

## HL 44: Organic semiconductors I

Time: Thursday 10:45–13:00

Location: POT 51

HL 44.1 Thu 10:45 POT 51

**Charge transfer and polarization screening at organic-metal interfaces** — ●HEIKO PEISERT, DANIEL KOLACYAK, and THOMAS CHASSÉ — University of Tübingen, Institute of Physical and Theoretical Chemistry, Auf der Morgenstelle 8, 72076 Tübingen, Germany

Core hole screening effects at organic/metal interfaces were studied using core level X-ray photoemission spectroscopy (XPS), x-ray excited Auger electron spectroscopy (XAES) and valence band ultraviolet photoemission spectroscopy (UPS). The comparison of energetic shifts in XPS and XAES enables the estimation of electronic relaxation energy (screening ability). Magnesium phthalocyanine (MgPc), zinc phthalocyanine (ZnPc) and perfluorinated zinc phthalocyanine (ZnPcF16) evaporated on single crystalline Au(100) were used as model molecules. Two different features in the metal Auger spectra can be clearly separated for (sub-)monolayer coverages while only minor changes of the shape of corresponding photoemission features are observed. In contrast, Auger spectra of fluorine in ZnPcF16 do not show different components for ultrathin films. Applying a dielectric continuum model, the major screening mechanism cannot be described sufficiently by polarization screening due to mirror charges, significant contributions by charge transfer screening have to be considered. The work was supported by the German Research Council Ch 132/20-1.

HL 44.2 Thu 11:00 POT 51

**In-situ study of electronic properties of pentacene transistors during growth** — ●DANIEL BECKMEIER<sup>1,2</sup>, MATTHIAS FIEBIG<sup>1</sup>, and BERT NICKEL<sup>1</sup> — <sup>1</sup>Department für Physik, Ludwig-Maximilians-Universität, D-80539 München — <sup>2</sup>Institut für Physik, Universität der Bundeswehr München, D-85579 Neubiberg

Organic thin film transistors (TFT) with pentacene as semiconductor material were grown by molecular beam deposition (MBD). They were electrically characterized in situ during growth at vacuum conditions to analyze the dependence of the electronic properties on the film thickness of the pentacene layer.

TFT structures were electrically connected inside the MBD chamber. The channel length of the structures was 25  $\mu\text{m}$ . A 150 nm thick silicon oxide was used as gate dielectric. To improve the pentacene film growth, polymer layers (polystyrene and cyclic olefin copolymer) were spin-coated on top of the oxide. Pentacene was evaporated onto the structures. Simultaneously, the transfer and output characteristics were measured. The data was analyzed using TFT theory to extract the mobility and threshold voltage as a function of film thickness. Starting from about 1 nm film thickness, a linear increase of mobility with film thickness was observed. The mobility saturated at film thicknesses between 8 and 30 nm, depending on substrate and growth conditions. Once transferred to ambient conditions, the TFTs showed a strong hysteresis, a reduction in mobility and a shift of the threshold voltage towards more positively biased values.

HL 44.3 Thu 11:15 POT 51

**Potential Measurements in the channel of organic field-effect transistors in top gate geometry** — ●RICHAR SHARMA, BENEDIKT GBUREK, TORSTEN BALSTER, and VEIT WAGNER — Jacobs University Bremen, Bremen, Germany

It has been found that the ordering of the semiconductor adjacent to the dielectric interface, where charge transport takes place, is crucial. Additional information on charge transport by measuring the voltage distribution over the channel can be obtained. This is not trivial in top-gate geometry due to the buried semiconductor layer. To enable potential measurements in this geometry, source and drain electrodes along with two sense fingers are patterned in the channel by optical lithography. In the experiment the drain current along with the potential values at the sense fingers are recorded simultaneously during drain and gate voltage variations. Model simulations of the transistor yielding current and potential values are compared to the experimentally obtained values. The measured voltage distributions show considerable deviations from the calculated values obtained by the gradual channel approximation. These deviations are mainly attributed to contact effects and major modifications of the voltage distribution in the channel in the sub-threshold regime.

