ABSTRACT OF PHD THESIS

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Title: ***Solution processed OLEDs based on host–guest systems***

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The doctoral thesis concerns research on the mechanisms responsible for efficient emission of solution processed organic light emitting diodes (OLEDs). These studies were devoted to the phenomena occurring in emissive layers based on host–guest system. Two main competitive pathways were considered, *i.e.* exciton energy transfer and charge carriers trapping processes. This aim was realised by photoluminescence, electroluminescence and thermoluminescence results analysis.

Fabrication and characterisation of solution–processed OLEDs with use of new iridium (III) (Ir) complexes are reported in this work. A great amount of ionic and neutral benzo[*h*]quinoline–based heteroleptic emitters were investigated. Photophysical properties of Ir complexes have been determined in solutions as well as in thin films. Majority of complexes exhibit dominant contribution of metal ligand charge transfer (MLCT) states in the radiative recombination. Studied ionic compounds emit light in colour range from green to orange, whereas all β–ketoiminate complexes can be classified as green emitters.

Performed studies of photophysical behaviour of examined compounds helped to select the most promising emitters for electroluminescent devices. OLEDs were fabricated based on chosen emitters, and their fundamental operating parameters were determined. The analysis facilitated selection of the most efficient emitter, that was applied in further investigations. Working parameters obtained for the best single–layered device were as follows: current efficiency of 12 cd/A, external quantum efficiency of 3.2 % and luminance around 16 000 cd/m^2.

Furthermore, efforts have been made with the interest of efficiency enhancement. In order to support exciton energy transfer a sensitizer was introduced to host–guest systems. Two compounds exhibiting thermally activated delayed fluorescence (TADF) were examined as the assistant dopant. In case of 'matrix–TADF' and 'matrix–TADF–Ir complex' systems various matrixes and wide range of dopants concentrations have been considered. The impact

of their different compositions was checked in order to receive the most efficient OLED. Significant improvement of working parameters was achieved by TADF material insertion into the host–guest emissive system. The best OLED presented current efficiency of 24 cd/A, external quantum efficiency ~7.5 % and luminance over 18 000 cd/m^2.

Further investigations of charge carriers trapping and recombination processes in selected systems were carried out by using spectrally resolved thermoluminescence method in temperature range of 20–315 K. The analysis of photoluminescence, electroluminescence and thermoluminescence results allowed establishment of dominant mechanisms responsible for efficient emission of OLEDs. In case of 'host–phosphorescent guest' systems charge carriers trapping processes on the emitter molecules seems to be prevailing. On the contrary, for systems enriched by TADF sensitizer, exciton energy transfers are contributing foremost.

In addition, attempts of OLEDs emissive layers fabrication by printing technique were made. Slot–die–coating technique was examined as an alternative to spin–coating method. Development of printing conditions allowed to obtain successfully emissive layers with similar quality by using both techniques. As a consequence, efficiencies of OLEDs based on 'matrix–Ir complex' emissive layer were comparable. Nevertheless, negative impact of the atmosphere condition on 'matrix–TADF–Ir complex' system was observed. Such OLEDs were three times less efficient due to quenching of TADF molecules excited states by oxygen. This detrimental effect was minimised by printed layers annealing in the nitrogen atmosphere. Such approach allowed to receive two times more efficient slot–die–coated OLEDs. Therefore, devices preparation by means of this technique in the inert environment should offer fabrication of efficient devices independently of applied materials.

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