# DS 44: Organic Thin Films I

Time: Friday 10:15–11:45 Location: H8

DS 44.1 Fri 10:15 H8

**Charge Transport Investigation in Organic Semiconductors by Electro-Reflectance** — •Steve Pittner and Veit Wagner — School of Engineering, Jacobs University Bremen, Campus Ring 1, D-28759 Bremen, Germany

Organic semiconductors have proven to be suitable materials for electronic devices, such as organic solar cells, organic field effect transistors (OFET), and organic light emitting diodes. Generally organic semiconductors exhibit rather low charge mobility and it is crucial to understand the details of charge transport within organic material for further improvements. Disordered organic materials often exhibit a charge carrier density dependent mobility (see e.g. Vissenberg/Matters) and the aim of this work is to analyse the contribution of carriers with different mobilities during the electrical charge transport between electrodes. For this purpose the spectral fingerprint of the charge carriers under investigation is detected locally by electro-modulation spectroscopy. This is done in an OFET-like geometry with an applied alternating voltage. Clear changes of the fingerprint spectrum with the DC gate voltage as well as with the lateral distance to an electrode are detected. The changes occur at a photon energy around 1.9 eV for a poly(3-hexylthiophene) (P3HT) semiconducting layer. The depletion of the high energy shoulder clearly reflects the charge carrier population modification with gate voltage and/or distance to the injecting electrode. The changes are interpreted as time-dependent settling of the injected charge carriers to lower energy polaronic states related to the band tails of the material.

DS 44.2 Fri 10:30 H8

**Simultaneous in-situ real-time measurements of X-ray reflectivity and optical spectra of organic semiconductor thin film during growth** — •Takuya Hosokai, Alexander Gerlach, Alexander Hinderhofer, Christian Frank, Ute Heinemeyer, and Frank Schreiber — Institut fuer Angewandte Physik, Universitaet Tuebingen, Auf der Morgenstelle 10, 72076 Tuebingen Germany

The relation between optical and structural properties of organic semiconductors in thin films is crucial for their fundamental understanding as well as their application in electronic devices. Here we present first results of simultaneous in-situ real-time measurements of X-ray reflectivity (XRR) and differential reflectance spectroscopy (DRS) of perfluorinated copper phthalocyanine ($F_{16}$CuPc) thin films grown on $SiO_2$/Si wafers. Using DRS we determine the optical absorption spectra of the thin films starting from monolayer coverage whereas real-time XRR provides structural information about the film growth. After a rapid decrease of the reflectivity in the monolayer regime we observe intensity oscillations in time at constant qz with a strong damping. By calibrating film thickness d(t), we found oscillation period of 1.45 nm at 1/2q Bragg, which correspond to the lattice spacing of standing $F_{16}$CuPc molecules. This behaviour is characteristic for layer-growth with a finite roughness. In the monolayer regime the DRS signal shows a broad absorption peak at ∼2.0 eV, while for coverages of more than one monolayer an additional and relatively sharp peak appears at ∼1.6 eV. These results indicate that the film structure in the monolayer regime is different from the layer-growth regime.

DS 44.3 Fri 10:45 H8

**In-situ Photoconduction Measurements of Mixed Films to Detect Isolated Clusters of Molecular Semiconductors** — •Dominik Klaus, Christopher Keil, and Derck Schlettwein — Institute of Applied Physics, Justus-Liebig-University Giessen, Germany. email:schlettwein@uni-giessen.de

A cone-shaped subphthalocyanine (*SubPcBCl*) absorbing in the green was used as an electron donor and a planar perfluorinated phthalocyanine ($F_{16}PcCu$) absorbing in the red as an electron acceptor to discuss their applicability as a photosensitive material. Mixed thin films (60 nm) of increasing contents of *SubPcBCl* were studied that were prepared by physical vapour deposition on electrode structures on glass. Conduction measurements were performed under illumination at three distinct wavelengths across the visible range of the solar spectrum during growth and conditioning of the films. Photocurrents were observed that indicated the expected contributions to the net photoconduction of both molecules but also anomal, negative contributions were found, leading to a decreased conduction under illumination, showing the presence of isolated clusters for films rich in *SubPcBCl*. This behaviour indicates a light-induced trapping of electrons in insulating pockets under illumination with green and blue light.

