Structural and spectroscopic studies of the influence of Ga flux on the growth of graded p-AlGaN contact layers

Poster/Oral Presentation
Date of presentation
Time of presentation

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AlGaN structures with high Al content are the basic materials for deep UV applications like sterilization of medical equipment, sensing, water, and air purification[1,2]. Currently, mercury lamps dominate the UV emitter market. However, light-emitting diodes based on AlGaN have many advantages over mercury lamps, such as low toxicity, the possibility of tuning the emitted wavelength, small size, and long working time. The only drawback is the low emission efficiency of such devices, which arises from, e.g., low hole concentration of the p-AlGaN layer. One approach to improve p-doping properties in (Al)GaN-based materials is using a method called polarization doping by growing the graded p-AlGaN layers.

In the presented paper, the graded p-AlGaN contact layers were deposited by plasma-assisted molecular beam epitaxy with different III/N ratios. Pandey et al. have shown that the growth of AlGaN structures with higher Ga flux allows for enhanced Mg dopant incorporation[3]. For this purpose, the influence of Ga flux on the growth of the gradient p-AlGaN structures and their structural and electrical properties was investigated. The surface quality of the layers was studied in situ by reflection high-energy electron diffraction and atomic force microscopy. The samples' electronic structure, chemical compositions, and crystalline quality were investigated by X-ray absorption spectroscopy (XAS), X-ray Photoelectron Spectroscopy, and Transmission Electron Microscopy (TEM). The polarity of the layers was analyzed using TEM. Our findings reveal that Ga flux significantly influences the structural quality and the type of conductivity of the obtained graded p-AlGaN contact layers. Deposition with the higher Ga flux leads to 2D growth and reduces the surface roughness but changes the type of conductivity to n-type.

Acknowledgements: This project was financed by the National Science Centre (NCN) Poland [2020/37/N/ST3/02248]. The authors acknowledge the Synchrotron SOLARIS for the provision of synchrotron radiation facilities. We would like to thank dr Marcin Zając and dr. Joanna Stepień for their assistance in using beamline XAS during the experiment.

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