CPP 19 SYMPOSIUM Functional Organic Thin Films I

Time: Thursday 09:30–12:30 Room: ZEU Lich

Invited Talk CPP 19.1 Thu 09:30 ZEU Lich

Electronic structure of hybrid interfaces for polymer-based electronics — •William R. Salaneck — Department of Physics, IFM, Linköpings Universitet, S-581 83 Linköping, Sweden

Conjugated polymers are currently used in organic molecular and polymer based electronics. The interface between the organic material (molecular or polymeric) and inorganic electrode materials controls a great deal of the interfacial charge transfer characteristics. In Linköping, studies of molecular modification of energy level alignment at hybrid interfaces have been carried out for many years. Molecular adsorption may be used to control interfacial electronic parameters almost as-desired for applications in molecular and polymer based electronic applications. The characterization of the electronic structure of the interface between spin-coated polymer films and metallic substrates (the device fabrication mode), is often carried out using photoelectron spectroscopies. Several examples of recent work on the molecular modification of hybrid interfaces, carried out in Linköping, will be presented. In addition, some very recent results on fast charge transfer at hybrid interfaces, studied by variations on UPS, will be discussed.

CPP 19.2 Thu 10:00 ZEU Lich

Optimized hole injection with strong electron acceptors at organic-metal interfaces — •Norbert Koch[1], Steffen Duhm[1], Antje Vollmer[2], Robert L. Johnson[3], and Jürgen P. Rabe[1] — [1]Humboldt-Universität zu Berlin, Institut f. Physik, Newtonstr. 15, 12489 Berlin — [2]BESSY GmbH, 12489 Berlin — [3]Universität Hamburg, Institut f. Experimentalphysik, 22761 Hamburg

The energy level alignment at interfaces between three electroactive conjugated organic materials and Au was systematically varied by adjusting the pre-coverage of the metal substrate with the electron acceptor tetrafluoro-tetracyanoquinodimethane (F4-TCNQ). Photoelectron spectroscopy revealed that electron transfer from Au to adsorbed F4-TCNQ was responsible for lowering the hole-injection barrier by as much as 1.2 eV. This novel interface modification scheme is independent of the charge transfer complex formation ability of the organic materials with the electron acceptor.

CPP 19.3 Thu 10:15 ZEU Lich

Interaction of Me atoms with thin organic films: In (Sn, K)/CuPc — •Olga Molodtsova[1], Victor Aristov[1,2], Victor Zhilin[2], Denis Vyalikh[3], and Martin Knupfer[1] — [1]Leibniz IFW Dresden, Germany — [2]ISSP, RAS Chernogolovka, Russia — [3]IFF, TU Dresden, Germany

Among the Organic Molecular Thin Film Crystals the family of the phthalocyanines (Pc*s) plays an important role and many researchers pay attention to this materials. In the present investigation we have focused on the evolution of the electronic structure of CuPc films during metal deposition and on interactions during this process. The measurements were performed by means of high-resolution photoemission electron spectroscopy, core-level and valence-band, and using synchrotron-radiation facility. In particular we have found, that e.g. the In deposition onto CuPc films is characterized by two stages of the In/CuPc interface formation. The first stage takes place until a nominal In coverage of 6 Å and is characterized by strong diffusion of the In atoms into the organic film. In atoms occupy sites close to the pyrolle nitrogens, strongly interact and transfer negative charge to CuPc. This stage comes to the end when a stoichiometry of In2CuPc is reached. The second stage begins just after the first is completed, at about 7 Å: on top of the In2CuPc compound a metallic indium film is formed. This behavior will be compared with formation of Sn (K)/CuPc interfaces.

CPP 19.4 Thu 10:30 ZEU Lich

Self consistent theory of charge carrier injection at the metal-organic interface — •Frederik Neumann, Yuri Genenko, Christian Melzer, and Heinz von Seggern — Institute of Materials Science, Darmstadt University of Technology, Petersenstraße 23, D-64287 Darmstadt, Germany

The effect of the injection barrier on charge transport plays an important role in understanding and development of organic electronic devices. In previous studies this effect was considered in the special cases of low and high injection barriers.

The focus of the present study is on the development of an injection model which incorporates space charge effects. The challenge of this task is the problem of self-consistency. The amount of injected charge carriers injected per unit time strongly depends on the barrier height, while at the same time the electrostatic potential generated by the injected charge modifies the height of the injection barrier itself.

Here a self-consistent model of the injection process on metal/organic interfaces is presented. This model requires a proper description of both, the organic and the metal side of the interface.

To describe the metal a DOS of quasi-free electrons is chosen. The description for the organic semiconductor is based on a gaussian DOS. Since charge transport in organic semiconductors occurs by hopping of charge carriers between localized states, we introduced the concept of a mobility edge and a field dependent mobility. The resulting differential equations are solved in a self-consistent manner by introducing continuity of the electrochemical potential and electric displacement.

— 15 min. break —

Invited Talk CPP 19.5 Thu 11:00 ZEU Lich

Fast and stable integrated polymer circuits — •Walter Fix — PolyIC GmbH & Co KG, Guenther-Scharowsky-Str. 1, 91052 Erlangen, Germany

Printed electronics based on polymer transistors will enable the availability of electronics on nearly every product. This will create a new electronics revolution, not by replacing standard electronic based on silicon, but it will enable the realization of electronic intelligence to products, where there is no electronics today. This includes low cost radio frequency identification (RFID) applications, e.g. as a substitute of the optical barcode, as well as smart objects and electronics for flexible displays. This is possible due to the new polymer electronics technology, PolyIC combines soluble electronic polymer materials with high volume printing processes to archieve low cost, high volume printed electronics. Recent results on our technology as well as our roadmap towards printed electronics products will be presented, including fast and stable circuits as well as RFID Tags working at 13.56 MHz.

