

DS 21: Organic Thin Films I

Time: Wednesday 9:30–11:00

Location: GER 38

DS 21.1 Wed 9:30 GER 38

In-situ STXM investigations of pentacene-based OFETs during operation — CHRISTIAN HUB¹, •MARTIN BURKHARDT², MARCUS HALIK², GEORGE TZVETKOV¹, and RAINER FINK¹ — ¹Department Chemistry and Pharmacy, Universität Erlangen-Nürnberg, Egerlandstraße 3, 91058 Erlangen — ²Institute of Polymer Materials, Universität Erlangen-Nürnberg, Martensstraße 7, 91058 Erlangen

Thin-film pentacene-based organic field-effect transistors on commercially available silicon nitride membranes produced by high-vacuum deposition are demonstrated. The produced devices show excellent electronic performance. Due to their overall thickness below 150 nm scanning transmission x-ray microspectroscopy (STXM) experiments are possible. Zone-plate based STXM at the PolLux beamline at the Swiss Light Source provides both high chemical sensitivity and a spatial resolution less than 35 nm. Thus a correlation of the local structural and electronic properties of our devices may be established by this microspectroscopic method. Through the subtle design of our experimental setup an in-situ investigation at highest spatial and spectral resolution during OFET operation is possible to observe modifications in the electronic structure. Recorded NEXAFS spectra show a significant local dichroism. Detailed analysis of the NEXAFS spectra revealed different orientations of the pentacene nanocrystals within the film. Unfortunately spectral changes while the OFET is operated can hardly be detected with the current experimental setup. We will discuss these experimental findings in terms of relevant interface properties. This project is funded by the BMBF, contract 05 KS7WE.

DS 21.2 Wed 9:45 GER 38

Potential mapping in the channel of organic thin film transistors. — PETER BAKALOV, •TORSTEN BALSTER, and VEIT WAGNER — Jacobs University Bremen, Bremen, Germany

For the analysis of transport properties of organic semiconductors additional information about the potential distribution within the channel of organic thin film transistor (OTFT) would be extremely helpful, which is not easily accessible by integral IV measurement.

For this purpose we have patterned sense fingers in the channel of a transistor in bottom gate geometry by lithographic means on a silicon substrate with 58 nm silicon oxide as insulator. Therefore, the potential within the conducting channel can be directly accessed by high impedance electrometers attached to the sense fingers. As organic semiconductors thiophene oligomers and polymers have been investigated.

The measured current and potential data are evaluated using a combined model of contact resistance and charge carrier density dependent mobility. P3HT devices with and without an additional protection layer of PMMA were analyzed this way. The latter shows superior performance and stability, e.g. the mobility increases almost by a factor of 2, while the threshold voltage shifts by +15 V. The potential data recorded allow to reveal laterally inhomogeneous trapping efficiencies in the device, e.g. resulting in hysteresis.

DS 21.3 Wed 10:00 GER 38

Microscopic Origin of Pentacene OFET improvement by usage of Pd electrodes — •DANIEL KÄFER¹, GREGOR WITTE², CLAUDIA BOCK³, ULRICH KUNZE³, and CHRISTOF WÖLL¹ — ¹Physikalische Chemie I, Ruhr-Universität Bochum, 44780 Bochum — ²AG Molekulare Festkörperphysik, Philipps-Universität Marburg, 35032 Marburg — ³Lehrstuhl für Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, 44780 Bochum

Due to its high charge carrier mobility pentacene is a promising molecular semiconductor for the fabrication of organic field-effect transistors (OFETs). While gold has been commonly used as electrode material in pentacene-based thin film transistors a strong increase in the charge carrier mobility and decrease in contact resistance and activation energy can be achieved using Pd electrodes instead. On the one hand, the improved device characteristics for Pd electrodes are caused by an advantageous morphology and a different microscopic orientation compared to the growth of pentacene on Au electrodes as revealed by a combination of microscopic (AFM, SEM), spectroscopic (NEXAFS) and diffraction (XRD) techniques. A detailed UPS study, on the other hand, indicates that also different electronic properties like the absence of an interface dipole and a low hole injection barrier cause the

superior device performance. The importance of these pentacene film parameters for a resulting OFET will be discussed.

