

Abstract

In this work organic semiconducting host materials for phosphorescent emitters are synthesized and characterized. The novel host materials feature distinguished properties in terms of their suitability for the application in highly efficient solution processed multilayer OLEDs. The physical properties are modified by using a combination of counteracting subunits for a bipolar character and by changing the kind of electronic decoupling (by a spirobifluorene core or by a connection of a phenyl group in m- and o-position (m/o-linkage)). The host materials consists of hole conducting triphenylamine subunits and different electron conducting subunits: nucleophilic hetero cyclic rings, non-nucleophilic fluorene containing phenyl groups or pure phenyl compounds. Through these bipolar properties a balanced charge transport can be realized resulting in advanced charge carrier recombination within the emitting layer.

The synthesis of phosphorescent green Ir(III)-complexes allow a highly efficient emissive layer due to harvesting from both singlet and triplet states. This is due to strong spin-orbit coupling by the heavy-metal. Thus, an internal quantum efficiency of up to 100 % can be reached. The application of a host:guest system in which small emitter content doped into a host prevents undesired concentration quenching and triplet-triplet annihilation. The energy levels of the guest need to be enclosed by the energy levels of the host to effectively confine the excitons on the emitting material achieving high device efficiencies. The HOMO energy levels are determined by cyclic voltammetry measurements and the bandgap was obtained from absorption spectra to calculate the LUMO energy levels of organic semiconductors. Finally, the first excited singlet states are obtained from fluorescent spectra.

All organic semiconductors were equipped with oxetane moieties, which can be crosslinked by a cationic ring-opening polymerization with the help of an electrophilic initiator. The resulting insoluble polyether layer allows the fabrication of solution based multilayer OLEDs. Since nucleophilic positions

within the host inhibit the crosslinking reaction, crosslinking tests were performed to improve the polymerization degree. Additionally, the required initiator concentrations could be reduced and hence, luminescence quenching was minimized. All investigated organic semiconductors were successfully implemented into fully solution processed multilayer OLED devices. Attributable to a better energy alignment concerning the emitter of the m/o-linked host materials higher current efficiencies were achieved compared to the spiro-linked compounds.

In the second part of this work inorganic Si and Ge nanoparticles of different sizes were generated. The surface of the NPs was modified with organic ligands (anisole for Si and TPD for Ge) resulting in novel hybrid materials. Thus, favourable properties of both material classes can be combined such as conductivity of the metal and flexibility of the organic material. Finding the best way of synthesis different methods like Schlenck techniques, microwave reactions or a directly on-substrate approach were investigated. Kelvin Probe measurements of the Ge NPs were performed to determine the work function investigating the influence of organic ligand and different sizes of NPs. Through surface treatment of the NPs with organic ligands, stable dispersions are formed. However, film formation of the hybrid NP solutions had to be improved due to the addition of other solvents and using freshly synthesized particles. To investigate their suitability as hole conducting layers TPD encapsulated Ge NPs were implemented in solution processed OLEDs.