HL 85: Organic Semiconductors: Transistors and OLEDS

Time: Thursday 15:00–17:30 Location: EW 203

HL 85.1 Thu 15:00 EW 203

New material combinations for ion gel gated organic thin film transistors — •Johannes Schöck[1], Daniel C. Frisbie[2], and Heiko B. Weber[1] — [1]Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, Erlangen, Germany — [2]Department of Chemical Engineering and Materials Science, University of Minnesota, Minneapolis, USA

Ion gels can efficiently gate thin film transistors made from small molecules. Sharing the same benefits as ionic liquids, they are easier to handle and promise better reproducibility. n- and p-type transistors were fabricated from PCBM and custom-made pentacene dimer derivatives. PVdF/[BMP+][FAP-] and PVdF/[EMIm+][TFSi-] ion gels were used as top gates, using P3HT as a standard semiconductor for comparison.

HL 85.2 Thu 15:15 EW 203

IR spectroscopy at the ITO-organic interface — •Milan Alt[1], Ahmad Shazada[3], Akemi Tamanai[2], Jens Trollmann[2], Tobias Glaser[2], Sebastian Beck[2], Sven Tengeler[2], and Annemarie Pucci[2] — [1]Karlsruher Institut für Technologie, Karlsruhe, Germany — [2]Kirchhoff-Institut für Physik, Heidelberg, Germany — [3]Max-Planck Institut für Polymerforschung, Mainz, Germany

Thin films of P3HT have been prepared by spin coating and electrooxidative polymerization on platinum- and ITO-coated substrates. Additionally, P3HT-films on silicon substrates have been prepared by spin coating only. The measured IR spectra of the spin coated films allowed for an elaboration of a detailed optical model for P3HT, which has been used to simulate IR reflection-absorption spectra on ITO and Pt substrates. Comparison of simulated spectra with measurements revealed no substrate influence on the IR spectra for the spincoated films. In case of spincoated P3HT-films on ITO-substrate, the obtained IR spectra correspond to simulation data very well up to 6000 wavenumbers. In the electropolymerized P3HT films we have identified residuals of the electrolyte ionic liquid, acting as dopand for P3HT. While IR spectra of the electropolymerized P3HT films on Pt substrate could be explained reasonably well as a superposition of chemically doped P3HT and the ionic electrolyte, the IR spectra of electropolymerized P3HT films on ITO substrates showed strongly deposition-time dependent deviations. These were most likely related to varying properties of the ITO surface between reference and sample measurement due to an interaction of ITO and the electrolyte at the film-substrate interface.

HL 85.3 Thu 15:30 EW 203

Tuning the Surface Properties of Gold Electrodes in Organic Field-Effect Transistors Using Self-Assembled Monolayers — •Janusz Schinke[1], Sebastian Hietzschold[3], Rebecca Saive[2,3], Lars Müller[3], Manuel Hamburger[4], Wolfgang Kowalsky[1,2], and Michael Kröger[1,2] — [1]TU Braunschweig, Institut für Hochfrequenztechnik — [2]Innovation Lab GmbH — [3]Universität Heidelberg, Kirchhoff-Institut für Physik — [4]Universität Heidelberg, Organisch-Chemisches Institut

In organic electronic devices, charge injection at the contacts is crucial for better electrical performance. In bottom-contact p-channel organic field-effect transistors (OFET), Au electrodes are very often used for drain and source contacts. A smart way of enhancing the device's performance is the use of self-assembled monolayers (SAMs) to tune the electrodes' work function or substrate conditions for deposition of the organic semiconductor. We have studied the properties of SAM-treated gold surfaces via Atomic Force Microscopy (AFM), Kelvin Probe (KP) and contact angle measurements. SAMs used for this work include fluorinated and non-fluorinated alkyl thiols. We compare the characteristics of SAM-treated OFETs using TIPS-pentacene as an organic semiconductor to standard devices. The gold electrode is subsequently treated by several SAM solutions to manipulate the effective work function and the device performance. Comparing to untreated OFETs, we see an enhancement of the mobility by two orders of magnitude and a significant reduction of the threshold voltage.

