SYOO 1 Organic Field-Effect Transistors

Zeit: Montag 09:45–11:15 Raum: TU C130

SYOO 1.1 Mo 09:45 TU C130

A pentacene ambipolar transistor: experiment and theory — •Roland Schmechel, Marcus Ahles, and Heinz von Seggern — TU-Darmstadt, Institut für Materialwissenschaft, Petersenstr. 23, D-64287 Darmstadt, (Germany)

A pentacene ambipolar transistor with top-gold and top-calcium contacts is realized by utilizing a parallactic effect of the shadow mask during vapor deposition. The pentacene has been deposited on top of a silicon dioxide gate-insulator, while the pentace/SiO2 interface has been Cadoped to compensate electron traps. An equivalent circuit model based on a resistor-capacitor network is used to describe the basic electrical properties of the transistor. Shockley-like analytical expressions for the output and transfer characteristics as well as analytical expressions for the potential and charge distributions in the channel are derived under the assumption of a high electron - hole recombination probability. The model is fitted to the experimental results and yields comparable hole and electron mobilities, both in the order of $0.1 cm^2/Vs$. The increasing threshold voltages with increasing gate voltages are discussed as an indication for an increasing amount of captured charge carriers in the channel.

SYOO 1.2 Mo 10:00 TU C130

Redox behaviour and charge transport in molecular azo glasses — •Michael Arlt, Tobat P.I. Saragi, Irina Suske, Josef Salbeck, and Thomas Fuhrmann-Lieker — Makromolekulare Chemie und molekulare Materialien, FB Naturwissenschaften, Universität Kassel, Heinrich-Plett-Str. 40, 34109 Kassel

Low bandgap materials are interesting for bipolar charge transport in organic electronic devices. We demonstrate that the molecular azo glass N,N′-bis(4-phenyl)-N,N′-bis[(4-phenylazo)-phenyl]benzidine (AZOPD) can act as hole-transport as well as electron-transport material. Electrochemical measurements show reversible oxidation and reduction behaviour with redox potentials corresponding to an ionization energy of 5.2 eV and an electron affinity of 3.1 eV. p- and n-type organic field-effect transistor (OFET) structures are investigated in which holes and electrons are injected from Au bottom and Mg top contacts, respectively. The transistor characteristics are sensitive to light due to the photoisomerization property of the material.

SYOO 1.3 Mo 10:15 TU C130

Deposition of fluorinated phthalocyanines on insulating substrates for OFET applications — •Christine Mattheus[1], Christian Kelting[1], Wilfried Michaelis[2], Dieter Wöhrle[2], and Derck Schlettwein[1] — [1]Institute of Applied Physics, Justus-Liebig-University of Giessen, Germany — [2]Institute of Organic and Macromolecular Chemistry, University of Bremen, Germany

Phthalocyanines (Pc) are known to yield highly crystalline thin films under appropriate deposition condition. Fluorination of Pc increases the ionization potential, allows facile electrochemical reduction of the films and consequently leads to n-type conduction in thin films. This is of importance for applications in organic field-effect transistors (OFET), where n-type conductors are needed for logic circuits. Aside from this electronic effect, the F-atoms also decrease the intermolecular interactions considerably. This can lead to a large variation in the structure and morphology of thin films, allowing to tailor the film structure by the choice of the central atom group, the type of substrate and the deposition conditions. We have used UV-Vis absorption spectroscopy, atomic force microscopy, and I(V)-characteristics to analyse thin films on dielectric substrates suitable for OFET. We present data on the crystal structure, morphology and charge carrier mobility of fluorinated Pc on organic polymer substrates and reference surfaces.

SYOO 1.4 Mo 10:30 TU C130

Investigation of interface and bulk properties in polymer field effect devices — Martin Roggenbuck, •Silviu Grecu, Andreas Opitz, and Wolfgang Brütting — Experimentalphysik IV, Universität Augsburg, 86135 Augsburg, Germany

The influence of substrate treatment with self-assembled monolayers and polymer film annealing was analysed by electrical and structural measurements on field effect transistors and metal-insulator semiconductor (MIS) diodes using poly(3-hexylthiophene) (P3HT) as a semiconducting polymer and Si/SiO_2 wafers as a substrate.

It is found that surface treatment using silanizing agents like hexamethyldisilazane (HMDS) and octadecyltrichlorosilane (OTS) can increase the field effect mobility by up to a factor of 20, reaching values of about 3×10^{-2} cm^2/Vs. While there is a clear correlation between the obtained field effect mobility and the contact angle of water on the treated substrates, X-ray diffraction and capacitance measurements on MIS diodes show that structural and electrical properties in the bulk of the P3HT films are not influenced by the surface treatment. Contrarily thermal annealing is found to cause an increase of grain size, bulk relaxation frequency and thereby of the mobility perpendicular to the SiO_2/P3HT interface, but has very little influence on the field effect mobility. In conclusion, our investigations reveal significant differences between interface and bulk properties in polymer field effect devices.

SYOO 1.5 Mo 10:45 TU C130

Comparison between the charge carrier mobilities in OFET structures obtained from electrical characterization, four-point measurements and potentiometry — •R. Scholz, L. Mancera, F. Müller, A.-D. Müller, M. Hietschold, B.A. Paez, I. Thurzo, and D.R.T. Zahn — Institut für Physik, Technische Universität Chemnitz, Chemnitz, Germany

In a combination of experimental techniques including charge transient spectroscopy (CTS), optical spectroscopies (IR, visible/UV, Raman), and electrical probes, we develop concepts how to quantify the density of states of deep traps and their influence on the performance of OFET devices. With the so-defined densities of traps and the corresponding distribution over trapping and de-trapping rates, we deduce microscopic models for the influence of traps on the charge carrier mobility in the channel. Four-point measurements and potentiometry are used to investigate the contact resistances, so that the injection of the charges at the source contact and their extraction at the drain contact can be distinguished from the influence of trap states on the charge transport through the accumulation channel. For OFET structures based on pentacene thin films with Au bottom contacts, the mobility in the channel region as obtained from potentiometry and four-point measurements is about one order of magnitude higher than the average mobility fitted to the output characteristics.

SYOO 1.6 Mo 11:00 TU C130

Spectroscopic investigation of metal-organic contacts for organic electronics — •Achim Schöll, Ying Zou, Sönke Sachs, Matthias Paul, Rainer Fink, and Eberhard U mbach — Experimentelle Physik II, Am Hubland, 97074 Würzburg, Germany

Metal-organic contacts are of crucial importance for all organic electronic applications. The bonding of the organic molecules of the active layer and the metal contact has not only a key influence on the charge carrier transport through the interface but also on the morphology and structure of the organic film near the contact. We characterize this interface bonding for different model molecules (PTCDA, NTCDA, DIP) on Ag(111) and Au(111) surfaces using high-resolution PES and NEXAFS spectroscopy. In all cases the first molecular layer is flat lying. However, the molecules interact stronger with the Ag(111) surface, where PTCDA and NTCDA form different chemisorbed monolayer phases which can clearly be distinguished due to the high quality of the presented XPS data. The bonding is assigned to the interaction of the molecular aromatic pi-system with Ag s- and d-states and significant charge transfer from Ag into the NTCDA/PTCDA LUMO is observed. In contrast, all

investigated molecules show mainly physisorptive bonding to the Au(111) surface.