

## DS 4: Organic Electronics and Photovoltaics II (Joint Session DS/CPP/HL/O)

Time: Monday 14:00–15:30

Location: H8

DS 4.1 Mon 14:00 H8

**Influence of the substrate-lattice-geometry on the island shape of organic thin films** — ●M. BENEDETTA CASU<sup>1</sup>, BRITTE E. SCHUSTER<sup>1</sup>, INDRO BISWAS<sup>1</sup>, CHRISTOPH RAISCH<sup>1</sup>, HELDER MARCHETTO<sup>2</sup>, THOMAS SCHMIDT<sup>2</sup>, T. ONUR MENTES<sup>3</sup>, MIGUEL A. NINO<sup>3</sup>, ANDREA LOCATELLI<sup>3</sup>, and THOMAS CHASSÉ<sup>1</sup> — <sup>1</sup>IPTC, University of Tübingen, Tübingen, Germany — <sup>2</sup>Fritz-Haber-Institut, Berlin, Germany — <sup>3</sup>Sincrotrone Trieste S.C.p.A., Trieste, Italy

By using a combination of microscopic imaging and diffraction techniques with structural and chemical sensitivity, we studied the growth of diindenoperylene (DIP) on Au(100), and Au(111). Growth and structure of DIP films of different thickness were monitored in situ including real time PEEM and LEEM performed at the beamlines Nanospectroscopy at Elettra, and UE49-PGM-b-SMART at BESSY. A layer-by-layer mechanism characterizes the initial growth in both cases followed by island nucleation, i.e., the growth follows the Stranski-Krastanov mode. The islands surprisingly show a fractal-like shape when the DIP thin films are deposited on a Au(111) single crystal. DIP thin films deposited on various substrates at RT have been investigated, revealing the tendency to Stranski-Krastanov growth but the observed islands were always compact (i.e. non-fractal). In particular, real time LEEM investigations on Au(100), under the same preparation conditions as on Au(111), show compact islands. We interpret the fractal growth of DIP for these kinetic growth conditions as a consequence of the triangular symmetry of the substrate, as seen in homoepitaxial and heteroepitaxial metal on metal growth.

DS 4.2 Mon 14:15 H8

**Can X-ray microspectroscopy probe inhomogeneities in the electron structure of organic devices?** — ●CHRISTIAN HUB, MARTIN BURKHARDT, MARCUS HALIK, and RAINER FINK — Interdisciplinary Center for Molecular Materials (ICMM), Universität Erlangen, Egerlandstraße 3, 91058 Erlangen, Germany

The degree of homogeneity in the morphology of organic thin film devices has a major impact on the charge transport properties. Real devices usually strongly deviate from the ideal device structure since epitaxial growth with low defect concentrations cannot be achieved. We have recently started to investigate pentacene-based OFETs, which were prepared using commercial silicon nitride membranes as dielectric showing excellent transport characteristics. The overall device thickness is sufficiently small to perform scanning transmission X-ray microspectroscopy (SXTM) experiments at the PoLux microspectroscopy. Grains with varying preferential orientation in the polycrystalline pentacene films are detected using the significant local NEXAFS dichroism. The local NEXAFS contrast is utilized to investigate differences in the electronic structure within these films while the devices are operated. Using the standard photomultiplier tube of the PoLux as detector no pronounced changes were observed when current is driven through the organic films. Therefore electron detection was implemented to further enhance the sensitivity of the microscope to ultrathin films. We will discuss the related problems and opportunities to use local NEXAFS with lateral resolution below 30 nm. The work is funded by the BMBF under contract 05 KS7WE1.

DS 4.3 Mon 14:30 H8

**Morphology and electronic properties of an electron acceptor adsorbed on organic insulator pre-covered metal surfaces** — ●P. AMSALEM<sup>1</sup>, J. FRISCH<sup>1</sup>, A. WILKE<sup>1</sup>, A. VOLLMER<sup>2</sup>, R. RIEGER<sup>3</sup>, K. MÜLLEN<sup>3</sup>, J.-P. RABE<sup>1</sup>, and N. KOCH<sup>1</sup> — <sup>1</sup>Humboldt-Universität zu Berlin, Institut für Physik, Brook-Taylor-Str. 6, 12489 Berlin, Germany — <sup>2</sup>HZB-BESSY II, Albert-Einstein-Str. 15, 12489 Berlin, Germany — <sup>3</sup>Max Planck Institut für Polymerforschung, Ackermannweg 10, 55128 Mainz, Germany

In this work, we explore the possibility of tuning the interface energetics at a pi-conjugated (electron acceptor) molecule-metal interface by modifying the adsorbate-substrate distance through pre-adsorption of insulating organic monolayers. We report a photoemission study of the growth of hexaazatriphenylene-hexacarboxitrile (HATCN) deposited on N,N-bis-(1-naphthyl)-N,N-diphenyl-1,1-biphenyl-4,4-diamine ( $\alpha$ -NPD) or tris(8-hydroxyquinoline)aluminum (Alq<sub>3</sub>) pre-covered Ag(111) surfaces.  $\alpha$ -NPD and Alq<sub>3</sub> are known to be weakly adsorbed on Ag(111) and have both been used as thin organic spacer.

The choice of HATCN has been motivated by its high electronic affinity ( $\sim 3.5$  eV). HATCN molecules deposited on  $\alpha$ -NPD/Ag(111) are found to diffuse below the  $\alpha$ -NPD molecules pre-adsorbed on Ag(111). In the case of HATCN on Alq<sub>3</sub>/Ag(111), an interface state close to the Fermi-level is observed. This interface state differs markedly from the one measured for HATCN in direct contact with Ag(111). The results are discussed in terms of the formation of polaronic states and charge transfer across insulating layers.

