for fully polymer bulk heterojunction solar cells** — •MARTIN KNIPPER<sup>1</sup>, MICHAEL PIENKA<sup>1</sup>, VLADIMIR DYAKONOV<sup>1</sup>, JÜRGEN PARISI<sup>1</sup>, SILVIA JANIEZ<sup>2</sup>, BERT FISCHER<sup>2</sup>, and HARTMUT KRÜGER<sup>2</sup> — <sup>1</sup>Energy and Semiconductor Research Laboratory, Department of Physics, University of Oldenburg, 26111 Oldenburg — <sup>2</sup>Fraunhofer Institute Applied Polymer Research, Potsdam, Germany

Photoinduced electron transfer in composites of conjugated polymer poly-[2-methoxy-5-(2-ethylhexyloxy)-1,4-phenylvinylene] and poly(3-hexylthiophene) blended with copolyquinoxalines, materials with n-type semiconducting properties and low reduction peak potentials, is studied by means of photoluminescence, light-induced electron spin resonance, as well as quasi steady-state photoinduced absorption spectroscopy. The quenching of photoluminescence, the occurrence of two new optical absorption bands, and the formation of light-induced paramagnetic species on the polymer chain are altogether interpreted as an electron transfer between donor polymer and acceptor copolyquinoxalines in the excited state. Polymer/polymer photovoltaic devices are prepared from such blends as active single layers. The electrical parameters of the devices are determined and discussed, in terms of the mobility and blend morphology.

SYOO 6.23 Mo 18:00 Poster TU A

**The influence of active layer morphology on the performance of organic vacuum deposited bulk heterojunction solar cells** — •STEFAN SONNTAG<sup>1</sup>, MARTIN BAUER<sup>1</sup>, MARTIN PFEIFFER<sup>1</sup>, KARL LEO<sup>1</sup>, PETER BÄUERLE<sup>2</sup>, and PAUL SIMON<sup>3</sup> — <sup>1</sup>Institut für Angewandte Photophysik, TU Dresden, Germany — <sup>2</sup>Abteilung Organische Chemie II und Sektion Massenspektrometrie Universität Ulm — <sup>3</sup>Max Planck Institute for Chemical Physics of Solids, Dresden, Germany

The critical influence of the active layer morphology is known for polymeric bulk heterojunction solar cells. In particular, the performance can be strongly improved by reducing the typical scale of phase separation between the donor and the acceptor component. In solar cells based on a bulk heterojunction between zinc phthalocyanine (ZnPc) and fullerene C60, we find a significantly improved performance with fill factors up to 57 per cent when the active layer is deposited onto heated substrates (150°C). The heating leads to some degree of phase separation including crystalline C60 domains that enhance electron delocalization and thus reduce recombination losses. Moreover, we studied the influence of substrate temperature during layer growth for bulk heterojunctions of thiophene oligomers and C60. Firstly, the absorption of the thiophene is enhanced and red shifted at higher substrate temperatures due to a co-planarization of the thiophene rings in the solid. And secondly, the fill factor is improved significantly due to reduced recombination losses at low electric fields. Finally, we will discuss the influence of the oligomer length on the properties of the bulk heterojunction and the potential of thiophene oligomers for solar cells.

SYOO 6.24 Mo 18:00 Poster TU A

**Scanning Kelvin Probe Microscopy Investigations of Au-P3HT-Au Structures for Organic Field Effect Transistors** — •ANDRII GORIACHKO, KLAUS MÜLLER, IOANNA PALOUMPA, and DIETER SCHMEISSER — Lehrstuhl Angewandte Physik / Sensorik, BTU Cottbus, Konrad-Wachsmann-Allee 1, 03046 Cottbus, Germany

We report on the scanning Kelvin probe microscopy (SKPM) investigation of the source-channel-drain structures of organic field effect transistor (OFET). A poly-3-hexyl-thiophene (P3HT) organic semiconductor film, spin-coated on a glass-substrate and 65 nm thick, is used as a 2 μm channel between Au source (drain) electrodes. Depending on the preparation conditions, the P3HT film consists of either amorphous nm-sized molecular clusters or μm-long chains. The SKPM allows mapping of electric potential along with the surface topography on the DC-biased structures (8V applied between source and drain). It reveals a linear potential fall in the channel region as well as the absence of potential jumps (contact resistance) in the electrode/channel regions. This is a direct indication of the top-gate OFET type advantage, which the given structure is suited for. Due to the high spatial resolution of the UHV-based SKPM, doping inhomogeneities of the p-type P3HT semiconductor as well as the space charge region on the electron injecting electrode are observed. In addition we present SKPM investigations of the structure with source and drain electrodes but without a semiconductor, showing electric field configuration for the given electrodes geometry.

SYOO 6.25 Mo 18:00 Poster TU A

**Improved Low-Cost Fabrication of Submicron Polymer Field-Effect Transistors** — •SUSANNE SCHEINERT<sup>1</sup>, GERNOT PAASCH<sup>2</sup>, INGO HÖRSELMANN<sup>1</sup>, and ANDREI HERASIMOVICH<sup>1</sup> — <sup>1</sup>TU Ilmenau — <sup>2</sup>IFW Dresden

The novel low-cost technology [1] for short-channel transistors results in devices with low mobility and a nonlinear increase of the drain current at low drain voltages. Furthermore, an inorganic insulator is used to impede short-channel effects. We report technological investigations aimed to improve the device characteristics. A possibility to increase the mobility is the HMDS treatment of the silicon dioxide interface. We applied this process to a pure oxide layer and an oxide with prepared source/drain contacts. The increase of the mobility was only obtained operating the process on the pure oxide layer. Two-dimensional simulations have shown that the composite contact made from Cr/Au is the reason for the nonlinear drain current increase. Indeed, subsequently prepared devices with Au contacts only do not show this peculiarity. Different organic materials have been investigated as an alternative for the gate insulator. Layers with high break-through voltages at thicknesses down to 100nm have been achieved already, but for short-channel transistors 50nm or less are needed.

[1] S. Scheinert, T. Doll, A. Scherer, G. Paasch, I. Hörselmann, Appl. Phys. Lett. 84 (2004) 4427-4429.

SYOO 6.26 Mo 18:00 Poster TU A

**The Effect of Oxygen Exposure on Pentacene Electronic Structure** — ●A. VOLLMEYER<sup>1</sup>, O. D. JURCHESCU<sup>2</sup>, I. ARFAOUI<sup>2</sup>, P. RUDOLF<sup>2</sup>, T. T. M. PALSTRA<sup>2</sup>, J. NIEMAX<sup>3</sup>, J. PFLAUM<sup>3</sup>, I. SALZMANN<sup>4</sup>, J. P. RABE<sup>4</sup>, and N. KOCH<sup>4</sup> — <sup>1</sup>BESSY, Albert-Einstein-Str. 15, D-12489 Berlin — <sup>2</sup>Materials Science Center, Rijksuniversiteit Groningen, NL-9747 AG Groningen, Netherlands — <sup>3</sup>Universität Stuttgart, 3. Physikalisches Institut, D-70550 Stuttgart — <sup>4</sup>Humboldt-Universität zu Berlin, Institut f. Physik, D-12489 Berlin

We use ultraviolet photoelectron spectroscopy to investigate the effect of oxygen and air exposure on the electronic structure of pentacene single crystals and thin films. This study is motivated by the fact that a reliable comparison between charge carrier mobility values from different laboratories is often hampered by the variation of sample preparation and environmental conditions for measurements. We find that molecular oxygen and water do not react noticeably with pentacene, whereas ozone readily oxidizes the organic compound. Oxygen diffusion through pentacene thin films and single crystal surfaces is reversible, and does not leave behind (after re-evacuation) electrically active electronic states that would lead to p-type doping of the organic bulk. However, oxygen exposure lowers the hole injection barrier at the interface between Au and pentacene by 0.25 eV, presumably due to a modification of the Au surface properties.

