SYSA 4: Organic Devices II

Time: Tuesday 16:30–18:30 Location: H 2013

Invited Talk SYSA 4.1 Tue 16:30 H 2013

Polymer electronics - Charge transport at organic-organic heterointerfaces — •Henning Sirringhaus — Cavendish Laboratory, University of Cambridge, Cambridge, United Kingdom

Conjugated polymer semiconductors offer new opportunities for the controlled manufacturing of active electronic circuits by a combination of solution processing and direct printing. We will review current understanding of their device physics with a particular emphasis on understanding the electronic structure of polymer heterointerfaces and charge injection at metal-semiconductor interfaces governing the device performance. Recent advances towards realizing ambipolar organic transistors through control of interface electronic structure will be presented. We will also review recent progress towards manufacturing of organic transistor circuits by high-resolution printing techniques for applications in displays and low-cost intelligent labels.

SYSA 4.2 Tue 17:00 H 2013

How to adjust or avoid hysteresis in poly(vinyl alcohol) based organic field effect transistors — •Martin Egginger[1], Mihai Irimia-Vladu[2], Reinhard Schwödiauer[2], Andreas Tanda[3], Siegfried Bauer[2], and Serdar Sariciftci[1] — [1]LIOS, JK University Linz, Altenbergerstr. 69, 4040 Linz, Austria — [2]SOMAP, Soft Matter Physics, JK University Linz, Altenbergerstr. 69, 4040 Linz, Austria — [3]plastic electronic, Rappetsederweg 28, 4040 Linz, Austria

Poly(vinyl alcohol) (PVA) is an interesting water soluble gate insulator material in organic field effect transistors. Transistors with and without hysteresis in the transfer characteristic can be produced, depending on the process conditions of the PVA dielectric. Sodium acetate, an ionic salt that is needed in the production of PVA, is not completely removed during the industrial purification process. Such ionic impurities cause the hysteresis in PVA based organic field effect transistors [1]. While a hysteresis is desirable in memory elements it is unwanted in transistors for electronic circuits. Ways to prepare transistors with a desired transfer characteristic are described. Furthermore the influence of different ions on the size of the hysteresis is investigated. Finally we discuss that varying measurement conditions (temperature, sweep frequency and amplitude) also influence the size of the hysteresis.

[1] Martin Egginger, Mihai Irimia-Vladu, Reinhard Schwödiauer, Andreas Tanda, Irene Frischauf, Siegfried Bauer and Niyazi Serdar Sariciftci, Adv. Mat. 2007 (accepted), DOI: 10.1002/adma.200701479

SYSA 4.3 Tue 17:15 H 2013

Advanced modelling of optoelectronic characteristics of OLEDs — •Robert Nitsche[1], Matthias Kurpiers-Günther[1], Michael Thomschke[2], Matthias Schober[2], and Karl Leo[2] — [1]sim4tec GmbH, Schönfelder Landstr. 8, 01328 Dresden — [2]Insitut für Angewandte Photophysik, TU Dresden, George-Bähr-Str. 1, 01069 Dresden

A rapid development of highly efficient OLED devices could be observed during the last years. The main work was carried out using experimental trial and error methods which are cost intensive and time consuming. A better approach is to conduct numerical simulations for device design and optimization beforehand, thus reducing the experimental work significantly and gaining a deep understanding of the underlying device physics.

Here, we report on simulation results of multilayer single carrier devices and multilayer fluorescent and phosphorescent OLEDs including doped transport and emitter layers, using the integral OLED device simulator SimOLED. We first give an overview on optical and electrical modelling of OLEDs and discuss methodologies to obtain correct input parameters from fitting experimental results. Special focus is paid to the ambiguity of the extracted parameters to be used for further device modelling. The simulation results are compared to experimental data and conclusions are drawn concerning the distribution of electric field, recombination rates and exciton densities as well as charge carrier balance in the devices. Finally, we propose a generalized scheme for performing OLED simulations with predictive character.

SYSA 4.4 Tue 17:30 H 2013

Charge carriers dynamic and radiative recombination processes in organic light emitting devices studied by a sub-microsecond pulsed electroluminescence technique — •Eugenio Lunedei, Paolo Annibale, Yiqiang Zhan, and Carlo Taliani — ISMN-CNR, Bologna, Italy

Despite the realization of OLEDs with high performances and organic transistors with high mobility, the dynamic of charge carriers within a working device its is not always fully understood. The transport of charge through organic semiconductors is strongly affected by trap states in the energy gap, presence of interfaces, structural disorder and injection barriers at contacts. The transport properties are sometimes not obvious from I/V curves alone: the correlation between radiative emission and a pulsed charge injection allows to characterize both transport and optical properties of device. By making use of our time-resolved electroluminescence correlator capable of sub-μs voltage pulsewidth and time-resolution down to ns scale, we were able to follow the recombination processes in multilayer devices based on small molecules (as Alq_3 and T_6), blend of polymers, in inverted OLEDs with TCOs anode and in light emitting OFETs of T_6 and Pentacene. The charge carriers mobility is directly obtained by ToF measurements as well as its dependance on the applied voltage and on the trap-site density within the organic layers; furthermore, the possibility to record complete electroluminescence spectra during the application of the electric pulse and in successive time windows gives a new insight on the fate of injected charges and on the nature of trapping sites.

