Abstract of the doctoral thesis by Błażej Jabłoński, MEng,

"Analysis of the electric field dynamics in non-uniformly illuminated photorefractive multiple quantum wells structures"

The subject of this dissertation is the theoretical analysis of the dynamics of processes and the influence of nonlinear phenomena occurring during the formation of the space-charge field in inhomogeneously illuminated semi-insulating structures multiple quantum wells structures.

Nonlinear phenomena are strongly inherent in the nature of the systems of the world around us. As a result, they play an important role in many branches of modern science and technology. Their occurrence in some scientific disciplines is treated as an undesirable effect. This is different in the case of phenomena studied in some branches of optics. The search for and characterization of new optically nonlinear materials is a challenge undertaken by many research groups around the world. In this paper, I describe the positive aspect of the occurrence of near resonant nonlinear phenomena in photorefractive multiple quantum wells, which enables the application of these materials, for example, for efficient switching and processing of light signals.

The main goal of the dissertation was to complement the results of previous work on two-wave mixing in PR-MQW structures and to improve the methods of their analysis, including, among other things:

- comparison of two methods of solving equations describing the studied phenomena, the analytical and the numerical method, and determination of the scope of their applicability,
- analysis of the dynamics of optically induced distributions: concentration of charge carriers, concentration of ionized traps and internal electric field for different experimental conditions,
- investigating of the influence of material parameters of the structure, such as the type and concentration of impurities and the carrier trapping coefficient, on photorefractive phenomena,
- expanding the previously used numerical model to take into account the moving gratings,

- comparing the obtained results of numerical calculations with experimental results and approximate calculations made using a method based on the linearization of the equations.

After the analysis, it can be concluded that the numerical method used for the calculations, extended for the purposes of the described research, allows a detailed analysis of the effect of the photorefractive phenomenon. It also made it possible to obtain a better agreement between the results of calculations and experimental data described in earlier works.

The dynamics of the electric field in multiple quantum well structures is quite complex, which , among other things, is due to the nonlinearity of electron transport. The course of phenomena depends on the concentration of defects, the trapping coefficient, the intensity of light and the modulation depth of the interference pattern. The numerical model presented here makes it possible to analyze all these dependencies, but often requires lengthy calculations. The advantage of the analytical method, on the other hand, is the possibility of obtaining a very quick evaluation of the influence of various parameters on the course of the phenomenon in this dissertation. The range of applicability of the two methods is defined and a high degree of agreement in this regard is shown.