SYOO 6.27 Mo 18:00 Poster TU A

**Surface Stress in Organic Thin Film Growth - Pentacene on Si(111)** — ●PETER KURY<sup>1</sup>, FRANK MEYER ZU HERINGDORF<sup>1</sup>, KELLY ROOS<sup>2</sup>, KEVIN KIMBERLIN<sup>2</sup>, and MICHAEL HORN-VON HOEGEN<sup>1</sup> — <sup>1</sup>Institut für Laser- und Plasmaphysik, Universität Duisburg-Essen, 45141 Essen — <sup>2</sup>Bradley University, Peoria (IL), USA

Stress and strain are well established physical quantities in organical chemistry as well as in surface physics and have been investigated for decades. The formation of ordered layers of organic molecules on a crystalline surface, however, is a topic that has gained recently enormous interest and the investigation of the influence of stress on the morphology is a new challenge [1]. Due to the exclusive van der Waals interactions inside the organic material only small effects are to be expected during film growth, although covalent interactions are not unusual at the interface between the organic molecules at semiconductor surfaces like Si(111) [2]. Here we present high resolution surface stress measurements by means of surface stress induced optical deflection (SSIOD) on the molecular layer by layer growth [3] of the high performance organic semiconductor pentacene on Si(111). We demonstrate how the surface stress is correlated to the morphology by comparison of SSIOD data with microscopy (AFM, STM, PEEM).

[1]: M. Gsell et al., Science **280**, 717 (1998)

[2]: R. J. Hamers et al., Acc. Chem. Res. **33**, 617 (2000)

[3]: F. Meyer zu Heringdorf et al., Nature **412**, 517 (2001)

SYOO 6.28 Mo 18:00 Poster TU A

**Acridine orange base as a dopant for n-doping of C60 thin films** — ●FENGHONG LI<sup>1</sup>, ANSGAR WERNER<sup>1</sup>, MARTIN PFEIFFER<sup>1</sup>, KARL LEO<sup>1</sup>, and NAOKI HAYASHI<sup>2</sup> — <sup>1</sup>Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden, Germany — <sup>2</sup>Department of Chemistry, Graduate School of Science, Nagoya University, Nagoya 464-8602, Japan

We present a study on n-doping of C60 thin films by acridine orange base (AOB) combining conductivity, field effect and Seebeck measurements. It is found that the dark conductivity of C60 doped thin films can be enhanced by a light-induced activation of dopant precursor AOB: A conductivity up to  $6 \cdot 10^{-2}$  S/cm at 30°C is achieved when a diffusive illumination is provided in the vacuum chamber during the evaporation. The field effect and Seebeck measurements confirm the n-type conduction of C60 thin films and show that deep donor states are formed in AOB doped C60 films. A field effect mobility of 0.19 cm<sup>2</sup>/Vs is achieved for a doping level of 56:1. NIR and FTIR spectra demonstrate electron transfer from the dopant to the matrix: For C60 doped with AOB, C60 anion is present in NIR absorption and FTIR spectra. On the other hand, a peak corresponding to acridine orange (AO cation) is also observed in the FTIR spectrum of C60:AOB, where AO corresponds to AOB with one additional hydrogen attached. Electrochemical data of AOB and AO in acetonitrile suggest that the AOB radical cation is not stable but is rapidly transformed into a compound with similar properties to AO. We speculate that, in the codeposited layers, this compound is a dyad of AOB(+) and C60(-) connected by a C-N chemical bond.

SYOO 6.29 Mo 18:00 Poster TU A

**Parasitic Capacitances in Organic Field-Effect Transistors and their Influence on the cut-off Frequency** — ●I. HÖRSELMANN and S. SCHEINERT — Festkörperelektronik, TU Ilmenau, 98693 Ilmenau

Organic field-effect transistors (OFETs) are promising elements for low-cost electronics. Many processes presented for OFET mass production will lead to parasitic capacitances resulting in reduction of the cut-off frequency. These capacitances are mostly caused by the overlap of the gate and source/drain contacts. In particular, for comb-like structures the overlap is very large and consequently a critical parameter for the design. Furthermore, for commercial applications supply voltages smaller 10V are necessary. This requires thin organic insulator layers resulting in higher parasitic capacitances. We performed *ac* simulations to determine the cut-off frequency for different OFET designs. Simulations have been carried out for various gate overlaps. Mobility, channel length, and insulator thickness have been chosen as parameters. The results show indeed, that the overlap in the comb-like structure is the limiting factor for the cut-off frequency. Most promising for reducing parasitic capacitances is the self-alignment technique. In this case the cut-off frequency is determined solely by the channel length and the mobility of the semiconductor material.

SYOO 6.30 Mo 18:00 Poster TU A

**Organic Field Effect Transistors with polymer high-k dielectric insulator** — ●KLAUS MÜLLER, IOANNA PALOUMPA, KARSTEN HENKEL, and DIETER SCHMEISSER — Brandenburgische Technische Uni. Cottbus, Angewandte Physik-Sensorik, 03013 Cottbus, P.O.Box 101344, Germany

Organic field effect transistors consisting of the copolymer poly(vinylidene fluoridetrifluoroethylene) (P(VDF-TrFE)) and P3HT (poly(3-hexylthiophene)) as active layer have been fabricated. The influence of P(VDF-TrFE) on the transconductance of organic field effect transistors was investigated and enhanced gate effects are observed compared to similar transistors with PMMA (Polymethylmetacrylate) as gate dielectric. Due to the high dielectric constant of P(VDF-TrFE) (DK=12) an operation voltage smaller than for a conventional organic dielectric like PMMA (DK=3.3) was observed. The thickness of the spincoated dielectric layers is in the range of 2microns and in consequence, no significant hysteresis was found, a prerequisite for transistor operation.

SYOO 6.31 Mo 18:00 Poster TU A

**Dependence of poly-3hexylthiophene Electrical Properties on Residual Doping** — ●A. HERASIMOVICH<sup>1</sup>, S. JANIETZ<sup>2</sup>, S. SCHEINERT<sup>1</sup>, and I. HÖRSELMANN<sup>1</sup> — <sup>1</sup>Festkörperelektronik, TU Ilmenau, 98693 Ilmenau — <sup>2</sup>Fraunhofer-Institut für Angewandte Polymerforschung (IAP), 14476 Golm

Field effect transistors (FET) and MOS capacitors have been prepared with different poly-3-hexylthiophenes (P3HT). The purity of the organic active layer and the controlled doping level are important parameters for the production of stable FET. We have investigated electrical properties of the devices with active layers made from unpurified, purified and intentionally doped P3HT, which are prepared by spin coating on *n*<sup>+</sup>-Si/SiO<sub>2</sub> substrates. The measuring results of the capacitors from impedance spectroscopy and the data obtained for the FET show the following results: (i) Devices prepared from purified P3HT have a low residual doping of about 10<sup>16</sup> cm<sup>-3</sup> compared to the unpurified material with a doping level of about 10<sup>17</sup> cm<sup>-3</sup>, (ii) controlled doping results in a concentration of about 3 × 10<sup>16</sup> cm<sup>-3</sup>, (iii) the devices made from purified and doped materials show smaller hysteresis effects in comparison to the ones prepared from unpurified P3HT, (iv) the lateral mobility in devices with a HMDS treated oxide increases from 2 × 10<sup>-4</sup> cm<sup>2</sup>/Vs for the purified material, up to 10<sup>-3</sup> cm<sup>2</sup>/Vs for the unpurified one. Controlled doping results in a value of about 7 × 10<sup>-4</sup> cm<sup>2</sup>/Vs.

SYOO 6.32 Mo 18:00 Poster TU A

**Ambipolar field-effect transistors based on mixed organic layers** — ●MARKUS BRONNER, JOSH ASKIN, ANDREAS OPITZ, and WOLFGANG BRÜTTING — Experimentalphysik IV, Universität Augsburg, 86135 Augsburg, Germany

So far organic field-effect transistors (OFETs) are only available as unipolar devices (mostly p-channel transistors). These devices have inherent drawbacks compared to complementary logic devices, among them: limited performance, high power consumption and low tolerance to parameter variations. OFETs based on ambipolar materials are one possibility to realize complementary logic and thus improve the functionality

of organic electronic circuits.