DS 4.4 Mon 14:45 H8

**Energy levels and work function of ultra-thin polythiophene films on conductive polymer electrodes** — ●JOHANNES FRISCH<sup>1</sup>, ANTJE VOLLMER<sup>2</sup>, JÜRGEN P. RABE<sup>1</sup>, and NORBERT KOCH<sup>1</sup> — <sup>1</sup>Humboldt-Universität zu Berlin, Institut f. Physik, Brook-Taylor-Straße 6, D-12489 Berlin — <sup>2</sup>Elektronenspeicherring BESSY II, Albert-Einstein-Str. 15, D-12489 Berlin

In modern organic photovoltaic cells (OPVCs), poly(ethylene-dioxythiophene):poly(styrenesulfonate) (PEDT:PSS) and poly(3-hexylthiophene) (P3HT) are prototypical materials used as transparent anode and as donor polymer, respectively. In this context, it is essential to clarify how the efficiency of OPVCs based on these materials depends on the position of the energy level at the interface. In the present work, the morphology, work function, and energy level alignment of ultra-thin films of P3HT on PEDT:PSS were investigated using photoelectron spectroscopy (XPS, UPS). Ultra-thin films (down to sub-monolayer coverages) were produced by spin coating P3HT films on PEDT:PSS followed by a subsequent washing process. It has been found that the deposition of ultra-thin P3HT films on PEDT:PSS lowers the sample work function ( $\Phi$ ) by 0.4 eV due to doping of P3HT film with positive charges from the PEDT:PSS layer. The valence band edge (VBE) is located only 0.1 eV below the Fermi-level. For thicker P3HT films (ca. 10 nm),  $\Phi$  further decreases by 0.2 eV and the VBE is observed 0.2 eV below the Fermi-level. These results are discussed within existing concepts of local work function fluctuations and energy level bending at the P3HT/PEDT:PSS interface.

DS 4.5 Mon 15:00 H8

**Electronic properties of Cu-phthalocyanine-fullerene planar and bulk heterojunctions on PEDOT:PSS** — ●ANDREAS WILKE, TOSHIKO MIZOKURO, RALF PETER BLUM, JÜRGEN P. RABE, and NORBERT KOCH — Institut für Physik, Humboldt-Universität zu Berlin, Brook-Taylor-Str. 6, D-12489 Berlin

In organic photovoltaic cells (OPVCs) typically two organic materials with electron-acceptor and electron-donor properties are placed between anode and cathode, forming either a layered planar or mixed bulk heterojunction where charge separation should occur. To improve the efficiency of this central process it is important to know and understand the energy levels at such heterojunctions, and how they may depend on heterojunction morphology. We report ultraviolet and X-ray photoelectron spectroscopy studies on layered planar and mixed bulk heterojunctions of Cu-phthalocyanine (CuPc) and C<sub>60</sub>, a prototypical material pair for OPVCs. The respective heterojunctions were formed on poly(ethylene-dioxythiophene):poly(styrenesulfonate) substrates, in order to achieve morphologies comparable to those in actual OPVCs. The energy offset between the highest occupied levels of CuPc and C<sub>60</sub> was determined to 1.3 eV for both the layered and mixed bulk heterojunction. Our results demonstrate that the energy levels that determined the efficiency of charge separation in OPVCs made of CuPc and C<sub>60</sub> are independent of particular interface morphology, and that differences in device efficiency are due to other effects.

DS 4.6 Mon 15:15 H8

**A high molecular weight donor for electron injection interlayers on metal electrodes** — ●BENJAMIN BRÖKER<sup>1</sup>, RALF-PETER BLUM<sup>1</sup>, LUCA BEVERINA<sup>2</sup>, OLIVER T. HOFMANN<sup>3</sup>, GEORG HEIMEL<sup>1</sup>, ANTJE VOLLMER<sup>4</sup>, JOHANNES FRISCH<sup>1</sup>, JÜRGEN P. RABE<sup>1</sup>, EGBERT ZOJER<sup>3</sup>, and NORBERT KOCH<sup>1</sup> — <sup>1</sup>Institut für Physik, Humboldt-Universität zu Berlin, Newtonstrasse 15, D-12389 Berlin, Germany — <sup>2</sup>Department of Materials Science and INSTM, State University of Milano-Bicocca, Via Cozzi 53, I-20125 Milano, Italy — <sup>3</sup>Institute of Solid State Physics, Graz University of Technology, Petersgasse 16, A-8010 Graz, Austria — <sup>4</sup>Helmholtz-Zentrum Berlin, Bessy II, Albert-Einstein-Str. 15, D-12489 Berlin, Germany

The molecular donor 9,9-ethane-1,2-diylidene-bis(N-methyl-9,10-dihydroacridine) (NMA) has been synthesized, and its electronic properties were characterized at interfaces to metals with photoelectron spectroscopy. Here a decrease of the sample work function is observed that becomes larger with increasing molecular coverage and clearly exceeds values that would be expected for metal surface electron "push back" alone, confirming the electron donating nature of NMA.

For tris(8-hydroxyquinoline)aluminum (Alq<sub>3</sub>) deposited on top of a NMA-modified Au(111) surface, the electron injection barrier (EIB) is reduced by 0.25 eV compared to that on pristine Au(111). Furthermore, the EIB reduction depends linearly on  $\Theta$  of the donor-modified Au(111) surface, adjustable by NMA pre-coverage. Comparisons will also be given to the stronger donor MV0.

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