Improving the performance of phosphorescent light-emitting electrochemical cells without sacrificing stability

— Sebastian Meier1,2, Wiebke Sarfert2, David Hartmann2, and Albrecht Winnacker1

1 University of Erlangen-Nuremberg, Department of Materials Science, Chair VI: Materials for Electronics and Energy Technology, Martenstr. 7, 91058 Erlangen, Germany — 2Siemens AG, Corporate Technology, GTF ORE, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany

Within the past few years a novel class of solution-processable solid-state organic light-emitting devices referred to as light-emitting electrochemical cells (LECs) has attracted considerable interest. Key feature of these devices is the existence of mobile ions within the active layer, which enable in-situ electrochemical doping with subsequent formation of a light-emitting p-n-junction. Due to their simple architecture and the use of air-stable electrodes LECs are regarded as an attractive approach for flexible large area lighting applications.

To compete with state of the art lighting technologies, however, the overall device performance of LECs has to be improved. For this purpose, an optimization of the device configuration and processing conditions as well as the use of a proper driving mode can be helpful. We show that the performance can be significantly enhanced due to modifications in the stack configuration (e.g. interfaces, layer thickness, cathode), processing conditions and by an adequate mode of operation without any losses in the device stability.

OLEDs under high current densities – transient electroluminescence turn-on dynamics and singlet-triplet quenching

— Daniel Kasemann, Hartmut Fröös, and Karl Leo

Institut für Angewandte Physik, Technische Universität Dresden, 01062 Dresden, Germany

Organic solid state lasers have been intensively studied during the last decade due to the promising combination of versatile organic materials with the advantages of solid state emitters. Even though various optically pumped devices comprising different resonator types and material combinations have been shown, direct electrical pumping has not been achieved yet. The high excitation density needed in the active layer to achieve inversion is easily created by pulsed optical pumping, but additional losses prevent the excitation to reach the critical point when driven electrically.

To estimate the dimensions of these additional losses, we investigate full pin-OLEDs comprising the singlet emitter system DCM doped into Alq3 under high current densities. With the OLED active area reduced to 100×100μm², these devices sustain current densities in the order of kA/cm² in pulsed operation. The results of time resolved electroluminescence (EL) measurements as well as power dependent emission spectra give promising insight into the behaviour of OLEDs under these extreme excitation conditions. Intense EL transient turn-on peaks on the nanosecond time scale can be explained by modelling the singlet and triplet population taking into account singlet-triplet and triplet-triplet quenching in the emission layer.

Investigation of the chemical and electronic structure of F16CoPc from Monolayer to thick films by photoemission spectroscopy

— M. Grobosch and M. Knupper

IFW Dresden, D-01069 Dresden, Germany

We have grown F16CoPc with different film thickness under ultra high vacuum conditions on polycrystalline Au surfaces. By means of combined X-ray and ultraviolet photoemission spectroscopy (XPS, UPS) we have investigated the chemical and electronic structure of the F16CoPc films. Within the first monolayers we could identify a charge transfer from the substrate on the F16CoPc molecules. Our results indicate a clear difference in the valence band spectra for submonolayer thin and several nm thick F16CoPc films. Furthermore, for F16CoPc the ionization potential can be changed by the fluorination of the molecules from 4.8 eV for CoPc to 6.5 eV for F16CoPc. The investigated heterointerface CoPc/F16CoPc can be characterized as free from chemical reactions.

Influence of sample geometry and contact metal on the characteristics of organic field-effect transistors

— Dominik Klaus, Christopher Keil, Jan Hartel, and Derck Schlettwein

Institute of Applied Physics, Justus-Liebig-University Giessen, Germany. email:schlettwein@uni-giessen.de

Thin films of F16PcCu were prepared by physical vapor deposition on µ-structured electrode arrays of different contact metals. I/V-measurements of structures with various channel lengths showed a nonlinear injection of charge carriers for low Source-Drain-Voltages \( V_{DS} \). Such behavior was especially found for \( µ \)-structures of small channel length indicating an influence of the contact behavior at the interface between metal electrode and organic semiconductor channel. A model was developed based on different aspects of an injection barrier, channel resistance and a parameter characterizing the geometry of the conducting channel which were separately used in the literature before. The model was used to determine the charge carrier mobility also for low values of \( V_{DS} \) and consistent values with those from typically evaluated large \( V_{DS} \) in the saturation regime were obtained. Implications for technical applicability of such transistors and general validity of such model are discussed.