DS 21.4 Wed 10:15 GER 38

Intermolecular bipolaronic nature of electroluminescence in Organic Light Emitting Field Effect Transistor

— •EUGENIO LUNEDI, PAOLO ANNIBALE, FABIO BISCARINI, and CARLO TALIANI — Institute for the Study of Nanostructured Materials ISMN-CNR, Bologna, Italy

Spectrally resolved light emission from an operating α -Sexithienyl (α -T6) thin film Field Effect Transistor (FET) was measured and its electroluminescence properties put in relation to the ns-time resolved fluorescence. Light emission, following charge carrier injection, matches closely the delayed ($\Delta t > 5$ ns) photoluminescence, but not the prompt one and exhibits a non-excitonic character. Injection of electrons in the FET channel takes place via high-electric field induced tunnelling through the drain electrode contact barrier. The spatial sites of radiative recombination inside FET channel are correlated to regions located at interfacial areas between layered domains where inter-molecular bipolarons (π -dimers) are effectively formed. The formation of such stacks of radical cations gives rise to new allowed optical transitions, with a spectroscopic fingerprint markedly different from that of the bulk crystalline states. Radiative emission from π -dimer states appears to be the fundamental mechanism involved in light emission from electro-optical organic devices based on well ordered layered thin films.

DS 21.5 Wed 10:30 GER 38

Contacts for spin injection into organic semiconductors: Energy level alignment and interactions — •MANDY GROBOSCH, KATRIN DÖRR, RAMESH B. GANGINENI, and KNUPFER MARTIN — IFW Dresden, D-01069 Dresden, Germany

The energy level alignment at interfaces between $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ (LSMO) and two archetype organic semiconductors, copper-phthalocyanine (CuPc) and sexithiophene (6T) has been studied by combined X-ray photoelectron spectroscopy (XPS) and ultraviolet photoelectron spectroscopy (UPS). $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ is a ferromagnetic metal and can be used to inject spin-polarized current into organic semiconductors. Thin films of this material have been grown using pulsed laser deposition. Prior to the deposition of the organic semiconductors the LSMO has been cleaned by either an ex-situ treatment only, or by annealing in an oxygen atmosphere. The former results in surfaces that are covered by a thin contamination layer while the latter yields atomically clean surfaces. All interfaces are characterized by a rather large interface dipole and substantial charge injection barriers. Moreover, at the interfaces between clean $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ and the two organic semiconductors there is a chemical reaction resulting in a partial oxidation of the organic molecules. At such interfaces the energy level alignment considerably depends on the LSMO cleaning procedure prior to the deposition, i.e. whether there is still a contamination layer present.

DS 21.6 Wed 10:45 GER 38

Optimisation of the insulator/organic interface for DIP/sapphire OFETs — •SÖNKE SACHS¹, MATTHIAS BRÄUNINGER¹, ACHIM SCHÖLL¹, and EBERHARD UMBACH^{1,2} — ¹Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg — ²Forschungszentrum Karlsruhe, Weberstraße 5, 76021 Karlsruhe

The quality of the insulator/organic interface, where the charge carrier channel is located in organic field-effect transistors (OFETs), decisively determines the performance, particularly the charge carrier mobility of the devices. A high structural order of the organic film, as well as a small number of defects like grain boundaries are desirable. To optimise the insulator/organic interface diindenoperylene (DIP) microcrystallites were grown by organic molecular beam deposition (OMBD) on highly ordered, atomically flat, and clean sapphire single crystals. The properties of the surface and of the deposited organic films were analysed in situ by means of analytical tools such as LEED, XPS, and NEXAFS, as well as by AFM. The parameters for the OMBD deposition as well as for the substrate preparation were systematically optimised in order to increase the crystalline domain sizes in the organic film. After contacting, first measurements of the charge carrier

mobility were performed in order to correlate the device characteristics | with the film properties.