Abstract

Thin-film electroluminescent diodes with an active layer composed of II-VI colloidal quantum dots

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This dissertation covers the problems associated with the fabrication and characterization of electroluminescent diodes with an active layer composed of II-VI colloidal quantum dots (QLEDs). The study aimed to elaborate the methodology for QLEDs fabrication and to address selected technological issues related to their operation.

The first part of the results presents the synthesis method of thick-shell CdSe@ZnS/ZnS colloidal quantum dots with a gradient alloy core/shell structure emitting at 515 nm, which are used as an active layer, and provides a description of their optical and electrical properties. Next, the QLED structure, which comprises phosphomolybdic acid PMA as a substitute for the PEDOT:PSS hole injection layer and the ZnMgO electron transport layer obtained by the sol-gel method, is proposed. In particular, the transport properties of the ZnMgO layer are discussed in the context of optimization of device parameters. Obtained results lead to the demonstration of the working prototype and confirm the usefulness of both materials in QLEDs construction.

In the next part of the thesis, the performance of QLED is extended by implementing additional features such as flexibility and transparency. It is proposed to use PMA/Au/PMA electrode as a substitute for the commonly used ITO/PEDOT:PSS electrode and ZnMgO/Au/PMA electrode as an alternative to Al contact. The conducted research results in the demonstration of prototypes of flexible and transparent QLEDs.

In the last part of the thesis, QLED manufacturing in the ambient atmosphere is investigated as an important technological issue. The research focuses on the nanoparticle ZnMgO layer and the influence of its exposure to air on the efficiency and stability of QLEDs. The study consists of the examination of optical and electrical properties of ZnMgO in various atmospheres. The performed tests confirm that ZnMgO contact with air is beneficial to QLED performance and shed light on the possibility of device fabrication without the protection of an inert atmosphere, which is important from the point of view of balanced production costs and the availability of QLED technology.