We present first results on ambipolar OFETs and inverters based on low-molecular weight p-conducting and n-conducting materials. Using co-evaporated mixed layers of rubrene or pentacene together with fullerene OFETs with ambipolar characteristics have been realized. Due to favourable band bending at the Au/C<sub>60</sub> interface, Au contacts can be used for both electron and hole injection. Although only moderate charge carrier mobilities of 10<sup>-3</sup> cm<sup>2</sup>/Vs have been obtained so far, ambipolar inverters from these materials show an improved noise margin of about 8 V and a high gain of about 12. Further optimisation of layer growth and morphology is expected to lead to even better performance of these ambipolar OFETs.

SYOO 6.33 Mo 18:00 Poster TU A

**Concentration dependence of field effect mobility in methanofullerene : polythiophene blends** — •ELIZABETH VON HAUFF, VLADIMIR DYAKONOV, and JÜRGEN PARISI — Carl-von-Ossietzky University of Oldenburg, Faculty V, Institute of Physics, Department of Energy and Semiconductor Research, C-v-O Str. 9-11, 26129 Oldenburg, Germany

We report on the dependence of the field effect mobility of electrons and of holes on the concentration of methanofullerene (PCBM) in the PCBM: polythiophene (P3HT) blends typically used in polymer solar cells. The electron mobilities in pure PCBM and the hole mobilities in P3HT are roughly balanced, and in the order of 10<sup>-3</sup> cm<sup>2</sup>/Vs, whereas in the 2:1 (PCBM:P3HT) blends, the mobilities of both charge carriers are found to lie a factor of 10 lower. In this study, the concentration of PCBM was varied in the blends from half to over double the weight ratio of P3HT in the blend, and the effect of the PCBM concentration on the charge carrier mobilities in the blend was investigated. The effect of thermal treatment, known to be essential for solar cell performance, was investigated in P3HT films and PCBM:P3HT blends for its influence on the field effect mobility. In pure P3HT and PCBM:P3HT blends, a five fold increase in the hole mobility was observed.

SYOO 6.34 Mo 18:00 Poster TU A

**Charge carrier mobility measurements in organic single crystals** — •J. NIEMAX, A.K. TRIPATHI, and J. PFLAUM — 3. Phys. Inst., Universität Stuttgart, Germany

Charge carrier mobilities in ultra-pure organic single crystals define benchmarks for the transport in the corresponding thin films. But depending on the handling of the samples and the respective experimental setup, a broad variation of the transport parameters of single crystals is reported in literature. We therefore, present transport measurements on single crystals of polyacenes in combination with their chemical analysis. As previously shown, time-of-flight spectroscopy can be used to measure hole and electron transients along the c'-direction, in case the material can be purified by zone-refinement. For tetracene, which can be purified by sublimation only, the electron transport is strongly dispersive. In agreement with measurements of the field-effect mobility, the hole transport is thermally activated showing a behavior described by the Hoestery-Letson model. In this context, we obtained the highest FET hole mobility of 0.8 cm<sup>2</sup>/Vs at room temperature reported so far. Comparing trap density and energy deduced from this model with gas chromatography data, the conclusion can be drawn that the trapping is mainly caused by chemical impurities rather than by structural defects.

SYOO 6.35 Mo 18:00 Poster TU A

**Aqueous colloidal dispersions of ladder-type polymers as novel semiconducting materials for organic field effect transistor applications** — •DESSLAVA SAINOVA, SILVIA JANIEZ, HARTMUT KRUEGER, and ARMIN WEDEL — Fraunhofer Institute for Applied Polymer Research, Geiselbergstr. 69, 14476 Golm

The development of organic field effect transistors (OFETs) based on semiconducting polymers is an important and challenging topic of the modern microelectronics which enables devices that combine the advantages of easy processing, low weight, mechanical flexibility and ability of properties-tuning by structural modifications. Most of the reported semiconducting polymers show p-type properties. Nevertheless both charge transport types are necessary for the realisation of numerous important logic elements. Recently an interesting solution to this task has been proposed in the form of a conjugated ladder-type poly(benzobisimidazobenzophenanthroline) (BBL) showing either ambipolar or n-type field effect properties dependent upon the sample preparation and

processing. However this rigid-chain ladder polymer is not soluble in the common organic solvents resulting in a rather complicated technological transfer. We report the significant improvement of the BBL-processing utilizing aqueous colloidal dispersions and their OFET-application. The resultant devices demonstrate ambipolar electronic transport with charge carrier mobilities in the range of 10-5 cm<sup>2</sup>/Vs without specific optimization procedures.

SYOO 6.36 Mo 18:00 Poster TU A

**Surface Potential profiling on operating full organic thin film transistors by Kelvin probe force microscopy** — •MARKUS GEUSS, KLAUS MÜLLER, IOANNA PALOUMPA, and DIETER SCHMEISSER — BTU Cottbus, Lehrstuhl Angewandte Physik II/Sensorik, Universitätsplatz 3-4, 03044 Cottbus

Kelvin-AFM is employed to study all polymer organic thin film transistors which are promising candidates for low cost - low performance applications like active matrix displays, sensors or single-serving devices. We use bottom contact source-drain-electrode structures of different organic materials like carbon-black or graphite plotted on a printing foil. Semiconducting regioregular Poly(3-Hexylthiophene-2,5-diyl) (P3HT) was subsequently deposited by spin coating. Surface potential profiles across the transistor channel were measured by Kelvin-AFM for various source-drain potential differences and signs. We found that contact resistances cause characteristic steps in the surface potential near the channel edges which vary with the electrode material. Furthermore, nonlinearities appear in the potential gradient which possibly give evidence for lateral inhomogeneities of the carrier mobilities. In summary, surface potential imaging with high lateral resolution (approx. 100 nm) is introduced as a powerful tool for the characterisation of the transistor performance and the selection of suitable low cost electrode materials.

SYOO 6.37 Mo 18:00 Poster TU A

**Organic Field-Effect Transistor as a Bistable Memory Element** — •BIRENDRA SINGH<sup>1</sup>, NENAD MARJANOVIC<sup>1</sup>, GEBHARD MATT<sup>1</sup>, NIYAZI SERDAR SARICIFTCI<sup>1</sup>, REINHARD SCHWODIAUER<sup>2</sup>, and SIGFRIED BAUER<sup>2</sup> — <sup>1</sup>Linz Institute for Organic Solar Cells (LIOS), Physikalische Chemie, Johannes Kepler Universität Linz, Austria — <sup>2</sup>Soft Matter Physics, Johannes Kepler University Linz, Austria

Most of the organic field effect transistors (OFET) fabricated using organic dielectric exhibit an inherent small hysteresis mostly due to the charge trapping mechanism at the semiconductor/dielectric interface. Devices with a (polyvinyl alcohol), PVA, electret as gate dielectric show a very large, meta-stable hysteresis in its transfer characteristics. The observed hysteresis is found to be temperature dependent. We demonstrate a memory unit of write/read/erase/read cycles with write/erase pulses using positive and negative gate voltages, respectively. All devices have been fabricated using solution processable materials and can be used in large scale printing technologies.

SYOO 6.38 Mo 18:00 Poster TU A

**Structural properties of pentacene thin film transistors** — •BERT NICKEL, STEFAN SCHIEFER, NOK TSAO und UDO BEIERLEIN — Ludwig-Maximilians Universität, München

The structural properties of pentacene thin films which have been grown on SiO<sub>2</sub> and on an optically transparent polymer have been compared using x-ray reflectivity and grazing incidence diffraction. The analysis allows for quantifying the pentacene unit cell dimension, the dislocation densities within the thin film, and the molecular orientation as a function of growth temperature. Furthermore, the structural changes due to the Au-contacts (with and without passivation by a thiol layer) are demonstrated. Finally, we try to correlate the structural and the transport properties.

