HL 85: Organic light emission

Time: Thursday 9:30–10:45 Location: POT 006

HL 85.1 Thu 9:30 POT 006

OLED Lifetime Limitation by its Intrinsic Emission Characteristics — •Mustapha Al-Helwi[1,2,3], Jonathan Helzel[2], Johannes Reinker[2], Hans-Hermann Johannes[2], Ute Heinemeyer[1], and Wolfgang Kowalsky[2] — [1]BASF SE, Ludwigshafen, Germany — [2]Technische Universität Braunschweig, Brunswick, Germany — [3]Innovation Lab GmbH, Heidelberg, Germany

Organic light Emitting Diodes (OLEDs) already have efficiencies comparable to current commercial light sources. However, the chemical degradation of the materials during operation is still a major obstacle for the development of economically feasible devices. Thus investigating the mechanisms of the degradation origin is highly important. In this study we focus on the blue phosphorescent OLED. We introduce a differentiating lifetime measurement setup for probing of material stability toward different stress mechanisms. We identify the instability of fac-tris(N-diphenyl-benzimidazole-carbene)iridium(III): (Ir(dpbic)3), a hole transport material, towards high energetic exciton-polaron interaction. A sophisticated OLED spectrum measurement indicates the emission of UV photons with intensities strongly correlated to the device lifetime. Underpinned with polaron spectra, we signify our aging hypothesis: UV photons are generated by (Ir(dpbic)3) and absorbed by its positive polarons leading to the degradation of the molecule and hence to the limitation of the device lifetime.

HL 85.2 Thu 9:45 POT 006

Electroluminescence of Tamm states in a hybrid OLED/microcavity structure — •Stefan Meister, Robert Brückner, Daniel Kasemann, Hartmut Fröb, and Karl Leo — Institut für Angewandte Photophysik, Technische Universität Dresden, D-01062 Dresden, Germany

We implemented an organic light emitting diode (OLED) into a high quality microcavity consisting of two distributed Bragg reflectors (DBRs). The OLED is composed of seven different layers. In order to electrically contact the active region it is inevitable to implement two metal layers. The high absorption coefficient of metal, however, limits the thickness and the positioning of these layers inside the microcavity.

Therefore simulations based on the transfer matrix algorithm are performed and the structure of the OLED is optimized to maximize the resulting quality factor of the microcavity.

After designing a suitable structure, the complete sample is realised and both electrically and spectroscopically investigated. Evaluating an electroluminescent spectra clearly shows emission from coupled resonances, so called Tamm states exhibiting quality factors of at least 800.

In summary it is possible to get electroluminescence from an OLED in a microcavity with quite high quality factors.

HL 85.3 Thu 10:00 POT 006

OLED - a light emitting thermistor? — •Axel Fischer[1], Thomas Koprucki[2], Klaus Gärtner[2], Daniel Kasemann[1], Björn Lüssem[1], Karl Leo[1], Annegret Glitzky[2], and Reinhard Scholz[1] — [1]Institut für Angewandte Photophysik, Technische Universität Dresden, 01062 Dresden — [2]Weierstraß-Institut (WIAS), Mohrenstraße 39, 10117 Berlin

For lighting applications, OLEDs need much higher brightness than for displays, causing substantial self-heating. Recently, it has been shown that the temperature-activated transport in organic semiconductors favors thermal runaway and the occurrence of negative differential resistance (NDR) [1]. Here, we show by experiment and simulation that OLEDs produce such a strong electrothermal feedback that S-shaped NDR occurs similar to a thermistor device [2] but with the difference that the OLED comes along with a laterally extended crossbar architecture. Self-heating combined with the sheet resistance of the transparent electrode produces regions with declining voltage across the organic layers under rising voltage applied to the contacts. Interestingly, a part of these regions shows decreasing currents. Then, the current density becomes extremely inhomogeneous because regions with increasing and decreasing currents can occur at the same time, leading to strong local variations in luminance. [1] A. Fischer, P. Pahner, B. Lüssem, K. Leo, R. Scholz, T. Koprucki, K. Gärtner, and A. Glitzky, Phys. Rev. Lett. **110**, 126601 (2013) [2] A. Fischer, T. Koprucki, K. Gärtner, M. L. Tietze, J. Brückner, B. Lüssem, K. Leo, A. Glitzky, and R. Scholz, subm. to Adv. Funct. Mater. (2013)

HL 85.4 Thu 10:15 POT 006

Photolithographic structuring of organic electroluminescent devices with state-of-the-art efficiency — •Simonas Krotkus[1], Fabian Ventsch[1], Daniel Kasemann[1], Alexander A. Zakhidov[2], Simone Hofmann[1], Karl Leo[1], and Malte C. Gather[1,3] — [1]Institut für Angewandte Photophysik, Technische Universität Dresden, George-Bähr-Straße 1, 01069 Dresden, Germany — [2]Fraunhofer Research Institution for Organics, Materials & Electronic Devices COMEDD, 01109 Dresden, Germany — [3]School of Physics & Astronomy, University of St Andrews, North Haugh, St Andrews, KY16 9SS, Scotland, UK

Photolithography is a well-established patterning technique used in various applications, including color filter structuring for LCD displays. However, its use in pixel patterning for organic light-emitting diode (OLED) screens to date is rather limited, due to the use of organic or water-based solvents, etchants and photoresists, which are known to be detrimental to the OLEDs. Thus, structuring via shadow mask is used instead, which has its limitations in the high resolution patterning as well as the scalability to the large area substrates.

To address the incompatibility between organic semiconductors and the processing steps of the conventional photolithography, we utilize a double resist approach. It consists of a fluoropolymer as a lift-off layer in combination with a traditional photoresist/solvent process to allow pattern transfer. The lift-off step is performed in hydrofluoroether solvents, which are shown to be compatible with state-of-the-art OLED technology.

HL 85.5 Thu 10:30 POT 006

Inorganic nanolaminate-encapsulation for organic light emitting diodes — •Aarti Singh[1], Frederik Nehm[2], Hannes Klumbies[2], Uwe Schröder[1], Lars Müller-Meskamp[2], Christoph Hossbach[3], Matthias Albert[3], Karl Leo[2], and Thomas Mikolajick[1] — [1]Namlab GmbH, Nöthnitzerstr 64, 01187 Dresden, Germany — [2]Institut für Angewandte Photophysik, TU Dresden, George-Bähr-Straße 1, 01069 Dresden — [3]Institut für Mikroelektroniktechnik, Nöthnitzerstr 64, 01187 Dresden

TiO2/Al2O3 and HfO2/Al2O3 multilayer of 20-100 nm total thickness have been tested for their diffusion barrier properties as direct encapsulation on organic light emitting diodes (OLEDs) and as indirect barrier layers on flexible PPET substrates. The different atomic layer deposition (ALD) process precursors, individual layer thickness and the total thickness of the nanolaminate stack were varied to evaluate optimum parameters that yielded best protection for OLEDs and resulted in lowest transmission rates for water. Water vapour transmission rates deduced out of electrical Ca test measurement reflect that the thin single layers (approx. 2 nm) in multilayer film stacks prove to be the best encapsulation layers in TiO2/Al2O3 system. WVTR values of 4x10-5 g/m2/day have been measured at 38°C, 90 RH in 20 nm thick ALD single layers deposited at 80°C. Luminescence measurements on OLEDs/Glass will be presented. The measurements are in accordance with the results of WVTR measurements and show that nanolaminates with thin single layers in the range of 0.5-1nm protect OLEDs better and longer than nanolaminates with thick single layers.