

## DS 17: Contact Properties (SYOE 10)

Time: Wednesday 16:45–18:45

Location: H32

## Invited Talk

DS 17.1 Wed 16:45 H32

**Single grain contacts** — ●GREGOR WITTE — Physikalische Chemie I, Ruhr-Universität Bochum, 44801 Bochum

Because of attractive features such as low-temperature processing and flexibility organic electronics is presently attracting significant attention. Of particular interest of current research is a detailed understanding and optimization of intrinsic charge transport mechanism present in these materials. Besides their technological relevance organic thin film transistors (OFETs) are frequently used to characterize the electronic properties of such organic semiconductors. However, due to structural imperfections like grain or domain boundaries within the films as well as contact related problems the intrinsic transport properties are masked and typically only effective parameters are obtained.

While these problems can be avoided by investigating organic single crystals they are difficult to grow and frequently are not available in the required purity and perfection. An alternative strategy is based upon investigation of films containing large single crystalline grains as compared to the channel length of the used OFET device thus allowing single grain studies. In this talk I will give an overview of experimental approaches to realize single grain devices and to deal with proper contacts.

DS 17.2 Wed 17:30 H32

**Comparison of the charge injection barrier at realistic and ideal metal/organic interfaces: metals become faceless** — ●MANDY GROBOSCH and MARTIN KNUPFER — Leibniz-Institut für Festkörper- und Werkstoffforschung, Dresden, Germany

Most of the organic electronic devices are nowadays fabricated under poor vacuum conditions. In this regard, there is only little knowledge about the impact of contamination of the metal electrode on the charge injection barrier in this kind of electronic devices. In our study we have performed X-ray and ultra violet photoemission spectroscopy (XPS, UPS) on interfaces between the organic semiconductor  $\alpha$ -sexithiophene and sputter cleaned (ideal) metals as well as contaminated (realistic) metals. As metal substrates we have used silver, gold, palladium, and platinum. These metals provide us a wide range of metal work functions from 4.2 eV for silver up to 5.5 eV for platinum. For all interfaces of  $\alpha$ -sexithiophene and contaminated metals we have observed a reduction of the interface dipole and the hole injection barrier. The charge injection barrier in all four cases is almost independent of the underlying metal (within an error of 0.2 eV) and the interface dipole remains a finite size. We could demonstrate that the injection barrier of realistic interfaces is very different from that of the respective clean interfaces. Moreover, a loss of the individual characteristic of the metal upon contamination is observed - it becomes faceless.

DS 17.3 Wed 17:45 H32

**Influence of film thickness on contact resistance in nanoscale oligothiophene field effect transistors** — ●ARNE HOPPE<sup>1</sup>, TORSTEN BALSTER<sup>1</sup>, GÜNTHER GÖTZ<sup>2</sup>, PETER BÄUERLE<sup>2</sup>, and VEIT WAGNER<sup>1</sup> — <sup>1</sup>School of Engineering and Science, International University Bremen, Campus Ring 8, 28759 Bremen, Germany — <sup>2</sup>Department Organic Chemistry II, Ulm University, Albert-Einstein-Allee 11, 89081 Ulm, Germany

Nanoscale organic transistors for high switching frequencies are often limited by contact resistances. We report on a study of those contact resistances in nanoscale organic field-effect transistors (OFETs) by a systematic variation of the bandgap of the organic semiconductor. We use high mobility alkyl-substituted oligothiophenes (Dihexyl-n-thiophenes, DHnT) with n, the number of thiophene rings, ranging from four to seven. The bandgap variation also shifts the HOMO-level by almost 0.5 eV, which is expected to modify contact properties. Generally we find increasing mobilities up to 0.12 cm<sup>2</sup>/Vs towards larger molecules and at the same time decreasing contact resistances. We find for all materials a systematically decreasing mobility with decreasing channel length while the contact resistance remains fairly constant with channel length. We also report on thickness dependent in-situ electrical measurements on those nano OFETs, which are in agreement with the fact, that one monolayer is sufficient for electronic transport. Furthermore, we demonstrate monolayer-oscillations not only in the mobility, but also on the contact resistance. In contrast to the mobility, the contact-resistance shows minimal values with any

closed monolayer.