SYOO 6.39 Mo 18:00 Poster TU A

**P(VDF/TrFE) as a ferroelectric dielectric for Organic Field effect Transistors in MFIS structure** — •KARSTEN HENKEL, IOANNA PALOUMPA, KLAUS MÜLLER, and DIETER SCHMEISSER — Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, 03013 Cottbus, P.O.Box 101344, Germany

MFIS structures consisting of metal, ferroelectric poly(vinylidene fluoride trifluoroethylene) [P(VDF/TrFE)], insulator, semiconductor (Si) are fabricated and the influence of the polarization of the P(VDF/TrFE) on the CV characteristics of these structures is investigated. We find a characteristic ferroelectric hysteresis in the CV curves upon increasing the voltage scan window (e.g.-U...U, U=6...30V,  $|U_{P(VDF/TrFE)}| \leq 15V$ ,

$d_{(VDF/TrFE)} = 300$  nm). A writing process with adequate electric fields causes large shifts in the flatband voltage ( $\Delta U_{FB} > 4$  V for the quoted example before) which are stable over days. We report on our investigations which focus on the switching behavior by varying the parameters like polymer thickness, writing field strength and time, long time stability, reversing voltage and insulating material ( $SiO_2$ , PMMA (Polymethylmetacrylate)). This material combination is favorable for transfer into our full organic concept of field effect transistors for application as a nondestructive readout memory (NDRO) cell.

SYOO 6.40 Mo 18:00 Poster TU A

**Correlation of the OFET mobility and the morphology of pentacene films grown on alumina films** — ●MICHAEL VOIGT and MORITZ SOKOLOWSKI — Institut für Physikalische und Theoretische Chemie, Universität Bonn, Wegelerstrasse 12, 53115 Bonn

Organic field effect transistors (OFETs) were fabricated by evaporation of pentacene (Pc) onto alumina insulator films. The alumina films were prepared on ITO covered glass (gate) by rf magnetron sputtering. Source and drain contacts (Au; channel length  $L = 30 - 80$   $\mu m$ ) were made by shadow mask technique on top of the Pc films. The Pc films have been deposited at various evaporation rates ( $r = 1 - 10$  nm/min) at several substrate temperatures ( $T = -17 - 90^\circ C$ ). Investigations by AFM and polarization light (video) microscopy reveal that the morphology of the Pc films depends strongly on  $T$  and  $r$ . In the kinetic regime (low  $T$ , high  $r$ ) the films are closed whereas in the thermodynamic regime (high  $T$ , low  $r$ ) isolated crystallites are observed. The shape of the crystallites is either dendritic (for low  $T$ ) or granular (for high  $T$ ). The closed films show hole mobilities  $\mu$  of  $0.007 - 0.18$   $cm^2/Vs$  (highest  $\mu$  for  $T = 23^\circ C$ ) whereas for isolated crystallites no  $\mu$  could be measured. This work is supported by the DFG through the priority program "Organic Field Effect Transistors".

SYOO 6.41 Mo 18:00 Poster TU A

**Surface potential profiling on organic thin film transistors by photoemission-electron-microscopy (PEEM)** — ●KLAUS MÜLLER, YEVGEN BURKOV, and DIETER SCHMEISSER — Brandenburgische Technische Uni. Cottbus, Angewandte Physik-Sensorik, 03013 Cottbus, P.O.Box 101344, Germany

Surface potential imaging with Photoemission-electron-microscopy (PEEM) in high lateral resolution is introduced as a new tool for the characterisation of organic transistor structures. We use source-drain-electrode structures of different organic materials like carbon-black or graphite plotted on a printing foil. Semiconducting regioregular Poly(3-Hexylthiophene-2,5-diyl) (P3HT) was deposited by spin coating. For our measurements we used radiation of a standard high pressure Hg-lamp (4,9 eV) and synchrotron radiation at the BESSYII-U49/2 beam line. In contrast to Kelvin-AFM measurements of the surface potential, PEEM enables a simultaneous analysis of chemical composition by photoelectron spectroscopy. UPS, for example, at zero potential gives information on chemical homogeneity of the organic semiconductor in lateral resolution. PEEM images at applied voltages, compared with UPS-spectra, gives informations on doping profiles in the semiconductor, for example. In conclusion, PEEM should be a complementary method for characterisation of the surface potential with Kelvin-AFM. In addition, PEEM gives opportunities for measurements of chemical composition in the working state of the transistor (applied voltages).

SYOO 6.42 Mo 18:00 Poster TU A

**Molecular structure and electronic properties of poly(3-hexylthiophene)s** — ●ACHMAD ZEN<sup>1</sup>, MARINA SAPHIANNIKOVA<sup>1</sup>, DIETER NEHER<sup>1</sup>, JOERG GRENZER<sup>1</sup>, UDOM ASAWAPIROM<sup>2</sup>, and ULLRICH SCHERF<sup>2</sup> — <sup>1</sup>Department of Physics, University of Potsdam, Am Neuen Palais 10, 14469 Potsdam, Germany — <sup>2</sup>Macromolecular Chemistry, University of Wuppertal, Gauss Str.20, 42097 Wuppertal, Germany

It was shown recently that decreasing the molecular weight (Mw) of poly(3-hexylthiophene)s (P3HT) leads to a drastic reduction of the field effect mobility in thin layers.[1,2] Here, we present the results of structural studies of P3HT fractions of different molecular weight, in relation with their electronic properties. Using X-ray grazing incidence diffraction (GID), we found that films of the highest Mw fraction are amorphous at the surface, but slightly crystalline in the bulk, while films with the lowest Mw P3HT are highly polycrystalline throughout the sample. The data also suggest that the packing of the low molecular weight P3HT differs from that of the high Mw fraction. We conclude that the backbone pla-

narity and packing rather than grain boundaries controls the field effect mobility in these polymer layers.

[1]. R. J. Kline, M. D. McGehee, E. N. Kdnikova, J. Liu, and J. M. J. Frechet, Adv. Mater. 15 (2003) 1519. [2]. A. Zen, J. Pflaum, S. Hirschmann, W. Zhuang, F. Jaiser, U. Asawapirom, J. P. Rabe, U. Scherf, and D. Neher, Adv. Funct. Mater. 14 (2004) 757.

SYOO 6.43 Mo 18:00 Poster TU A

**Spatially inhomogeneous distribution of traps in organic diodes** — ●ARNE FLEISSNER, WIELAND WEISE, and HEINZ VON SEGGERN — Electronic Materials Department, Institute of Materials Science, Darmstadt University of Technology, Petersenstr. 23, D-64287 Darmstadt, Germany

The performance of organic light emitting devices is strongly influenced by charge carrier traps. It is therefore of great importance to combine theoretical models and experimental results in order to develop a better understanding of the effects of traps on the device characteristics. In this talk, the influence of the spatial distribution of shallow traps on space charge limited current (SCLC) through organic diodes is investigated. Devices with a well-defined spatial distribution of traps are prepared by means of co-deposition of the small molecule organic semiconductors 1-NaphDATA as the host and  $\alpha$ -NPD as the dopant. The resulting 1-NaphDATA films consist of three layers, wherein one is homogeneously doped with  $\alpha$ -NPD, which creates well-known shallow traps for holes. The position of the doped layer has a strong influence on the SCLC characteristics of the diodes. A model for unipolar SCLC through layers with a disparate concentration of shallow traps is presented. The model describes the experimental results quantitatively. It is employed to calculate the spatial distributions of the charge carrier density and the electric field strength in the differently doped devices.

SYOO 6.44 Mo 18:00 Poster TU A

**Spatial emission characteristics of waveguiding organic nanofibers** — ●RALF FRESE<sup>1</sup>, CHRISTIAN MAIBOHM<sup>1</sup>, JENS GRAVESEN<sup>2</sup>, MORTEN WILLATZEN<sup>3</sup>, and HORST-GÜNTHER RUBAHN<sup>1</sup> — <sup>1</sup>Fysisk Institut, Syddansk Universitet, Campusvej 55, DK-5230 Odense M, Denmark — <sup>2</sup>Dept. of Mathematics, Danmarks Tekniske Universitet, DK-2800 Lyngby, Denmark — <sup>3</sup>Mads Clausen Institut, University of Southern Denmark, Grundtvigs Allé 150, DK-6400 Sønderborg, Denmark

Organic molecules such as para-hexaphenylene form well-ordered nanostructures upon vacuum deposition on dielectric substrates such as mica. Since their widths can be of the order of several hundred nanometers with heights of a few ten nanometers and lengths of several ten to several hundred micrometers they act as waveguides (nanofibers) for visible light. This waveguiding affects the spatial emission characteristics of intense blue light that is emitted from the nanofibers upon UV light stimulation and leads to enhanced emission along the surface plane. We discuss the experimental findings and explain them with the help of a classical electrodynamics simulation of light propagation in ordered and disordered arrays of nanofibers.