HL 85.4 Thu 15:45 EW 203

Structural and Electrical Characterization of 3D Gate Organic Field Effect Transistor — •S S Phani Kanth Arekapudi[1], Daniel Lehmann[1], Danny Reuter[2], and Dietrich R T Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]2Center for Microtechnologies (ZFM), Chemnitz University of Technology, D-09126 Chemnitz, Germany

Recent implementation of 3D gate transistors proven to have high performance, power efficiency, and improved switching behavior with less leakage current, we present an investigation of structural and electrical properties of advanced 3D gate organic field effect transistors. In this work we prepared the structures on silicon substrates. To pattern the gate, source, and drain with desired mask dimensions, stepper lithography is employed. Using deep reactive ion etching the gate trenches with channel lengths (L) ranging between L = (500 - 1500) nm, channel widths (W) ranging between W = (150 - 700) nm, and channel depth (d) 500 nm are formed. As a dielectric layer 100 nm thick SiO2 is thermally deposited on prepatterned silicon. As an active layer pentacene (<400 nm thick) is deposited on to the SiO2 layer using organic molecular beam deposition under high vacuum (HV) condition. Gold deposition for source and drain electrodes is performed using thermal evaporation under HV conditions. The 3D gate confines the organic material inside the trench, which provides high durability with less leakage current and improved mobility for the device. Further details concerning the structure preparation and electrical characterization results will be presented and discussed.

HL 85.5 Thu 16:00 EW 203

Bio-functionalization of electrolyte-gated organic transistors — •Felix Buth, Andreas Donner, Aiswarya Pillai, Martin Stutzmann, and Jose Antonio Garrido — Walter Schottky Institut, Technische Universität München, Garching, Germany

Electrolyte-gated organic field-effect transistors (EGOFETs) can be operated at low voltages in aqueous environments, paving the way to the use of organic semiconductors in bio-sensing applications. However, it has been shown that these devices exhibit inherently a rather weak sensitivity to relevant electrolyte parameters such as pH and ionic strength. In order to increase this sensitivity and add specificity towards a given analyte, the covalent attachment of functional groups to the device surface would be desirable.

In this contribution we demonstrate the successful attachment of different silane molecules, which serve as linker molecules for the subsequent grafting of bio-molecules, to the surface of α-sexithiophene-based thin film transistors. Using surface characterization techniques like X-ray photoemission and infra-red spectroscopy we could confirm the presence of functional groups on the surface, which are stable under standard electrolytic conditions. As expected, the presence of these amphoteric groups (e.g. amino or carboxylic moieties) increases the pH-sensitivity of the EGOFETs. In addition, they can serve as anchoring sites for further bio-functionalization steps. These results confirm the potential of the EGOFETs for chemical- or biochemical-sensing applications.

Coffee Break (15 min)

HL 85.6 Thu 16:30 EW 203

Investigation of Triplet Exciton Dynamics in Fluorescent Polymer Light-Emitting Diodes — •Bodo Wallikewitz, Simon Gélinas, Dinesh Kabra, and Richard Friend — University of Cambridge, Optoelectronics Group, Cavendish Laboratory, JJ Thomson Avenue, Cambridge, CB3 0HE, UK

We report on fluorescent, polymer light-emitting diodes with a high external quantum efficiency of 6.5 %. To understand the high efficiency of these PLEDs, we investigated excited state dynamics on working devices. Emissive and non-emissive excited states were monitored by their characteristic absorption and emission features using transient optical absorption spectroscopy and transient, time-resolved electroluminescence measurements. By fitting a model for triplet decay to the experimental triplet and electroluminescence dynamics, we are able to quantitatively characterize triplet-triplet annihilation as the dominant triplet decay mechanism. Singlet states generated from triplet-triplet annihilation contribute up to 33% of the total amount of singlets generated in these fluorescent devices. To model these results, we require that triplet states can undergo bimolecular annihilation several times. With this model, we show that singlets can reach a maximum fraction of 40% of all excitons generated by charge recombination, without

violating spin statistics. Singlet states generated from triplet-triplet annihilation are one important explanation for high external quantum efficiencies found in these fluorescent devices.

