SUMMARY

„X-ray diffraction in the study of lattice mismatched alloys and semiconductor structures"

The PhD dissertation: entitled: "X-ray diffraction in the study of lattice mismatched alloys and semiconductor structures" was carried out in the Department of Nanometrology at the Faculty of Electronics, Photonics and Microsystems of the Wroclaw University of Science and Technology under the supervision Jarosław Serafińczuk, PhD. DSc., Prof. of WrUST

The aim of the work was to develop methods for characterization of lattice mismatched alloys and semiconductor structures with the use of modified measurement techniques and methods of results analysis. Parameters such as: dislocation density, lattice parameters and the resulting values of deformation and stresses of the crystal lattice, or the thickness of low-dimensional structures were tested.

In the presented dissertation, two main parts can be distinguished: the theoretical (literature) part and the research part. The theoretical part presents a description of the elements of crystallography, which lists issues related to the basic issues of crystal structure, such as: unit cell, reciprocal lattice or space group. Then, the main measurement method used in the research on lattice mismatched alloys and semiconductor structures - X-ray diffraction, was described. This chapter explains such issues as the derivation of the Bragg equation, description of the most important elements of the X-ray diffractometer structure, or the presentation of its principles of operation.

The research part of the dissertation was divided into three areas. Each of them presents a theoretical description of the presented issue and the results of the research. The first part describes the defects in the crystals. It includes the characteristics of point, line and surface defects along with a description of the methods for determining the value of dislocation density. This area describes the use of an innovative method of determining edge dislocation density values for various materials, including GaN, AlN, AlGaN, Ammono GaN. The chapter shows that thanks to the developed method it is possible to determine the edge dislocation density directly using the edge geometry.

The next part is devoted to strain and stress - the formation, the impact of their occurrence and the methods of their determination. In the course of the research, a direct method of determining the lattice parameters and calculating the strain and stress values was developed based on the XRD measurements taken from the surface and from the edge of the

sample. The influence of the deposited layer thickness on the stress and strain values in the AlN/sapphire structures was determined.

The third part consists of the description of the application of the Fourier transform in determining the thickness of epitaxial layers. The algorithm developed by the author is based on the analysis of the four-component InGaAsN quantum well structures. It has been shown that the use of the Fast Fourier Transform in the analysis of diffraction curves made by means of X-ray diffraction greatly improves the process of analyzing periodic structures.

In conclusion, the doctoral dissertation developed a research methodology enabling the characterization of lattice mismatched alloys and semiconductor structures. The developed measurement methods and techniques presented in the paper are used for the characterization and analysis of various epitaxial structures. Much of the research presented in this dissertation has been published in international journals.

PhD student signature