Investigation of intermixing in single quantum well and multi-quantum well structures of ZnO/ZnMgO and ZnO/ZnCdO

The most urgent need of modern electronics and optoelectronics is development of cheap and efficient sources of light and means of its detection. This involves visible sources of light as well as in ultraviolet and infrared. Despite the fact that there is quite a number of technologies and materials in the industry which cover almost whole spectral range, these technologies are still either expensive, toxic or energetically inefficient. However there exists a range of materials, which meet all requirements of modern light sources and detectors. Those are materials based on zinc oxide, which not only is abundant in the Earth crust but also very cheap and making possible to fabricate all variety of nano-forms and nano-structures. ZnO-zinc oxide is well known for some of time and used for ex. in cosmetology and construction, but only relatively recently, due to its semiconductor properties, it is a subject of intense studies as a potential material for optoelectronics and medicine.

In order to fabricate future ZnO-based devices, two requirements should be satisfied. The first is a possibility of fabricating diodes, which means elaborating technology allowing for obtaining semiconductor materials with electron conductivity and hole conductivity. The second is modulation of the band gap in active layers, barriers and quantum wells. Natural candidates for such manipulation of a ZnO parameters are magnesium oxide (MgO), which makes bandgap broader – shifts emission to ultraviolet, and cadmium oxide (CdO), which makes bandgap narrower – shifts emission to infrared. Both compounds cause a lot of problems during alloying with ZnO due to unlike and natural arrangement of atoms in each compound. This leads to low solubility, instability and low emission and detection efficiency. Despite of great progress in means of obtaining more and more perfect and specialized ZnO based materials, there is more questions than answers concerning alloying.

In this proposal we focus on intermixing and interdiffusion in quantum structures of ZnO/ZnMgO and ZnCdO/ZnO. Current semiconductor structures are very complex and contain heterojunctions and quantum well structures. This requires alloys and because of the presence of the large concentration gradients, their thermal stability is of primal importance. Interdiffusion of matrix components during processing is of inevitable concern, as it may lead to composition changes at the interfaces and well profiles and consequently to alteration of QW structure parameters and device parameters, in which given structure may found its application. Therefore, a quantitative knowledge of the inter-diffusion parameters during thermal processing and intermixing during ion implantation followed by annealing is essential. The study of intermixing and inter-diffusion gives information about thermal stability of such structures, about enhanced intermixing due to implantation and possible ways to overcome obstacles limiting further commercialization of ZnO.