HL 85.7 Thu 16:45 EW 203

Extraction of trapped modes in organic light-emitting diodes via high-index coupling — •Bert Jürgen Scholz, Jörg Frischeisen, and Wolfgang Brütting — Institute of Physics, University of Augsburg, Germany

The efficiency of organic light-emitting diodes (OLEDs) is still limited by poor light outcoupling efficiency. In particular, the excitation of wave-guided modes in the organic layers and surface plasmon polaritons at metal-organic interfaces represent major loss channels.
By combining optical simulations and experiments on simplified luminescent thin-film structures we elaborate the conditions for the extraction of surface plasmons via coupling to high-index media. As a proof-of-concept, we demonstrate the possibility to extract light from wave-guided modes and surface plasmons usually trapped in the OLED by a high-index prism.

HL 85.8 Thu 17:00 EW 203

Single Molecule Electroluminescence — •Maximilian Nothaft[1], Steffen Höhla[2], Fedor Jelezko[3], Jens Pflaum[4], and Jörg Wrachtrup[1] — [1]3. Phys. Ins., Univ. Stuttgart, 70550 Stuttgart — [2]Institut für Großflächige Mikroelektronik, Univ. Stuttgart, 70550 Stuttgart — [3]Institut für Quantenoptik, Univ. Ulm, 89081 Ulm — [4]Exp. Phys. VI, Univ. Wuerzburg und ZAE Bayern, 97074 Wuerzburg

In this study we present the feasibility of detecting single electrically driven molecules at room temperature. Thereby, phosphorescent iridium based dye molecules were employed as dopants in organic light emitting diodes (OLEDs). To be sensitive on electroluminescent emission from single isolated guest molecules we chose concentrations sufficiently low to render distances between next-neighboring molecules larger than the optical diffraction limit. By spectrally separating host-guest emission, optical properties and photon emission statistics of single electrically driven phosphorescent molecules could be analyzed. Besides proving that spectral properties of the dopant molecules are identical in optical and electrical excitation mechanisms, sub-poissonian non-classical photon statistics can be observed in the electroluminescence light of a single phosphorescent dye molecule at room temperature. This approach thereby shows a possible strategy towards electrically driven single photon sources at room temperature based on phosphorescent emitters.

HL 85.9 Thu 17:15 EW 203

Untersuchung der Degradationsmechanismen in organischen Licht-emittierenden Dioden — •Mustapha Al Helwi[1,2,4], Alexander Badinski[2], Ute Heinemeyer[2], Soichi Watanabe[2], Gerhardt Wagenblast[2], Ingo Münster[2] und Wolfgang Kowalsky[1,3,4] — [1]KIP, Universität Heidelberg, Heidelberg, Deutschland — [2]BASF SE, Ludwigshafen, Deutschland — [3]IHF, Technische Universität Braunschweig, Braunschweig, Deutschland — [4]Innovation Lab GmbH, Heidelberg, Deutschland

Organische Leuchtdioden (OLEDs) sind selbstleuchtende dünne Filme aus organischen Molekülen und werden für Beleuchtungs- und Display-Anwendungen benutzt. Diese innovative Technologie wird die Welt, wie wir sie heute kennen, revolutionieren. Die OLEDs sind flexibel, transparent, druckbar und damit sehr günstig produzierbar. Wie alle neuen Technologien, bringt auch die OLED-Technologie ihre eigenen Herausforderungen mit sich. Das Verständnis der Stabilität bzw. der Degradation gehört zu den wichtigsten, noch weitergehend ungelösten Fragestellungen. In diesem Vortrag wird eine Lebensdauermessmethode und erste Ergebnisse vorgestellt. Darüber hinaus wird die Anwendung verschiedener analytischer Methoden, wie etwa der Impedanz-Spektroskopie, bei der Untersuchung degradierter Proben gezeigt. Ein theoretisches Modell zur Beschreibung der Alterung wird erläutert und zum Fitten der experimentellen Daten benutzt. Das Zusammenspiel zwischen Experiment und Modellierung erlaubt durch die Diskriminierung und Quantifizierung der Degradationsmechanismen ein tieferes Verständnis der OLED-Stabilität.