HL 44.4 Thu 11:30 POT 51

**Electronic Spectroscopy of Organic Semiconductors in Helium Nanodroplets** — ●MATTHIEU DVORAK<sup>1</sup>, OLIVER BÜNERMANN<sup>1</sup>, FRANK STIENKEMEIER<sup>1</sup>, and ALEXANDER EISFELD<sup>2</sup> — <sup>1</sup>Physikalisches Institut, Universität Freiburg, Hermann-Herder Str. 3, D-79104 Freiburg — <sup>2</sup>MPI-PKS, Nöthnitzer Str. 38, D-01187 Dresden

Spectroscopy of molecules or molecular complexes embedded in helium nanodroplets is an outstanding tool to characterize electronic and geometric structures. Due to the unique properties of the superfluid droplets, helium nanodroplets isolation (HENDI) spectroscopy reaches far better spectral resolution than usually obtained in organic solvents or on thin films.

We applied HENDI to investigate the absorption and emission spectra of the PTCDA molecule and its complexes. The PTCDA monomer shows sharp vibronic lines ( $<1\text{ cm}^{-1}$ ) that can be assigned to different internal vibration modes as well as overtones and combination modes. PTCDA complexes show different spectral features. Sharp lines, red shifted compared to the monomer absorptions are assigned to T-structured dimers. Additionally, very broad absorption lines are observed. These are assigned to complexes forming sandwich structures [1]. Recent theoretical calculations can reproduce the spectra and support this interpretation. Furthermore, in comparison to absorption spectra, emission intensities allow to study the amount of internal relaxation before emitting a photon, giving further insight into the involved processes.

[1] M. Wewer and F. Stienkemeier, Phys. Rev. B 67, 125201, 2003

15 min. break

HL 44.5 Thu 12:00 POT 51

**The impact of oxygen on trap states in P3HT:PCBM blends** — ●JULIA SCHAFFERHANS<sup>1</sup>, ROLAND MARX<sup>1</sup>, CARSTEN DEIBEL<sup>1</sup>, and VLADIMIR DYAKONOV<sup>1,2</sup> — <sup>1</sup>Julius-Maximilians-University of Würzburg, Institute of Physics, Experimental Physics VI, D-97074 Würzburg — <sup>2</sup>Bavarian Centre for Applied Energy Research e.V. (ZAE Bayern), D-97074 Würzburg

Conjugated polymers receive a growing interest for application in organic solar cells due to their low cost processability from solution. Efficiencies of almost 6% for organic solar cells have already been achieved. A limiting factor, so far, is the lifetime of these devices. To investigate the stability and to obtain an understanding of the underlying degradation mechanism is an important prerequisite for a stable performance. Accordingly, the presence of defect states can be critical, as they reduce the charge carrier mobility, affect the driving voltage, disturb the internal field distribution and can act as recombination centers. We present investigations on the influence of oxygen on defect states in P3HT:PCBM blends, one of the most promising candidates for organic solar cells, by applying the thermally stimulated current technique. The results for the blends are compared with those obtained for pristine P3HT samples. The influence of the trap states on the charge carrier mobility as well as the reversibility of the oxygen-induced degradation are discussed.

HL 44.6 Thu 12:15 POT 51

**Degradation of phosphorescent blue organic light-emitting diodes** — ●CHIEN-SHU CHIU<sup>1,3</sup>, FRANK STEINBACHER<sup>2,3</sup>, RALF KRAUSE<sup>3</sup>, ARVID HUNZE<sup>3</sup>, and WOLFGANG KOWALSKY<sup>1</sup> — <sup>1</sup>Department of Electrical Engineering & Information Technology, Technical University of Braunschweig, Germany — <sup>2</sup>Department of Materials Science VI, University of Erlangen-Nuremberg, Germany — <sup>3</sup>Siemens AG, CT MM 1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany

Development of phosphorescent materials has significantly improved the efficiency of organic light-emitting diodes (OLEDs). By using efficient red, green and blue phosphorescent emitter materials high efficient white OLEDs can be achieved. However, due to low stability of blue phosphorescent materials the lifetime of phosphorescent white OLEDs remains an issue. As a result, degradation of blue phosphorescent materials needs to be further investigated and improved.