SYOO 6.45 Mo 18:00 Poster TU A

**Charge carrier mobility in Diindenoperylene (DIP) single crystals** — ●A. K. TRIPATHI and J. PFLAUM — 3. Phys. Inst., Universität Stuttgart, Germany

Realization of the electron field effect in the single crystal OFETs is limited by the oxidation of the crystal surface. We have experimentally verified sensitivity of organic crystals like tetracene and pentacene towards oxidation. Therefore we need a material that is stable against the oxidation. Diindenoperylene (DIP), because of its chemical properties, is very stable and hence a promising candidate for the transistor applications. For the first time, we have successfully grown single crystals of DIP by the sublimation growth method. Electrical characterization of these single crystals along the  $c'$ -direction was done using time-of-flight (TOF) and space-charge-limited-current (SCLC) techniques. Estimation of the electron mobility by the TOF method gives a value close to  $0.02$   $cm^2/Vs$  at room temperature. First estimation of the lower limit of hole mobility could be made by SCLC method, giving a relatively lower value. We shall discuss these results on the background of DIP thin film FETs [1].

[1] N. Karl, Synth. Metals, **133** (2003) 649



SYOO 6.46 Mo 18:00 Poster TU A

**CT interaction induced optical nonlinearities** — ●MARK GOEBEL<sup>1</sup>, MOUNAIM DEGHMOUCHE<sup>1</sup>, BORIS TRABER<sup>2</sup>, AHMED EL-KHAWAGA<sup>3</sup>, LISA KORST<sup>1</sup>, and RÜDIGER WORTMANN<sup>1</sup> — <sup>1</sup>TU Kaiserslautern — <sup>2</sup>Ruprecht-Karls-Universität Heidelberg — <sup>3</sup>University of Assiut, Egypt

Second-order optical nonlinearities of organic materials are largely controlled by the charge-transfer properties of molecular chromophores. Charge-transfer may occur between a donor and an acceptor group in an intramolecular CT band, typically through a  $\pi$ -conjugated system, or in an intermolecular (through-space) CT band. Quantitative relationships between molecular second-order polarizabilities and CT properties for both are established on the basis of consistent electric-field-induced second-harmonic generation (EFISHG), hyper-Rayleigh scattering (HRS) and electrooptical absorption measurements (EOAM). Results for a series of one and two-dimensional NLO chromophores including nondipolar structures with threefold symmetry, molecular CT complexes, supramolecular aggregates and phases with chemical reactions will be presented.

[1] R. Wortmann, K. Lukaszuk, Nonlinear Optical Responses of Molecules, Solides and Liquides: Methods and Applications, (2003) 179-193.

[2] B. Traber, J.J. Wolff, F. Rominger, T. Oeser, R. Gleiter, M. Goebel, R. Wortmann, Chemistry-A. European Journal, 10 (2004) 1227-1238.

[3] B. Traber, T. Oeser, R. Gleiter, M. Goebel, R. Wortmann, Eur. J. Org. Chem. (2004), 4387-4390.

SYOO 6.47 Mo 18:00 Poster TU A

**Organic photorefractive glasses with high transparency** — ●ANDREAS GEBHARD<sup>1</sup>, DENITSA YANCHEVA<sup>2</sup>, TSONKO KOLEV<sup>2</sup>, and RÜDIGER WORTMANN<sup>1</sup> — <sup>1</sup>Kaiserslautern University of Technology, Erwin-Schrödinger Strasse, D-67663 Kaiserslautern — <sup>2</sup>Institute of Organic Chemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev. Str., 1113 Sofia, Bulgaria

Organic photorefractive (PR) materials offer a variety of interesting photonic applications. We have shown in previous work that the PR response of organic glasses with low glass transition temperature is optimized with neutral dipolar dyes close to the cyanine limit. Such chromophores may combine large ground state dipole moments with large anisotropies of their first-order polarizability. The optical absorption of such chromophores typically limits the PR response to the red or even NIR spectral region. In this contribution we present PR glasses which are almost transparent in the whole visible region. The PR properties of the materials were studied at various wavelengths from the red to the blue spectral region by the holographic-optical techniques of two-beam-coupling and four-wave mixing. The benefits of increased performance at shorter wavelengths based on the dispersion-enhanced Kerr susceptibility in the blue will be demonstrated.

[1] R. Wortmann, C. Poga, R.J. Twieg, C. Geletneky, C.R. Moylan, P.M. Lundquist, R.G. DeVoe, P.M. Cotts, H. Horn, J. Rice, D.M. Burland; J. Chem. Phys. 1996, 105, 10637.

[2] P.M. Lundquist, R. Wortmann, C. Geletneky, R.J. Twieg, M. Jurich, V.Y. Lee, C.R. Moylan, D.M. Burland; Science 1996, 274, 1182.

SYOO 6.48 Mo 18:00 Poster TU A

**Structure, growth and optical properties of perylene films on glass and Si substrates** — ●MARYAM BEIGMOHAMDI, PHENWISA NIYAMAKOM, DOROTHEA BRUEGGEMANN, STEFAN KREMERS, and MATTHIAS WUTTIG — I.Physikalisches Institut, RWTH-Aachen

Organic films hold considerable promise for opto-electronic applications. We have deposited perylene films with different rate and thickness on glass and silicon substrates by thermal evaporation. XRD reveals that the films have a pronounced texture. Using surfaces coated by selfassembled monolayers, the texture can be modified considerably. AFM shows a pronounced dependence of the grain size and defect density as a function of film thickness and deposition rate. Strategies to deposit films with a low defect concentration will be discussed. Finally we have investigated optical properties as well as vibrational properties by a combination of spectroscopic ellipsometry, UV-VIS spectroscopy and FTIR. These investigations clearly demonstrate the pronounced anisotropy of the optical and vibrational properties, in line with the observed film texture.

SYOO 6.49 Mo 18:00 Poster TU A

**ON THE RELAXATION OF THE ENERGY OF CAVITY POLARITONS IN ORGANIC MATERIALS** — ●MARINA LITINSKAYA<sup>1,2</sup>, PETER REINEKER<sup>1</sup>, and VLADIMIR AGRANOVICH<sup>2</sup> — <sup>1</sup>Department of Theoretical Physics, University of Ulm, 89069 Ulm, Germany — <sup>2</sup>Institute for Spectroscopy RAS, Troitsk, Moscow region, 142190, Russia

We discuss the regime of strong light-matter coupling in organic microcavities. In contrast to conventional inorganic microcavities, in these structures typical Rabi splitting energies are huge (up to 0.5 eV at room temperatures), which is important both for fundamental studies and possible applications. We have shown recently, that in such structures the spectrum of elementary excitations has an unusual structure. Namely, the coherent polaritonic states coexist with spatially localized states, and these incoherent excited states form the majority of the excited states in the MC. The incoherent excited states are expected to dominate the relaxation dynamics in the MC. In this work we consider the decay of such an incoherent excited state into a lower-energy coherent polaritonic state via emission of a high-energy intramolecular vibration. We show that under a proper choice of the parameters of the microcavity, this relaxation channel may be effective for the population of the lowest energy polaritonic state, and probably may be used in the studies of possible Bose-Einstein condensation of cavity polaritons.