SYSA 4.5 Tue 17:45 H 2013

Magnetic field effects on the triplet-polaron quenching in Ir(III)-complexes — Alex Thiessen, •Dirk Hertel, and Klaus Meerholz — Institute of Physical Chemistry, University of Cologne, Luxemburger Str. 116, 50939 Cologne, Germany

Recently [1], we reported a study of phosphorescence quenching in polyspirobifluorene doped with the phosphorescent emitter platinum-porphyrin (PtOEP). It was shown that the phosphorescence reduction is due to the interaction of triplet excitons with charges (polarons) in a unipolar diode structure. The rate constant for triplet-polaron interaction has been evaluated to be 10-13 cm3/s leading to an interaction radius of 0.2 nm. In our current work we have used the methodology [1] to elucidate the role of this process in materials relevant to phosphorescent OLEDs. We have studied a red-emitting Ir(III)-complex doped into low molecular weight materials and in polymers. It will be shown, that the efficiency of triplet-polaron annihilation depends mostly on the nature of the matrix and not on the structure of the heavy-metal complex. The results give insight to a possible origin of the magneto-resistance effects in organic materials [2]. Recently [3], it has been proposed that triplet-polaron annihilation might play a crucial role. We will discuss the influence of magnetic fields on the triplet-polaron annihilation for our model system.

References [1] Hertel, D.; et al. J. Phys. Chem. B 2007, 111, 12075. [2] Mermer, O.; et al. Phys. Rev. B 2005, 72, 202202. [3] Desai, P.; et al. Phys. Rev. B 2007, 75, 094423.

SYSA 4.6 Tue 18:00 H 2013

Hysteresis effects and non-volatile memory behaviour of organic heterostructure devices. — •Frank Lindner, Karsten Walzer, and Karl Leo — Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden

Within the last few years, organic memory devices have attracted considerable attention. During such experiments, we observed a hysteretic current-voltage behaviour of organic heterostructure devices. We report reproducible bistable electrical switching and memory phenomena in an organic multilayer heterostructure, consisting of materials which are well characterized from organic light emitting device investigations. Similar to OLEDs, the organic layers were embedded between a ITO and a metal contact. In contrast to other organic memory concepts we reached a high reproducibility and stability. The measured current-voltage characteristics shows two states of different conductivity at the same applied voltage. We could achieve more then 1000 Write-Read-Erase cycles without degradation. It was found that the ratio of the ON/OFF current depends on the writing and erasing voltage, respectively. The two states were yet retained for several days before reading the devices. Both states are stable at room temperature and can be measured reproducibly. We discuss the device operation mechanism. Device performance tests show that the heterostructure devices are a promising candidate for high-density, low-cost electrically addressable

data storage applications.

SYSA 4.7 Tue 18:15 H 2013

C(V) and C(t) measurements on MFIS structures consisting P[VDF/TrFE] as ferroelectric layer — •Karsten Henkel, Bernd Seime, Ioanna Paloumpa, Klaus Müller, and Dieter Schmeisser — Brandenburgische Technische Universität Cottbus, Angewandte Physik - Sensorik, Konrad-Wachsmann-Allee 17, 03046 Cottbus, Germany

Ferroelectric Field Effect Transistors (FeFETs) are considered as a candidate for future non volatile and non destructive readout memory cells. A possible low cost solution is the use of poly[vinylidene fluoride trifluoroethylene] (P[VDF/TrFE]). Using P[VDF/TrFE] we focus on metal ferroelectric insulator semiconductor (MFIS) capacitor structures. In this contribution we will summarize our investigations related to capacitance measurements in dependence of applied bias (C(V)) and time (C(t)). The thickness of the ferroelectric layer as well as the thickness and the material of the buffer layer have been investigated for optimization of the write voltage. CV measurements at higher temperatures deliver decreased flatband voltage shifts within one CV loop resulting in lower memory windows. At temperatures around 100°C the hysteresis totally vanished, pointing out the ferroelectric behavior of the system. C(t) measurements at a constant bias have been performed for retention analysis of the MFIS stack. After applying a writing pulse we could distinguish between a higher and a lower capacitance state for more than 5 days. This work is supported by Deutsche Forschungsgemeinschaft within priority program 1157 (SCHM 745/11-2).