Project 4.34. Spectroscopic studies of ZnMgO)O/Zn(Cd)O:Eu/ZnMgO quantum structures

Supervisor: Prof. Adrian Kozanecki/Dr hab. Ewa Przeździecka

Institute: Institute of Physics of the Polish Academy of Sciences

Unit: Division of Physics and Technology of Wide-Band-Gap Semiconductor Nanostructures. ON4.4 Group of Electron Microscopy and Electron Spectroscopy (Formerly - Group of MBE Growth of Oxide Nanostructures).

www. http://info.ifpan.edu.pl/Dodatki/WordPress/on44pl/

Background:
Red luminescence from wide band gap semiconductors is a key technology for realizing novel light-emitting devices such as integrated full-colour displays. To date, optoelectronic devices based on InGaN-compounds have achieved high performance in the near-ultraviolet to green spectral regions. However, using InGaN in the red spectral ranges remains a challenge at the higher indium content due to the degraded crystalline quality of InGaN quantum wells and strong local internal piezoelectric fields in c-oriented active layers. In this project we propose another approach to red emitters, namely ZnO-based oxides doped with Eu (ZnMgO, ZnCdO layers and quantum wells). There is no information in literature about optical properties of Eu in these kinds of quantum structures. So, the way of incorporation of Eu atoms into oxide quantum structures and mechanisms of excitation of Eu ions are entirely unexplored area.

Aim:
In the first stage of the project simple ZnO:Eu QWs will be studied to examine the influence of quantum confinement on the photoluminescence (PL) efficiency. In this part of the project two types of structures will be tested: c-oriented polar and m- or a- oriented nonpolar structures. The main idea of using non-polar substrates is to get rid of the polarization fields in hexagonal wurtzite structure and their negative influence on recombination processes in ZnO-based quantum wells and superlattices. Growth of nonpolar multilayer structures seems to be favorable for the emission efficiency, when dopants are located in optically active regions such as quantum wells. This is a very important issue for the final outcome of the project. We want to check experimentally how spatial separations of charge carriers may influence the PL efficiency of Eu3+. It will tell us quite a lot about mechanisms of excitation and this is another aim of this project. Manipulation with the barrier heights should allow to find the optimum compositions for the maximum emission of Eu. It is also expected that the project will answer the question about the role of Eu2+ charge state in excitation of the red emission of Eu3+ ions.

Requirements:
Master of Sciences in solid state physics (preffered), or in material sciences, or in chemistry, but with some interests in solid state physics; basic knowledge of the methods of optical spectroscopy, knowledge of written and spoken English; some knowledge of principles (and practise) of MBE technology is welcome.