DS 16: Organic Light Emitting Diodes (SYOE 9)

Time: Wednesday 14:30–16:30 Location: H32

DS 16.1 Wed 14:30 H32

Dynamics of the triplet state in Alq_3 — •Nils A. Reinke, Johannes Höchtl, Valentin Kamm, and Wolfgang Brütting — University of Augsburg, Institute of Augsburg, Experimental Physics IV, Augsburg, Germany

As demonstrated by recent work, the organic electroluminescent material Alq_3 has a long–lived triplet state with a lifetime in the 10ms range [1]. Depending on the excitation density and the sample preparation delayed fluorescence and phosphorescence with varying relative intensities can be detected at low temperature. In order to get deeper insight into the underlying mechanism, we have combined different experimental techniques to study the triplet dynamics in Alq_3. Using time–resolved photoluminescence measurements on neat films, matrix-isolated molecules as well as films doped with phosphorescent emitters the direct observation of the excited states dynamics is possible in a broad time-window from the nanosecond to the millisecond range. Relatively intense phosphorescence can be observed in Alq_3 doped with phosphorescent molecules containing heavy metal atoms, such as $Ir(ppy)_3$[2]. A significantly reduced lifetime in such systems indicates that the transition rate of the triplet state to the ground state is strongly affected by the phosphorescent dopant. We will further demonstrate an indirect determination of the triplet lifetime in Alq_3 from singlet emission using a novel pump–probe technique. [1] M. Cölle et al., JAP 96 (2004) 6133-6141, [2] I. Tanaka et al., PRB 71 (2005) 205207

DS 16.2 Wed 14:45 H32

Charge trapping and triplet quenching in conjugated polymers — •Dirk Hertel and Klaus Meerholz — Institute of Physical Chemistry, University of Cologne, Luxemburgerstr. 116

According to spin statistics the formation of excited states in OLEDs from uncorrelated charge carriers yields 25% singlet and 75% triplet states, the latter do usually not contribute to electroluminescence. Little is know about triplet charge carrier (polaron) interaction in conjugated polymers. The quenching of triplets by polarons might play an important role for the degradation of OLEDs or for applications such as organic lasers, since triplets are accumulated in the device due to their long lifetime. From combined experimental investigations of time resolved emission and charge transport we are able to show that in a poly-spirobifluorene doped with PtOEP triplet polaron quenching is a major loss mechanism. We derived a triplet polaron quenching constant of about 10-13 cm3/s from direct measurements of the phosphorescence lifetime under space charge limited conditions. The influence of PtOEP concentration and film thickness on the quenching efficiency is studied. The investigation of charge transport by current voltage characteristics as a function of temperature yields hole mobilities of 10-4 cm2 /Vs for the SCLC regime. Comparison with mobility measurements depending on temperature and electric field by time of flight technique shows that in the SCLC regime the mobility is trap limited.

DS 16.3 Wed 15:00 H32

Photophysical properties of deep blue emitting Iridium complexes — •S. Haneder[1], E. Da Como[1], A. Rogach[1], J. Feldmann[1], P. Erk[2], E. Fuchs[2], K. Kahle[2], O. Molt[2], S. Nord[2], H. Reichelt[2], and G. Wagenblast[2] — [1]Photonics and Optoelectronics Group, LMU, 80799 München — [2]BASF AG, 67056 Ludwigshafen

Improving the efficiency of lighting is imperative in optimizing the use of available energy resources. Electrophosphorescence based organic light-emitting diodes (OLEDs) have shown an internal efficiency of nearly 100% [1]. For lighting applications it is mandatory to produce OLEDs with white light emission, based on red, green and blue phosphors. Highly efficient green and red OLEDs have been successfully demonstrated. However, the development of blue emitting phosphors with reasonable photophysical stability and operational lifetime is a real challenge and still needs to be addressed.