SYOO 6.50 Mo 18:00 Poster TU A

**A quantum-chemical study on excited state absorption spectra of perylene derivatives** — ●K. SCHMIDT<sup>1</sup>, D. BELJONNE<sup>1</sup>, J.-L. BRÉDAS<sup>1</sup>, E. ENGEL<sup>2</sup>, K. LEO<sup>2</sup>, and M. HOFFMANN<sup>2</sup> — <sup>1</sup>School of Chemistry and Biochemistry, Georgia Institute of Technology, Atlanta, Georgia 30332-0400, USA — <sup>2</sup>Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden, www.iapp.de

Analysis of spectroscopic data or absorption-loss-mechanisms at high exciton densities requires detailed knowledge about optical transitions from the lowest exciton states to higher excited states. We consider such transitions in isolated molecules of the widely investigated perylene derivatives 3,4,9,10-perylene-tetracarboxylic dianhydride (PTCDA) and N,N'-dimethylperylene-3,4,9,10-dicarboximide (MePTCDI). A highly correlated quantum chemical method, i.e., intermediate neglect of differential overlap (INDO) multireference double-configuration-interaction (MRD-CI) technique, provides all excited states and the transition dipole moments between them. The excited state absorption spectra calculated for the fully relaxed excited state geometries are compared to experimental transient absorption spectra of matrix isolated molecules. The experimental spectra in the energy range between 1.2 eV and 2.1 eV (onset of linear absorption) can be clearly assigned to the calculated transitions.

SYOO 6.51 Mo 18:00 Poster TU A

**Energy transfer excitation of single molecules using colloidal semiconductor nanoantennae** — ●K. BECKER<sup>1</sup>, J. M. LUPTON<sup>1</sup>, D. V. TALAPIN<sup>2</sup>, H. WELLER<sup>2</sup>, A. L. ROGACH<sup>1</sup>, and J. FELDMANN<sup>1</sup> — <sup>1</sup>Photonics and Optoelectronics Group, Physics and CeNS, LMU München — <sup>2</sup>Institute of Phys. Chem., Univ. of Hamburg

Hybrid systems based on inorganic and organic materials offer advantages over pure systems consisting of only one type of material. We present experiments on the energy transfer in a system of single elongated rod-like semiconductor core-shell nanoparticles [1] embedded in a film of dye molecules showing that nanoparticles can act as tiny antennae collecting the excitation energy and delivering it to the dye molecules. When illuminating the sample, a local increase of the dye's photoluminescence at the spatial positions of the individual nanoparticles is observed, demonstrating energy transfer from the nanoparticles to the surrounding dye molecules. Correspondingly, the donor emission is considerably quenched and its fluorescence lifetime is shortened. Blinking and one-step photobleaching of the dye show typical fingerprints of single molecules. Energy transfer excitation of dye molecules therefore provides a unique way of addressing single emitters in an ensemble using spatially discrete nanoantennae.

[1] D. V. Talapin et al., Nano Lett. 3, 1677 (2003)



SYOO 6.52 Mo 18:00 Poster TU A

**Anisotropic optical properties of poly(3-hexylthiophene)/fullerene composite films** — ●ULADZIMIR ZHOKHAVETS<sup>1</sup>, TOBIAS ERB<sup>1</sup>, GERHARD GOBSCH<sup>1</sup>, HARALD HOPPE<sup>2</sup>, and N. SERDAR SARICIFTCI<sup>2</sup> — <sup>1</sup>Institute of Physics, Ilmenau Technical University, PO Box 100565, D-98693 Ilmenau, Germany — <sup>2</sup>Linz Institute for Organic Solar Cells (LIOS), Physical Chemistry, Johannes Kepler University Linz, Altenbergerstr.69, A-4040 Linz, Austria

P3HT/PCBM- (poly[3-hexylthiophene-2,5-diyl]/[6,6]-phenyl C61 butyric acid methyl ester) composites are promising materials for organic solar cells. The anisotropic optical properties of thin P3HT/PCBM-films were studied by spectroscopic ellipsometry. The optical anisotropy of the films is related to the preferred orientation of polymer molecules parallel to the substrate. Significant changes are observed both in parallel and perpendicular components of the dielectric function after annealing. In particular, the optical anisotropy is increased and the absorption maximum is shifted to lower photon energies for the annealed films. These changes are attributed to the formation of polymer crystallites upon annealing.

SYOO 6.53 Mo 18:00 Poster TU A

**Trap Limited Hole Mobility in Semiconducting Poly(3-hexylthiophene)** — ●VLADIMIR DYAKONOV<sup>1,2</sup> and ZIVAYI CHIGUVARE<sup>1</sup> — <sup>1</sup>Energy and Semiconductor Research, University of Oldenburg, D-26111 Oldenburg, Germany — <sup>2</sup>Experimental Physics, University of Würzburg, Am Hubland, 97074 Würzburg, Germany

Bulk transport properties of poly(3-hexylthiophene) (P3HT) were studied by analyzing temperature dependent current-voltage characteristics of the polymer thin films sandwiched between Indium Tin Oxide/polystyrene sulfonate doped Polyethylene dioxy-thiophene (ITO/PEDOT) and aluminium electrodes. It was found that the contacts limit charge injection under reverse bias, but under forward bias the current is limited by space charge that accumulates near the hole injecting electrode (ITO/PEDOT) resulting in a rectification of  $10^3$ . The forward current density obeys a power law of the form  $J \sim V^m$ , with  $m > 2$ , described by space charge limited current in the presence of exponentially distributed traps within the band gap. In this work we describe the deduction, and discuss the limits, of an expression for the calculation of the total trap density, based on the exponential trap distribution model, which yielded reasonable agreement with our experimental  $J(V)$  data. The total deep hole trap density was estimated to be  $3.5 \times 10^{16} \text{ cm}^{-3}$ , and the activation energy extrapolated to zero Kelvin was obtained to be 0.054 eV. Temperature dependent hole mobility in P3HT under trap-free space charge conditions was also estimated.

SYOO 6.54 Mo 18:00 Poster TU A

**Electronic properties of pristine and potassium doped organic semiconductor hetero-interfaces CuPc/C60 and C60/CuPc** — ●OLGA MOLODTSOVA<sup>1</sup>, TORSTEN SCHWIEGER<sup>1</sup>, VICTOR M. ZHILIN<sup>2</sup>, DENIS VJALIKH<sup>3</sup>, VICTOR YU. ARISTOV<sup>2</sup>, and MARTIN KNUPFER<sup>1</sup> — <sup>1</sup>Leibnitz Institute for Solid State and Materials Research, D-01069 Dresden, Germany — <sup>2</sup>Institute of Solid State Physics, Chernogolovka, Moscow District 142432, Russia — <sup>3</sup>Institute of Solid State Physics TU Dresden, D-01069 Dresden, Germany

In this contribution we report on the study of interface properties of the molecular organic semiconductor copper phthalocyanine (CuPc) deposited on C60 using photoemission spectroscopy (PES). Additionally we present the results obtained for the inversely prepared interface C60/CuPc with different orientation of the CuPc molecules (standing on polycrystalline gold substrate and lying on gold single crystal). We discuss important electronic parameters like electron and hole injection barriers and chemical interactions at these organic interfaces. Also we report on the study of changes of the electronic structure of CuPc at different levels of potassium (K) doping using PES and near-edge X-ray absorption spectroscopy (NEXAFS).

SYOO 6.55 Mo 18:00 Poster TU A

**Design, preparation and optical characterization of high finesse organic microcavities** — ●R. GEHLHAAR, M. KOSCHORRECK, V. G. LYSSENKO, H. FRÖB, M. HOFFMANN, and K. LEO — Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden, Germany, www.iapp.de

Planar microcavity structures provide a versatile means to investigate optical properties of semiconductors. When a material is placed in a microcavity, the available states are determined by the electromagnetic

modes of the cavity. So the internal electromagnetic field is amplified at the cavity mode and suppressed for nonresonant frequencies.

We report on high finesse double distributed Bragg reflector ( $R \approx 0.99$ ) structures, containing a half wavelength layer of the guest-host composite tris-(8-hydroxyquinoline) aluminum (AlQ3) and 4-dicyanmethylene-2-methyl-6-p-dimethylaminostyryl-4H-pyran (DCM) as active organic semiconductor. Photoluminescence measurements show a strong dependence of emission on angle of observation and polarization. In multi microcavity structures we observe the coupling of the cavity modes.