CPP 19.6 Thu 11:30 ZEU Lich

Full-Organic and Highly Efficient Top-emitting PIN-OLEDs for Display Applications — •Michael Hofmann[1], Thomas Stübinger[1], Philipp Wellmann[1], Martin Vehse[1], Jan Birnstock[1], Ansgar Werner[1], Jan Blochwitz-Nimoth[1], and Qiang Huang[2] — [1]Novaled GmbH, Tatzberg 49, 01307 Dresden, Germany — [2]TU Dresden, George-Bähr-Straße 1, 01069 Dresden, Germany

The next generation of active matrix displays is going to incorporate bright top-emitting organic LEDs. The top-emission design with high aperture ratio of 70% is favourable, because bottom emitting OLEDs suffer from the area occupation of advanced driving circuitry in the backplane. The concept of doped charge transport layers will easily enable the implementation on TFT-substrates. Furthermore, the approach ensures low operating voltage and high power efficiency over a large brightness range. Additionally, doped OLEDs can be adapted to a variety of electrode materials.

Essential requirements for OLED applications on reflective substrates are summarized. Performance and emission characteristics as well as lifetime data of full-organic OLED-stacks using molecular p- and n-doped transport layers are presented. In order to improve the quality of OLED-devices, thin film simulation tools are applied to study the influence of organic layer thicknesses and optical properties of both the top-most semi-transparent electrode and the reflective bottom contact. Microcavity effects are revealed and light outcoupling means are proposed.

CPP 19.7 Thu 11:45 ZEU Lich

Full-Color Polymer OLED Displays and White Solid-State-Lighting Devices Fabricated by Direct Lithography — •Anne Köhnen[1], Malte Gather[1], Klaus Meerholz[1], Aurélie Falcou[2], and Heinrich Becker[2] — [1]Institut für Physikalische Chemie, Luxemburgerstr. 116, Köln 50939, Germany — [2]Merck OLED Materials GmbH, Industrial Park Höchst, F 821, 65926 Frankfurt/Main, Germany

We report on a full color passive matrix display fabricated by a three step direct photo-lithography process. The device consists of parallel stripes of red, green and blue emitting conjugated polymers which are sandwiched between a transparent anode and a metal cathode in passive matrix geometry. The photo-activated oxetane-based crosslinking reaction which was used to pattern the emissive layers had no negative effect on the device performance. Each pixel in the final device can be addressed separately and covers an area of 0.3 mm^2. Pictures and animations were readily displayed on the panel using a commercially available passive matrix driver.

The color coordinates of the red (0.68,0.32), green (0.29,0.59) and blue (0.17,0.20) emitting polymers are well saturated and in good agreement with the PAL color standard for display applications. Colors within this triangle were accessible by adjusting the intensity of the primaries.

Due to the high efficiency of the device we also discuss application of the display as a solid-state white-light or mood-light source. The emission profile can be accurately adjusted to coincide with the white point or with any other color. At a brightness of 400 Cd/m^2 the power efficacy for white light (CIE=0.33,0.33) reaches 2.5 lum/W.

CPP 19.8 Thu 12:00 ZEU Lich

Large area polymer OLEDs for lighting — •Christoph Gärditz[1,2], Dirk Buchhauser[1,3], Ralph Pätzold[1], Oliver Weiss[1,4], Joachim Wecker[1], and Albrecht Winnacker[2] — [1]Siemens AG, CT MM 1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — [2]Department of Materials Science VI, University Erlangen-Nuremberg, Germany — [3]Department of Experimental Physics, University of Freiberg, Germany — [4]Department of Materials Science, Technical University of Darmstadt, Germany

Recently OLEDs have gained increasing attention for their use in the field of lighting and signage. Large area OLEDs open up completely new areas of application by offering a new freedom in design and shape. They can be used as a 2-dimensional light source which is thin, flat and lightweight generating diffuse, non glaring illumination. Unlike existing organic displays, OLEDs for lighting need to be optimized with respect to larger active areas with brightnesses in the range of 1000 cd/m2. However, on large active areas defects such as dark or bright spots are far more likely to occur. As they can affect the lifetime of the device and deteriorate its appearance, the investigation of both the origin and the temporal evolution of inhomogeneities is a major issue. In our contribution we present results on OLEDs for lighting applications based on white light emitting copolymers. Performance and characteristics are discussed with regard to the topics mentioned above.

CPP 19.9 Thu 12:15 ZEU Lich

New highly conductive formulation of PEDOT:PSS - a substitute of ITO for OLED anodes — •Karsten Fehse[1], Karsten Walzer[1], Gufeng He[1], Martin Pfeiffer[1], Karl Leo[1], Wilfried Lövenich [2], and Andreas Elschner[2] — [1]Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden, Germany — [2]H.C. Starck GmbH, Central Research and Development Division, c/o Bayer AG, Bldg. B 202, D-51368 Leverkusen, Germany

Standard organic light emitting diodes (OLEDs) emit through a transparent and electrically conductive substrate. Indium tin oxide (ITO) is usually used for this purpose. Due to increasing costs of ITO, we suggest the use of a polymer instead, which carries out both hole transport and injection. The OLED itself is based on a stack of small molecules with doped transport layers.We use a new highly conductive formulation of PEDOT:PSS with a conductivity of 500 S/cm, that provides a smooth and electrically suitable substrate for the OLED stack. We discuss both fluorescent and phosphorescent monochromic OLEDs based on such a formulation which achieve good efficiencies. The OLEDs made thereon will be compared with devices of similar stack on ITO.