Here we present results on a new family of phosphorescent Iridium carbene complexes [2] emitting in the blue. By a combination of steady-state and time-resolved spectroscopy techniques we study the photophysics of these complexes in thin films. The results demonstrate the influence of the ligand chemical structure in tuning the emission colour. Moreover, the nature of the non-radiative pathways involved in the emission process is figured out on the basis of phosphorescence lifetime and quantum yield measurements. These non-radiative pathways are important in limiting the overall device efficiency.

[1] Y. Sun et al., Nature 440, 908 (2006) [2] BASF AG, PCT Patent Appl. WO 2005/019373, August 19, WO 2005/113704, May 18, 2004

DS 16.4 Wed 15:15 H32

Lifetime enhancement of organic top and bottom light-emitting diodes — •Michael Hofmann, Philipp Wellmann, Tobias Canzler, and Jan Birnstock — Novaled AG, Tatzberg 49, Dresden, Germany

Recent efforts regarding the development of organic light-emitting diodes (OLEDs) resulted in a major stability enhancement. Crucial factors are the improved metal electrodes and the introduction of an edge passivation layer preventing electrical shorts at the border of the anode contact. We present latest data on long-living top-emitting OLEDs with doped transport layers reaching 100.000 h for green and 12.000 h for blue devices at 500 cd/mˆ2.

Still the lifetime of blue OLEDs remains challenging because the stability of the emitter material itself is limited. Additionally, structures which generate high energy excitons place further demands on the adjacent transport and interlayer materials. A sensing layer method is applied to locate the position of the recombination zone. It contains a green emitter selected to quench blue excitons. The thin sensing layer is sandwiched in the predominantly electron-conducting emission layer (EML). In case of a high electron supply, the recombination zone is close to the EBL/EML interface and 6 nm wide. We conclude that this can be shifted away from the interface by an adjusted electron supply. The reduced stress on the surrounding organic materials and the broadening of recombination zone to 15 nm increases device stability. The presented blue bottom-emitting OLED with modified electron supply has a significantly increased lifetime of 18.000 h at 500 cd/mˆ2.

DS 16.5 Wed 15:30 H32

Polymer-based Optoelectronic Devices with Interlayers — •D. Neher[1], C. Yin[1], X. Yang[1], B. Pieper[1], B. Stiller[1], Th. Kietzke[1,2], and H.-H. Hörhold[3] — [1]Univ. Potsdam, Inst. Physics, 14469 Potsdam, Germany — [2]Inst. Mater. Res. & Eng. (IMRE), 117602 Singapor — [3]Univ. Jena, Inst. Org. Chem. & Macromol. Chem., 07743 Jena, Germany

Recently, a novel approach to insert ultrahin polymer layers with well-controllable electronic properties into solution-processed optoelectronic device structures has been proposed [1]. This approach allows to establish property-function relationships, which are not accessible by the study of conventional blend device. Experiments on electrophosphorescent devices as well as Kelvin-probe experiments under illumination showed that these layers are dense and exhibit a strong electron-blocking function [2]. Upon proper choice of the HOMO and LUMO level of the interlayer material, efficient recombination of charges at the interface could be realized. Comparable studies on bilayer and solar cell devices based on poly(p-phenylene vinylenes) suggest that the performance of these devices is not determined by charge transport and free carrier recombination. This supports the view that the efficiency to form free carriers is the main limiting factor.

[1] J. S. Kim, R. H. Friend, I. Grizzi, J. H. Burroughes, Appl. Phys. Lett. 87 (2006) 023506.