SYOO 6.56 Mo 18:00 Poster TU A

**Blue emitting organic nano-fibers grown by Hot Wall Epitaxy** — ●ANDREI ANDREEV<sup>1</sup>, FRANCESCO QUOCHI<sup>2</sup>, HARALD HOPPE<sup>3</sup>, HELMUT SITTER<sup>1</sup>, NIYAZI SERDAR SARICIFTCI<sup>3</sup>, ANDREA MURA<sup>2</sup>, and GIOVANNI BONGIOVANNI<sup>2</sup> — <sup>1</sup>Institute for Semiconductor and Solid State Physics, University Linz, Linz, Austria — <sup>2</sup>Dipartimento di Fisica, Università di Cagliari, Istituto Nazionale per la Fisica della Materia, I-09042 Monserrato, Italy — <sup>3</sup>Linz Inst. f. Organic Solar Cells (LIOS), Physical Chemistry, University Linz, Austria

We focus our study on epitaxially grown structures based on paraxiphenyl (PSP) deposited by Hot Wall Epitaxy (HWE). HWE allows to grow epilayers close to thermodynamic equilibrium, which is essential in the case of van der Waals epitaxy of oligophenylenes. Moreover, PSP molecules perform a self-organization during HWE on mica substrates. Among other optical properties of the nano-fibers, we report the observation of lasing in crystalline PSP grown by HWE on mica. Well defined parallel oriented nano-fibers with average base width and height of about 220 nm and 110 nm, respectively, pumped with sub-picosecond laser pulses, feature lasing threshold fluencies as low as  $0.5 \mu\text{J}/\text{cm}^2$  per pulse on the emission band near 425 nm, up to room temperature.

SYOO 6.57 Mo 18:00 Poster TU A

**Phosphorescence lifetime measurements of Ir-based phosphorescent dyes in PVK matrix** — ●SÖNKE KLINGER, XIAO-HUI YANG, FRANK JAISER, and DIETER NEHER — University of Potsdam, Am Neuen Palais 10, D-14469 Potsdam, Germany

Most light-emitting diodes based on PVK doped with phosphorescence dyes contain additional carrier-transporting components to improve the electroluminescence performance. We performed phosphorescence lifetime measurements to obtain information on how the phosphorescent dye interacts with these molecules. In particular PVK+Ir(ppy)<sub>3</sub> or FIrPic doped with several charge trapping and transporting moieties such as PBD, OXD, TPD were studied with different concentrations of all components. The lifetime of the PVK+FIrPic+PBD sample is much longer than those of PVK+FIrPic and PVK+OXD+FIrPic. At the same time, photoluminescence efficiency of the former sample decreases when the dye is directly excited at 405 nm. This can be explained by the fact of poor confinement of the triplet excited state on FIrPic due to the lower triplet energy of PBD. Consistent with lifetime measurements, LEDs with OXD showed much higher efficiency (12-14 cd per A) than that with PBD (4-6 cd per A).

SYOO 6.58 Mo 18:00 Poster TU A

**Experimental study of charge carrier trapping in PVK/TPD blends** — ●L. KULIKOVSKY<sup>1</sup>, F. JAISER<sup>1</sup>, D. NEHER<sup>1</sup>, S. KOEBER<sup>2</sup> and K. MEERHOLZ<sup>2</sup> — <sup>1</sup>University of Potsdam, Am Neuen Palais 10, D-14469 Potsdam — <sup>2</sup>University of Köln, Luxemburgerstr.116, D-50939, Köln

PVK is an important host material for molecular doped phosphorescent light-emitting diodes. However, little is known about the charge transport in this material. Here, we report on the experimental study of charge carrier trapping in PVK based materials doped with TPD. Blends with different low concentrations of TPD have been investigated. Using pulsed irradiation, regimes in which the photocurrent dynamic is dominated either by photogeneration, recombination or trapping can be distinguished. The measurements are interpreted by use of an adopted Schildkraut model (1). It is shown that on a short time scale the current dynamics is determined by photogeneration and trapping in shallow PVK traps and TPD traps. The current decrease at the pulse end is limited by recombination and later by detrapping. Surprisingly, trapping by the TPD traps is significant already in the very early stage of the transient carrier dynamics, indicating the absence of an energetic barrier for the capture of charges by the TPD molecules. By varying the illumination conditions, we have determined all trapping parameters for PVK and TPD.

(1) L. Kulikovskiy et.al, Photocurrent dynamics in a poly(phenylene vinylene)-based photorefractive composite, PRB 69 (2004) 125216-1-11

SYOO 6.59 Mo 18:00 Poster TU A

**Structural relaxations in electronically excited poly(para-phenylene)** — ●MICHAEL ROHLFING<sup>1</sup>, EMILIO ARTACHO<sup>2</sup>, MICHEL CÔTÉ<sup>3</sup>, PETER D. HAYNES<sup>4</sup>, RICHARD J. NEEDS<sup>4</sup>, and CARLA MOLteni<sup>5</sup> — <sup>1</sup>School of Engineering and Science, International University Bremen, P.O.Box 750561, 28725 Bremen, Germany — <sup>2</sup>Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ, UK — <sup>3</sup>Département de Physique, Université de Montréal, C.P. 6128, succ. Centre-Ville, Montreal, Quebec, H3C 3J7, Canada — <sup>4</sup>TCM Group, Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge, CB3 0HE, UK — <sup>5</sup>Physics Department, King's College London, Strand, London WC2R 2LS, UK

Structural relaxations in electronically excited poly(para-phenylene) are studied using many-body perturbation theory and density-functional-theory methods. A sophisticated description of the electron-hole interaction is required to describe the excitonic energies, but the associated structural relaxations can be obtained quite accurately within a constrained density-functional-theory approach. We find that the structural relaxations in the low-energy excitonic states extend over about 8 monomers, leading to an energy reduction of 0.22 eV and a Stokes shift of 0.40 eV.

SYOO 6.60 Mo 18:00 Poster TU A

**Threshold reduction in polymer lasers based on poly(9,9-dioctylfluorene) with statistical binaphthyl units** — ●MATTHIAS HOPING<sup>1</sup>, TORSTEN RABE<sup>1</sup>, DANIEL SCHNEIDER<sup>1</sup>, EIKE BECKER<sup>1</sup>, HANS-HERMANN JOHANNES<sup>1</sup>, WOLFGANG KOWALSKY<sup>1</sup>, THOMAS WEIMANN<sup>2</sup>, JING WANG<sup>2</sup>, PETER HINZE<sup>2</sup>, BENJAMIN NEHLS<sup>3</sup>, ULLRICH SCHERF<sup>3</sup>, TONY FARELL<sup>3</sup>, and THOMAS RIEDL<sup>1</sup> — <sup>1</sup>Institut für Hochfrequenztechnik, Technische Universität Braunschweig, Schleinitzstrasse 22, 38092 Braunschweig — <sup>2</sup>Physikalisch Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig — <sup>3</sup>Bergische Universität Wuppertal, Gauss Strasse 20, 42097 Wuppertal

We introduce novel statistical copolymers of poly(9,9-dioctylfluorene) (PFO) which contain binaphthyl spacer groups in different concentrations. The incorporation of these spacer groups results in a large dihedral angle between neighbouring naphthalene units and leads to a suppression of the highly ordered  $\beta$ -phase formation in thin films of the copolymers. In low temperature photoluminescence measurements we observed a shift of the spectra from the typical signature of the  $\beta$ -phase PFO at 442 nm to smaller wavelengths with a binaphthyl concentration of ca. 12 percent. The beneficial effect of the suppressed  $\beta$ -phase is reflected in the minimum lasing thresholds of second order distributed feedback (DFB) lasers based on thin films of the copolymers. While the minimum lasing threshold energy of the homopolymer is found at 11.7  $\mu\text{J}/\text{cm}^2$  an incorporation with binaphthyl units in the copolymer backbone leads to a lasing threshold of 3  $\mu\text{J}/\text{cm}^2$  for a binaphthyl concentration of ca. 12%.

