

Abstract

This work includes the synthesis of organic semiconductors with excellent properties in terms of efficiency and lifetime concerning their application in organic light-emitting diodes (OLEDs). The physical properties of these materials were tuned by straight-forward chemical modifications. Moreover, the materials allow the fully solution based fabrication of modern multi-layer devices, due to their functionalization with crosslinkable oxetane moieties. Cationic ring opening polymerization (CROP) of the materials forms an insoluble polyether network. Thus, additional layers can be introduced into the device architecture without dissolving previous layers.

The first part of this thesis focused on the development of a new series of hole-conducting molecules, based on the 1,1-bis[4-[*N,N'*-di(*p*-tolyl)amino]phenyl]cyclohexane (TAPC) hydrocarbon core. The important energy levels, such as highest occupied (HOMO) and lowest unoccupied molecular orbital (LUMO) of these materials were varied by chemical modification. This was achieved by attaching electron withdrawing or –donating subunits to their aromatic core. The impact of changes in their energy levels was investigated in terms of the efficiency of blue phosphorescent solution based OLEDs. Moreover, the results were compared to a different class of hole-conductors, *N*⁴,*N*⁴,*N*^{4'},*N*^{4'}-tetraphenylbiphenyl-4,4'-diamine (TPD), which were used instead of the TAPCs in an analog device architecture. In relation to the higher hole mobility and higher LUMO level at comparable HOMO, TAPC based devices outperform OLEDs with TPDs as hole conducting interlayer. Also, the triplet energies of the TAPCs are higher than the ones of TPDs. This impedes the thermal energy back transfer from excited emitting molecules to non-radiative states of the adjacent hole-conductor.

The second part of this thesis focused on the synthesis of electroluminescent materials based on Ir(III)-complexes and on the synthesis of host materials based on spirobifluorenes and carbazoles, respectively. These materials were implemented as a so called host-guest system into a multi-layered OLED fabricated entirely from solution. In addition, these OLEDs were optimized regarding their maximum luminous efficiency.

Transition-metal complexes, such as Ir(III)-compounds, were used as the guest in the above mentioned host-guest system. They allow the emission from triplet states due to enhanced spin-

orbit coupling. In contrast to fluorescent emitters, phosphorescent materials can yield an internal quantum efficiency of unity in electrically driven OLEDs due to simple spin statistics. When the energy level alignment of the host-guest system fits, triplet harvesting yields enhanced efficiency of the OLED.

Host materials were synthesized based on carbazole compounds, as those feature a high triplet energy and an acceptable hole mobility. Additionally, spirobifluorene based counterparts were developed as well. They allow the combination of two molecular segments, e.g. donor and acceptor, on one molecule by a bridging spiro carbon atom. Thus, donor and acceptor have a perpendicular orientation to each other, which decouples their electronic systems. As a result, their original properties are preserved. Due to the spatial separation of HOMO and LUMO in the spiro-compounds, their singlet-triplet-splitting energy is reduced in comparison to non-spiro bridged counterparts. This ensures a high triplet energy of the host and consequently impedes the energy back transfer from an excited triplet state of the guest to non-radiative triplet states of the host.

The discussed compounds were successfully incorporated into multi-layer, fully solution-processed OLEDs and were tested therein. Despite a lower triplet energy level, the host materials based on spirobifluorene outperformed the carbazole type host materials in terms of luminous efficiency. The main reason for this is the bipolar character of the spirobifluorenes, which ensures charge carrier balance inside the emitting layer. As a result, higher quantum efficiencies are achievable.