Influence of a magnetic field on the device performance of OLEDs

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Magnetic field effects in organic light emitting diodes (OLEDs) have attracted more and more attention in recent research activities. In an external magnetic field both the current flow through an OLED and the light emission from the device are increased. Even though the exact physical mechanism causing this magnetoresistance effect is not yet revealed we show strong evidence that the presence of triplet excitons within the device is linked to the appearance of the effect. We measured the magnetoresistance in different OLED structures as a function of magnetic field and driving voltage. Using different cathode and emitter materials we show a dependence of the magnetoresistance effect on the charge carrier balance within the device. In double-carrier devices a significant magnetoresistance effect is observed whereas in single-carrier devices the effect is lower by at least one order of magnitude. The effect occurs in fluorescent devices for voltages above turn-on and in devices where both electrons and holes are injected and form excitons. Introducing phosphorescent emitters in a fluorescent matrix results in a decrease of the magnetoresistance effect since triplet excitons are effectively removed from the system by radiative decay. In photoluminescence measurements no influence of an external field on the signal could be detected. Since optical excitation creates only singlet excitons this suggests that triplet excitons created after electrical charge carrier injection play a major role in the magnetoresistance mechanism.

FDTD and RCWA simulations of oled light extraction structures

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In a conventional bottom emitting organic light emitting diode about 50% of the generated photons are unguided and dissipated in the oled stack, the other 50% being emitted into the substrate (about 25% of which are extracted into air). The main reason is the refractive index mismatch between the organic layers (n=1.7-1.9) and the glass substrate (n=1.5). One possibility to extract the organic modes into the glass substrate is the application of scattering structures close to the emission zone, e.g. photonic lattices between the anode and the substrate. The prediction of the efficiency enhancement by numerical solution of the Maxwell equations for a radiating dipole in a planar medium including structured layers. We show how this can be accomplished with the Finite Difference Time Method and/or the Rigorous Coupled Wave Analysis. Efficient numerical implementations of these well-known methods are presented and their pros and cons discussed. The results of the simulations are compared to experimental values taken from the literature. The general conclusion is that extraction of the organic modes by scattering structures into the substrate seems to be limited by their strong attenuation due to absorption and the overlap of the modes with the scattering structures.

Towards an experimentally validated second-generation OLED device model

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Organic Light Emitting Diodes (OLEDs) are potentially high-efficiency, large-area light sources that can be used for general-lighting applications. In the past years, the luminous efficacy of prototype white OLEDs has shown a very fast, fivefold, increase. In principle, there seems to be no fundamental obstacles towards 100 lm/W efficiency, beyond that of fluorescent lamps. However, trial-and-error approaches as used today will in future not anymore be optimal for reaching that goal. In view of the ever-increasing complexity of OLEDs (20 layers or more), in the future development of efficient OLEDs, the availability of an experimentally validated device model will be crucial. In this talk, we present recent progress in the development of more advanced OLED device models, supported by experimental results.
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