In this work, blue OLED devices based on the phosphorescent emitter FIrpic were investigated. Single-carrier hole-only as well as electron-only devices were fabricated. For investigation of degradation process the devices were stressed with electrical current and UV-light

to study the impact of charge carriers as well as excitons and exciton-polaron quenching on the stability of the blue dye.

HL 44.7 Thu 12:30 POT 51

**Oxygen-Influence on P3HT studied by Photoluminescence and Electron Spin Resonance** — ●ANDREAS SPERLICH<sup>1</sup>, HANNES KRAUS<sup>1</sup>, CARSTEN DEIBEL<sup>1</sup>, and VLADIMIR DYAKONOV<sup>1,2</sup> — <sup>1</sup>Experimental Physics VI, Physical Institute, Julius-Maximilians-University of Würzburg, Am Hubland, D-97074 Würzburg — <sup>2</sup>ZAE Bayern, Div. Functional Materials for Energy Technology, Am Hubland, D-97074 Würzburg

The influence of oxygen on polymers is crucial to understand and prevent aging effects of organic polymer:fullerene solar cells. We simultaneously performed photoluminescence (PL) and light-induced electron spin resonance (L)ESR studies of the influence of oxygen on thin films of poly(3-hexylthiophene) (P3HT). The samples were illuminated by a 532nm green laser at 100K. In vacuum, P3HT shows a strong PL, as the optically excited singlet excitons (spin=0) recombine completely radiatively, whereas no ESR-signal is observed. When introducing oxygen, the PL is quenched within seconds and a growing ESR-signal from polarons on the P3HT can be observed. This is due to oxygen absorbing an electron by the polymer, leaving an ESR-active hole behind. The influence of oxygen on the polymer is slow in dark and very rapid under illumination. When turning off the illumination, the ESR-signal remains almost constant, which indicates that the signal is corresponding to deep traps. The process is mostly reversible by applying vacuum

and 140°C for several minutes. We discuss our findings with respect to the application in organic solar cells.

HL 44.8 Thu 12:45 POT 51

**Enhanced magnetoresistance in organic light emitting diodes** — ●ULRICH NIEDERMEIER<sup>1,2</sup>, WIEBKE SARFERT<sup>1</sup>, SERGEY BAGNICH<sup>2</sup>, CHRISTIAN MELZER<sup>2</sup>, and HEINZ VON SEGGERN<sup>2</sup> — <sup>1</sup>Siemens AG, CT MM 1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — <sup>2</sup>Technische Universität Darmstadt, Fachbereich Material- und Geowissenschaften, Petersenstr. 23, 64287 Darmstadt, Germany

Magnetic fields can influence the electro-optical properties of organic light emitting diodes via the organic magnetoresistance effect. We investigated the magnetoresistance in poly(paraphenylene vinylene)-based devices as a function of magnetic field and driving voltage. Electrical conditioning at high current densities has been identified as an efficient method to significantly enhance the magnetoresistance effect [1]. Depending on duration and intensity of the conditioning process the absolute value of the magnetoresistance effect can be increased from 1% to values even exceeding 20% at 4V and 40mT. Qualitatively, the increase in magnetoresistance during conditioning can be correlated with a decrease in electro- and photoluminescence. We attribute these results to a change in the charge carrier transport properties of the bulk emitter material during conditioning. Finally, we discuss our results in the framework of recently published theories on the possible origin of the organic magnetoresistance effect.

[1] U. Niedermeier *et al.*, Appl. Phys. Lett. **92**, 193309 (2008).