Photophysics and Light-extraction in Organic Light-emitting Diodes

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The quantum efficiency of organic light-emitting diodes is a product of different factors which have to be optimized separately to achieve highly efficient devices. Besides a balanced charge carrier injection and transport, two of the most important factors are the singlet-triplet ratio and the efficiency of coupling light out of the multi-layer stack.

The first part of the presentation will be devoted to photophysical investigations of Tris(8-hydroxyquinoline)aluminium (Alq_3) which still serves as a model system for organic singlet emitters. By time resolved fluorescence and phosphorescence spectroscopy we demonstrate the importance of bimolecular processes involved in intersystem crossing between singlet and triplet states.

In the second part we will present results on light-extraction from organic multi-layer OLEDs. Although the internal quantum efficiency of organic light-emitting diodes can reach values close to 100%, the fraction of light that is actually leaving the device is considerably less. Loss mechanisms are for example waveguiding in the organic layers and the substrate as well as the excitation of surface plasmons at metallic electrodes. Using numerical simulations we are able to identify and quantify different loss mechanisms. This enables us to derive design rules for efficient OLED stacks.