[2] X.H. Yang, F. Jaiser, B. Stiller, D. Neher, F. Galbrecht, U. Scherf, Adv. Funct. Mater. 16 (2006) 2156

DS 16.6 Wed 15:45 H32

Metal organic-interfaces and their impact on inverted top-emitting organic light emitting diodes — •Qiang Huang[1], Sebastian Scholz[1], Karsten Walzer[1], Karl Leo[1], and Michael Hofmann[2] — [1]Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden — [2]Novaled AG, Tatzberg, D-01307 Dresden

In order to compete with other flat panel display technologies, amorphous silicon TFT (α-Si TFT) backplanes,which operate by n-channel transistors,are desired in active-matrix organic light-emitting displays (AMOLEDs). Thus, inverted top-emitting OLEDs with a bottom cathode and top anode have to be implemented. However, inverted top-emitting OLEDs reported so far show worse performance, e.g. increased operating voltage, than their corresponding non-inverted coun-

terparts. This is mainly due to a charge carrier injection problem at the metal/organic interface. We use single carrier devices to study the difference between the metal-organic and organic-metal interface, where asymmetric I-V characteristics demonstrate different interface effects. It is found that when thermal metal deposition is used, the topmost organic layer is destroyed or reacts with hot metal atoms forming a deteriorated organic interlayer which hinders hole injection. In contrast, this effect is beneficial for electron injection in the non-inverted case due to the formation of additional gap states. Based on the study, highly efficient inverted top-emitting OLEDs are presented with a current efficiency well above 80 cd/A at a brightness of 1000 cd/m2.

DS 16.7 Wed 16:00 H32

Novel solution processable cathode structures for PLEDs — •Riikka Suhonen[1,2], Andreas Kanitz[1], Wiebke Sarfert[1], Ralph Pätzold[1], and Albrecht Winnacker[2] — [1]Siemens AG, CT MM1, Günther-Scharowsky-Str. 1, 91058 Erlangen, Germany — [2]Department of Material Science VI, University Erlangen-Nuremberg, Martensstraße 7, 91058 Erlangen, Germany

Polymer light-emitting diodes (PLEDs) have attracted much attention due to their potential use in large area, flat-panel displays. The key challenges related to the use in commercial applications are the device stability, device efficiency and the ease of fabrication.

The contacts between the inorganic and organic layers are known to play a crucial role in the PLED device performance. In general, low work function metals like barium or calcium are used to reduce the energy barrier height between the cathode and the polymer. Also the concept of a nanoscale thin interfacial layer of alkali halide salt, such as LiF, has been shown to increase the electron injection in OLEDs and is being widely used. However, both low work function metals and alkali halides are reactive towards atmospheric moisture and oxygen and must be processed under vacuum conditions.

In this contribution, we replace the low work function metals with a thin layer of alkali salt. We show that comparable diode performance can be achieved independent of the deposition method of the thin salt layer. We compare the performance of solution processed and evaporated salt cathodes to the standard barium-aluminum cathode.

DS 16.8 Wed 16:15 H32

Organic light emitting diodes on ITO-free polymer anodes — •Karsten Fehse, Gregor Schwartz, Karsten Walzer, and Karl Leo — Institut für Angewandte Photophysik, TU Dresden, D-01062 Dresden

The high material cost of indium, being the main component of the commonly used indium-tin-oxide anodes (ITO) in organic light emitting diodes (OLEDs), is an obstacle for the production of efficient low-cost OLEDs. Therefore, new anode materials are needed for large scale OLED production. Recently, we demonstrated that the polymer PEDOT:PSS can substitute ITO as anode. Another highly conductive polymer is polyaniline (PANI) that provides 200 S/cm with a work function of 4.8 eV. In this study, we use PANI as anode for OLEDs (without ITO layer underneath the polymer) with electrically doped hole- and electron transport layers and intrinsic materials in between. Fluorescent blue (Spiro-DPVBi) as well as phosphorescent green ($Ir(ppy)_3$) and red emitters ($Ir(MDQ)_2(acac)$) were used for single colour and white OLEDs. Green single and double emission OLEDs achieve device efficiencies of 34 lm/W and 40.7 lm/W, respectively. The white OLED shows a power efficiency of 8.9 lm/W at 1000 cd/m^2 with CIE coordinates of (0.42/ 0.39).