Electro-optical studies of deep levels in MBE grown *n*-ZnMgO/*p*-Si heterostructures with ZnO/ZnMgO quantum wells

E. Zielony[1], F. Oriold[2], K. Gwóźdź[1], E. Płaczek-Popko[1], K. Paradowska[1], M.A. Pietrzyk[3], and A. Kozanecki[3]

[1]Department of Quantum Technologies, Faculty of Fundamental Problems of Technology, Wroclaw University of Science and Technology, Wybrzeze Wyspianskiego 27, 50-370 Wroclaw, Poland
[2]Institute of Functional Materials, Department of Physics, Technical University of Munich, James-Franck-Strasse 1, 85748 Garching, Germany
[3]Institute of Physics, Polish Academy of Sciences, al. Lotnikow 32/46, 02-668 Warsaw, Poland

It is well known that zinc oxide (ZnO) is a promising functional material which can be efficiently used in various optoelectronic devices, e.g. light emitting diodes. The possibility of a self-organized growth of ZnO-based nanostructures opens up new perspectives of application for this compound. For research and application purposes the band-gap engineering of ZnO is necessary. In ZnMgO the band gap can be tuned from 3.3 eV to 4.5 eV by substitution of Mg atoms into Zn sites. Therefore, ZnMgO is an appropriate candidate as a barrier material for ZnO quantum wells (QWs). QWs of ZnO/ZnMgO reveal type-I of band alignment, which is favorable for the emission efficiency. Taking into account the potential applications of ZnO-based structures a lot of effort is directed towards their fundamental studies.

It is well known that defects present in ZnO-based compounds are responsible for the occurrence of luminescence in the visible spectral range. The literature data report that deep level emission (DLE) can be attributed to transitions between the native point defects which are common in ZnO and most widely observed in ZnO nanostructures [1, 2]. However, the origin of emission from defects' levels is still unclear. According to these facts, the investigations of ZnO-based heterostructures for the presence of defects is of great importance.

In this work we focus on the defects studies in the molecular beam epitaxy grown *n*-ZnMgO/*p*-Si heterostructures with ZnO/ZnMgO QWs located in the ZnMgO nanocolumns. Deep level traps have been studied by means of photoluminescence (PL) and electrical measurement techniques, such as: current-voltage and capacitance-voltage (C-V) characteristics as well as deep level transient spectroscopy (DLTS). PL examined in the near-UV spectral range has provided information on the excitonic transitions associated with QWs. A strong emission peak located at 540 nm assigned to DLE has been also observed. The origin of the emission band in the PL spectra has been analyzed by means of electrical methods. The C-V results proved that the depletion region of the studied diodes is located within the *n*-ZnMgO. The DLTS measurements reveal the presence of electron trap-related signals. The activation energies and capture cross sections of these traps were determined and their possible origin has been discussed.

[1] E. Lai, et al., *Nano Res.* **1**, 12-128 (2008).
[2] J. R. Sadaf, et al., *Nanoscale Res. Lett.* **6**, 513 (2011).

Acknowledgements: The project was supported by the Polish National Science Centre (NCN) based on the decision No: DEC-2013/09/D/ST5/03881.