SYOO 6.61 Mo 18:00 Poster TU A

**Spectroscopic properties of different perylene derivatives** — ●HARALD GRAAF<sup>1</sup>, CHRISTINE MATTHEUS<sup>2</sup>, THOMAS UNOLD<sup>3</sup>, and DERCK SCHLETTWEIN<sup>3</sup> — <sup>1</sup>Institut für Physik, TU Chemnitz, 09107 Chemnitz — <sup>2</sup>Department Solar Energy, Hahn-Meitner-Institut Berlin, 14109 Berlin — <sup>3</sup>Institut für Angewandte Physik, Justus Liebig Universität Gießen, 35392 Gießen

Intermolecular interactions of molecules of perylene carboxylic acid derivatives (PTCD) and therefore their spectroscopic properties can be strongly influenced by chemical modification at the aromatic core. While unsubstituted PTCD showed strong chromophore coupling in the solid state, bay-chlorinated Cl4PTCD is characterized by weak intermolecular interactions which can be clearly seen in optical studies. Temperature dependent luminescence measurements at thin films of both materials were obtained. The results indicate the formation of different radiative decay channels due to different arrangements of molecules in the solid state as it was shown before for PTCD [1].

[1] A. Yu. Kobitski, R. Scholz, H.P. Wagner, D.R.T. Zahn, Phys.Rev.B 68, 155201 (2003)

SYOO 6.62 Mo 18:00 Poster TU A

**Design of the electronic structure of poly-MTO** — ●R. MILLER, CH. HELBIG, J. HERRMANN, G. EICKERLING, K. TRÖSTER, R. HERMANN, E.-W. SCHEIDT, and W. SCHERER — CPM, Institut für Physik, Universität Augsburg, 86135 Augsburg, Germany

Polymeric methyltrioxorhenium (poly-MTO),  $(\text{CH}_3)_x\text{ReO}_3$  ( $x \approx 0.92$ ), is the first member of a new class of organometallic hybrids which adopts the structural motives and physical properties of classical perovskites in two dimensions [1]. Several attempts have been undertaken to use its unique chemical properties to design new materials by manipulating its chemical composition. In this study we demonstrate how the electronic structure of poly-MTO can be tailored by intercalation of organic and organo metallic donor molecules such as tetrathiafulvalene (TTF) [2] and Cobaltocen (CoCp2). With increasing TTF/CoCp2 intercalation the metallic behavior of the parent compound  $(\text{CH}_3)_x\text{ReO}_3 \cdot \text{D}_y$  ( $\text{D} = \text{TTF}$  or CoCp2) becomes suppressed leading to an insulator at donor concentrations  $y$  larger than 0.5. Specific heat, electric resistance and magnetic susceptibility studies indicate that an increasing amount of TTF/CoCp2 causes the itinerant electrons of the poly-MTO matrix to localize. [1] W. A. Herrmann, W. Scherer, R. W. Fischer, J. Blümel, M. Kleine, W. Mertin, R. Gruehn, J. Mink, H. Boysen, C. C. Wilson, R. Ibberson and L. Bachmann, J. Am. Chem. Soc 117., 3231, (1995). [2] R. Miller, Ch. Helbig, G. Eickerling, R. Herrmann, E.-W. Scheidt and W. Scherer, Physica B, in print.

SYOO 6.63 Mo 18:00 Poster TU A

**A XANES study of a family of Copper Porphyrazines** — ●D.R. BATCHELOR<sup>1</sup>, D. POP<sup>2</sup>, B. WINTER<sup>2</sup>, H. PEISERT<sup>3</sup>, I. BISWAS<sup>3</sup>, and W. FREYER<sup>2</sup> — <sup>1</sup>EP2 Univ. Würzburg — <sup>2</sup>MBI for Nonlinear Optics, Berlin — <sup>3</sup>Institut für Physikalische und Theoretische Chemie, Univ. Tübingen

The metal Porphyrazines have long been used in the chemical industry as dyes. This together with their close relation to the Porphyrins make them interesting candidates for various applications in molecular electronics and sensor developments. A family of linear benzo-annelated copper porphyrazine molecules were studied using XANES in an effort to understand the role of charge transfer between the central copper atom and the conjugated ring of nitrogen atoms as a function of annelation.

The XANES of both Copper and Nitrogen edges will be presented and compared with literature data. The Nitrogen edge data will be discussed using results of calculations with STOB code.

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**Patterning of thin films for organic electronic and photonic devices by microcontact printing and selective surface dewetting** — ●AMARE BENOR, DIETMAR KNIPP, and VEIT WAGNER — International University Bremen, School of Science and Engineering,

Non-lithographic methods for patterning of thin films are desirable to realize inexpensive organic electronic and photonic devices on the micro and nanoscale. Microcontact printing ( $\mu\text{CP}$ ) was used to pattern Ag, Au and ITO films on silicon and glass substrates. In the first step of the patterning scheme self-assembly monolayers (SAMs) like octadecyltrichlorosilane (OTS,  $\text{CH}_3(\text{CH}_2)_{17}\text{SiCl}_3$ ) were microcontact printed on different substrates to define hydrophobic and hydrophilic areas. The modified surface energies lead to selective dewetting of the substrate which was used to pattern resists like Poly(methyl methacrylate), PMMA. A standard lift-off process was applied to finally pattern the Ag, Au and ITO films. Such scheme can be used to pattern electrodes for organic light emitting diodes or organic thin film transistors. The influence of the different processing parameters on the resolution of the patterning scheme will be discussed. Moreover, the influence of microcontact printed Au drain and source contacts on the performance of small molecule based organic thin film transistors will be discussed in greater detail.

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**Gain switching as lasing mechanism in organic microcavities** — ●M. KOSCHORRECK, R. GEHLHAAR, V. G. LYSSENKO, M. HOFFMANN, and K. LEO — Institut für Angewandte Photophysik, TU Dresden, 01062 Dresden, Germany, www.iapp.de

We report on the dynamic processes in the organic laser host-guest composite of tris-(8-hydroxy quinoline) aluminium ( $\text{Alq}_3$ ) and 4-(dicyanomethylene)-2-methyl-6-(p-dimethylaminostyryl)-4H-pyran (DCM) embedded in a double distributed Bragg reflector microcavity, which builds an organic vertical cavity surface emitting laser. Lasing action was observed at a threshold of 0.4 nJ corresponding to 20  $\mu\text{J}/\text{cm}^2$

with a line-width of 0.05 nm (resolution limit). Using a sub-picosecond up-conversion technique we get a comprehensive insight into the dynamics of the build-up of LASER emission. We observed a nonlinearly intensity dependent delay of the emitted radiation burst and a step-like threshold behavior, known from the gain switching mechanism. All experimental results were successfully modeled by a set of coupled rate equations and gave a complete picture of the dynamic processes.

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**Functional Nanostructures for Electronic Devices** — •FRANK SPERKA<sup>1</sup>, ELENA MENA-OSTERITZ<sup>2</sup>, and OTHMAR MARTI<sup>1</sup> — <sup>1</sup>Dept. Experimental Physics, University of Ulm — <sup>2</sup>Dept. Organic Chemistry, University of Ulm

The aim of this project is to produce nanostructured surfaces on structured substrates adapted to molecular structures. Furthermore we want to study the local electric and optical properties of those surfaces.

Various series of self-assembly-structures of macrocycles Cyclo(terthiophen-diine) like C[3T-DA]<sub>n</sub>, Cyclo(quinquethiophen-diine), C[5T-DA]<sub>n</sub> and Cyclo[n]thiophenes C[n]T were studied with STM. Different patterns and nanostructures for different molecule-symmetries and diameters (1-5 nm) of the cycles were found.

The characterization of the devices will be done with a combined AFM/STM. A combined AFM/STM distance-control can avoid the damage of the tip in a nonconductive region of a sample. The concept of such an AFM/STM-combination is described. Combined with SNOM-techniques and/or confocal fluorescence microscopy an extensive electro-optical characterization will be possible.