DS 17.4 Wed 18:00 H32

**Electrode - molecular semiconductor contacts: work-function-dependent hole injection barriers versus Fermi-level pinning** — ●NORBERT KOCH<sup>1</sup> and ANTJE VOLLMER<sup>2</sup> — <sup>1</sup>Humboldt-Universität zu Berlin, Institut für Physik, Berlin, Germany — <sup>2</sup>BESSY GmbH, Berlin, Germany

Contacts between two molecular organic semiconductors [p-sexiphenyl (6P) and pentacene] and conducting polymers based on poly(3,4-ethylenedioxythiophene)/poly(styrenesulfonate) (PEDT:PSS) were investigated with photoemission spectroscopy. The dependence of the hole injection barrier (HIB) at 6P/CP interfaces on substrate work function (WF) exhibited a transition from almost Schottky-Mott limit-like behavior to Fermi-level pinning. For pentacene, no significant variation of the HIB as function of WF was observed, despite the large range of work function spanned by the conducting polymers (4.4 eV to 5.9 eV). The results on contacts with conducting polymers are compared to those with metals, where none of the two limiting cases for HIBs as a function of WF were observed. In addition, we present clear-cut relations between residual water incorporation in PEDT:PSS layers and the resulting surface morphology and work function. These results are of direct relevance for organic opto-electronic device fabrication processes.

DS 17.5 Wed 18:15 H32

**Structure and growth of organic-organic heterojunctions elucidated by in-situ X-ray diffraction studies** — ●ESTHER BARRENA<sup>1,2</sup>, DIMAS G. DE OTEYZA<sup>1</sup>, JUSEP OSSÓ<sup>3</sup>, STEFAN SELNER<sup>1</sup>, and HELMUT DOSCH<sup>1,2</sup> — <sup>1</sup>Max-Planck-Institut für Metallforschung — <sup>2</sup>Institut für Theoretische und Angewandte Physik, Universität Stuttgart — <sup>3</sup>Institut de Ciència de Materials de Barcelona

Although numerous studies have been devoted to the characterization and optimization of the performance of p-n organic-organic heterojunctions-based devices, the present-day knowledge on the physical principles of the growth of organic heterostructures is still poor. By combining atomic force microscopy with surface-sensitive X-ray diffraction, we have been able to get a detailed in-situ insight into the microscopic processes which take place during the growth of p-conducting di-indenoperylene (DIP) molecules onto n-conducting copper-hexadecafluorophthalocyanine (F16CuPc) thin films. We demonstrate the self-organization of well-ordered DIP nanodots with high crystallinity and show that their growth is intimately related to a novel type of interface reconstruction of the underlying F16CuPc film which affects three monolayers adjacent to the organic p-n interface. In spite of the close resemblance to the formation of semiconductor nanostructures for inorganic heteroepitaxy, the present results conclusively demonstrate a distinctly different growth mechanism for organic heteroepitaxy whose understanding demands further theoretical studies.

E. Barrena, D. G. de Oteyza, S. Sellner, H. Dosch, J. O. Osso, and B. Struth Physical Review Letters 97, 076102-1-4 (2006)

DS 17.6 Wed 18:30 H32

**Fabrication and temperature-dependent conductivity studies of conducting polymer nanowires** — J.H. FRANKE, B. DONG, H. FUCHS, and ●L. CHI — Physikalisches Institut, WWU Münster, Wilhelm-Klemm-Str. 10

We describe a general approach to pattern conductive polymer nanowires, e.g. polypyrrole (PPy), at pre-defined areas on insulating surfaces and to address the wires with external microelectrodes. E-beam lithography and AFM lithography were used to create defined surface patterns. The successful construction of PPy structures (10-120 nm in thickness and down to 80 nm in width) was achieved by employing a random copolymer strategy combined with self-assembly. The process can also be applied to structures of substituted thiophene, aniline and their derivatives. Furthermore, surface patterns created by parallel processes like nanoimprint lithography (NIL) can be combined with this method to construct large area polymer nanowire devices. Temperature-dependent conductivity studies on polymer structures were carried out to check for a metal-insulator transition. Results indicate an increasingly 'insulating' behaviour with decreasing thick-

ness, e.g. a steeper rise in conductivity with increasing temperature.

1. B. Dong, N. Lu, M. Zelsmann, N. Kehagias, H. Fuchs, C.M. Sotomayor Torres, L. Chi Adv. Funct. Mater. 16,1937 (2006).

2. B. Dong, D. Zhong, L. Chi, H. Fuchs, Adv. Mater. 2005, Adv.

Mater. 17 (2005) 2736.

3. B. Dong, M. Krutschke, X. Zhang, L. Chi, H. Fuchs, Small, 1 (2005), 520-524.