DS 44.4 Fri 11:00 H8

**Coupling effects in heterostructures of Pentacene and perfluorinated Pentacene studied by optical spectroscopy** — •Katharina Broch[1], Ute Heinemeyer[1], Alexander Hinderhofer[1], Falk Anger[1,2], Oriol Ossó[2], Reinhard Scholz[3], Alexander Gerlach[1], and Frank Schreiber[1] — [1]Institut für Angewandte Physik, Auf der Morgenstelle 10, 72076 Tübingen — [2]MATGAS 2000 AIE, Campus de la UAB, 08193 Bellaterra — [3]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching

Heterostructures of organic semiconductors gain increasing interest in the last years because of their potential applications in organic electronics. To optimize those devices the understanding of the intermolecular coupling is crucial. Therefore, we investigate the optical absorption spectra of heterostructures and possible differences to the spectra of their single components. The combination of pentacene (PEN) with perfluorinated pentacene (PFP) is promising due to their similar geometric structure which can give rise to coevaporated films with a significant level of intermixing and accordingly an efficient intermolecular coupling. Indeed, performing in-situ-measurements with differential reflectance spectroscopy and spectroscopic ellipsometry we find features in the absorption spectra of mixed films that cannot be explained by a linear combination of the single film spectra. In the energy range between 1.4 eV and 2.4 eV spectra of PFP and PEN single and coevaporated films with different mixing ratios are compared and possible theoretical scenarios for coupling effects are discussed.

DS 44.5 Fri 11:15 H8

**In Situ Spectroscopic Investigation of CuPc Thin Films Grown on Vicinal Si(111)** — •Li Ding, Marion Friedrich, Ovidiu Gordan, and Dietrich R. T. Zahn — Semiconductor Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany

Spectroscopic ellipsometry (SE) and reflection anisotropy spectroscopy (RAS) [1] are both surface sensitive and non-destructive techniques. SE is used to determine the dielectric functions, from which the out-of-plane anisotropy of thin films can be deduced. RAS is capable to measure the very tiny in-plane anisotropy in the order of $10^{-3}$.

SE and RAS are employed simultaneously to monitor the growth process of Copper phthalocyanine (CuPc) thin films on passivated vicinal Si(111), in order to investigate the change in anisotropy and molecular orientation with increasing film thickness. The films were grown by organic molecular beam deposition (OMBD). The RAS features of CuPc are linearly dependent on the film thickness in the range of 30 nm, indicating a strong influence of the surface steps on the in-plane molecular alignment in the film. The in situ SE spectra are analyzed to investigate the change in the out-of-plane molecular orientation.

References

[1] P. Weightman, D. S. Martin, R. J. Cole, and T. Farrell, Rep. Prog. Phys. 68, 1251 (2005).

DS 44.6 Fri 11:30 H8

**Model simulations of magneto-optical Kerr effect spectra of organic films** — •Klaus Seidel, Michael Fronk, Dietrich R. T. Zahn, and Georgeta Salvan — Physics Department, Chemnitz University of Technology, D-09107 Chemnitz, Germany

The rotation of the light polarization upon transmission through a magnetized sample is known as the Faraday effect, and the change in the ellipticity as magnetic circular dichroism (MCD). The change in the polarization state induced by reflection on a sample under magnetic field is known as magneto-optical Kerr effect (MOKE). These effects have their origin in the modification of the dielectric properties of the material in the presence of a magnetic field and can be described by a material parameter Q, the so-called Voigt constant, which occurs in the off-diagonal components of the macroscopic dielectric tensor. The MCD spectra are commonly simulated using the Faraday A, B, and C terms and compared to the experimental spectra in order to determine the number of the optical transitions, their energy position,

and their electronic origin. In this work we apply the same approach to simulate the Voigt constant of Copper-Phthalocyanine films. In a second step we calculate, with the same set of parameters describing the optical transitions, the MOKE spectra and minimize the least square deviation from the experimental data.