Electrolyte-gated organic thin film transistors — \textit{Felix Buth$^1$, Marin Steenackers$^2$, Deepu Kumar$^1$, Martin Stuttzmann$^1$, and Jose Antonio Garrido$^1$} — 1Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany — 2Institut für Advanced Study, Technische Universität München, Arcisstr. 21, 80333 München, Germany

Organic semiconductors are today widely used as the active material in several applications based on thin film transistors. For most of these devices large operational voltages are required. One approach to reduce the gate voltage is increasing the capacitance of the gate dielectric. Several materials, including high-k dielectrics, ultra-thin cross-linked polymers or polyelectrolytes have been tested for this purpose. Among those, polyelectrolytes offer extraordinarily high capacitances with a relatively low technology cost. The high capacitance results from the electrical double layer formed at the polyelectrolyte/semiconductor interface, opening the possibility of using organic thin film transistors for biological and chemical sensors, in which in-electrolyte operation is required. Since, however, water stable organic semiconductors are generally deposited by evaporation in UHV, the surface of the polyelectrolyte needs to be smooth to enable the growth of high quality films. In this contribution the properties of different polyelectrolyte dielectrics are investigated. We show how polyelectrolytes can be directly prepared on conductive substrates, resulting in homogeneous films with high interfacial capacitances. Furthermore, we show the preparation of high quality pentacene thin films onto the polyelectrolyte films.
Macromolecular Chemistry, University of Bremen, Germany.
Perfluorinated phthalocyanines (F$_{3}$PC) show n-type characteristics as active layers in organic field transistors while organic field transistors with unsubstituted phthalocyanines (PC) exhibit p-type characteristics. The growth of F$_{3}$PC and PC films has been studied in OFETs on organic (polyimide, PMMA) and inorganic insulating layers (SiO$_{2}$) with different surface modifications (HAFs). Measurements. We report here about the dependence of the growth mode of the films and the field effect mobility on the used substrate for the copper complexes. The development of the electrical conduction was studied in-situ during film growth and the field effect mobility was determined for various film thicknesses in different regimes of the Stranski-Krastanov growth mechanism that led to the formation of ultrathin conductive layers in the monolayer range followed by reorganization towards island growth. Optical absorbance was measured in reflection or transmission in dependence of the used substrate to investigate details of the intermolecular coupling.

15 Min. Coffee Break

HL 20.8 Tue 11:30 H15
Carrier density in a Gaussian density of states: Approximation for the Gauss-Fermi integral — Gernot Paasch and Susanne Scheiner2 — IPW Dresden — TU Ilmenau

The density of hopping transport states in organics can be approximated by a Gaussian DOS. As a consequence, the mobility becomes a function of carrier density, field, and of course temperature. Such dependencies can now be implemented easily in advanced device simulation programs as Sentaurus Device. However, the carrier density as a function of the Fermi energy is not taken into account until now. For inorganic semiconductors with a square root DOS the situation was similar with the carrier density expressed by the Fermi-Dirac integral. Further Fermi-Dirac integrals are needed for the electronic energy density and for Einstein’s relation. For these cases analytical approximations have been developed early allowing for fast simulation. For the Gaussian DOS the carrier density is given by the integral over the product of Gaussian DOS and Fermi-Dirac distribution, the Gauss-Fermi integral. Related integrals describe the electronic energy density and occur in Einstein’s relation. Here we present an extremely simple and accurate approximation for the Gauss-Fermi integral and discuss its potential applicability in simulation of organic devices.

HL 20.9 Tue 11:45 H15
Comparative transport studies in Bridgman and sublimation grown 9,10-Diphenylanthracene single crystals — Andreas Steindam, Ashutosh K. Tripathi, Rainer Stöhr, Jörg Wrachtrup, and Jens Pflaum — Institute of Experimental Physics VI, Julius-Maximilians-University, 97074 Würzburg, Germany — Holst Centre/TNO, 5656 AE Eindhoven, NL — Physikalisches Institut, University of Stuttgart, 70550 Stuttgart, Germany

To improve organic electronic applications, knowledge about microscopic mechanisms determining the charge carrier mobilities is pivotal. Thus, the development of the electrical conduction was studied in-situ during film growth and the field effect mobility was determined for various film thicknesses in different regimes of the Stranski-Krastanov growth mechanism that led to the formation of ultrathin conductive layers in the monolayer range followed by reorganization towards island growth. Optical absorbance was measured in reflection or transmission in dependence of the used substrate to investigate details of the intermolecular coupling.

15 Min. Coffee Break

HL 20.11 Tue 12:15 H15
Energy band alignment at the oxide-organic interface ITO/ZnPC determined by photoelectron spectroscopy — Jürgen Gassmann and Andreas Klein — Surface Science Department, Istituto di Materiales Science, TU Darmstadt, Germany

The possibility to generate light on the front- and backside of an organic light-emitting diode (OLED) is given for inverted top-emitting OLEDs. For them the transparency of the back contact is crucial. Here, transparent conductive oxides (TCO) like indium tin oxide (ITO) or zinc oxide are of special interest, because these films can be deposited with magnetron sputtering at room temperature. In this work the energy band alignment between the organic material zinc phthalocyanine (ZnPC) and the transparent oxide ITO is evaluated. For this the X-ray photoelectron spectroscopy technique (XPS) is used and combined with an in-situ preparation of the films. The energy band alignments of the deposition sequences ITO on ZnPC and vice versa are compared. Here valence band offsets up to 1.3 eV can be detected. The energy band alignment shows a strong dependence on the deposition sequence. Additionally the electrical and optical properties of ITO films sputtered at room temperature are investigated.

HL 20.12 Tue 12:30 H15
Highly efficient white top-emitting organic light-emitting diodes with forward directed light emission — Patricia Freitag, Sébastien Reindl, Mauro Furrer, Björn Löser, and Karl Löser — Institute for Angewandte Physik, TU Dresden, George-Bähr-Straße 1, 01069 Dresden, Germany

The demand for highly efficient and energy saving illumination has increased considerably during the last decades. Organic light-emitting diodes (OLEDs) are promising candidates for future lighting technologies. They offer high efficiency along with excellent color quality, allowing substantially lower power consumption than traditional illuminants. Recently, especially top-emitting devices have attracted high interest due to their compatibility with opaque substrates like metal sheets. In this contribution, we demonstrate top-emitting OLEDs with white emission spectra employing a multilayer hybrid cavity structure with two highly efficient phosphorescent emitter materials for orange-red (Ir(MDQ)2(acac)) and green (Ir(ppy)3) emission as well as the stable fluorescent blue emitter TBP. To improve the OLED performance and modify the color quality, two different electron blocking layers and anode material combinations are tested. Compared to Lambertian emission, our devices show considerably enhanced forward emission, which is preferred for most lighting applications. Besides broadband emission and angle independent emission maxima, power efficiencies of 13.3 lm/W at 3 V and external quantum efficiencies of 5.3% are achieved. The emission shows excellent CIE coordinates of (0.420, 0.407) at approx. 1000 cd/m² and color rendering indices up to 77.