Report on the thesis

Study of the structure of ferromagnetic semiconductors by x-ray scattering methods

submitted by Mr. Lukáš Horák

The main topic of the presented thesis is the investigation of Mn-doped GaAs layers deposited epitaxially on GaAs substrates. The thesis is structured very clearly, with an introduction outlining the addressed problem, namely the incorporation of Mn at different sites in the GaAs crystal lattice and how to determine the different concentrations, as well as the current scientific state and the methods Mr. Horák is using to solve the problem.

The choice of methods is well motivated, and the methods are explained in very great detail, where methodological development was a central issue of the thesis, as in the case of high-resolution diffraction experiments and drift-diffusion simulations to understand the obtained impurity profiles at different stages of sample preparation, i.e., after growth as well as after various annealing steps. Other methods, which have been used but not developed further in thesis, are briefly introduced, which appears appropriate.

The two main aspects of the thesis, the interpretation of the diffraction experiments and the drift-diffusion simulations, are described and discussed in very great detail, and also very critically, giving not only the final results (defect concentrations in different crystal sites, which actually differ from previous assumptions, and the diffusion parameters of the drift-diffusion model), but also highlighting the experimental and numerical uncertainties and the limits and meaning of the developed methods and obtained results. I have to say that I really enjoyed this critical review, which nowadays is only very seldom found in published manuscripts.

The work is completed by several complementary experiments, which help to clarify issues to which high resolution x-ray diffraction with laboratory equipment is not sensitive (enough), again these experiments appear well planned and conducted. Of course, one would always like to obtain more complete sets of experimental data, which is clearly not possible due to time limitations using synchrotron radiation. What surprised me a little bit is the fact that this seems to be true even for laboratory experiments in the home lab, where measurement time is expected to be easier to obtain.

The results of the thesis are important in two aspects: on the one hand, the findings about the Mn distribution in (GaMn)As layers go significantly beyond the knowledge before the thesis, which is also reflected in Mr. Horák's publication record. Secondly, the method he has developed is applicable for the investigation of (GaMn)As epilayers. In principle, the method is also applicable to other material systems. It would be interesting to learn how difficult it is to implement other materials into the developed software package.

In conclusion, Mr. Horák clearly demonstrated his ability to carefully plan and conduct scientific experiments on his own, and he has obtained important results for the scientific community. Therefore, I recommend accepting his doctoral thesis!

Linz, 20.03.2014

Julian Stangl

[redacted]