Report on the Ph.D. thesis of Martin Zahradnik

The thesis of Martin Zahradnik with the title "Dynamic control of magnetization for spintronic applications studied by magneto-optical methods" is focused on the optical and magneto-optical research of two material groups, namely $La_{2/3}Sr_{1/3}MnO_3$ (LSMO) and $SrRuO_3$ (SRO). These materials are promising candidates in novel spintronic concepts where precise and dynamic control of magnetic order plays an important role. The aim of the thesis was to optically magneto-optically investigate physical phenomena which are responsible for changes in magnetism and electronic structure of investigated materials with respect to applied strain.

Prior to the main experimental work, Martin did a broad research of the current state of knowledge in this field studying relevant literature. This is visibly reflected in the thesis by relatively large number of cited references. He learned the macroscopic theory of electromagnetic waves in anisotropic multilayers for the calculation of magneto-optical quantities. He also managed to learn the microscopic theory of optical and magneto-optical response of solids, which he utilized in the analysis of experimental data and their discussion.

In the experimental part of the work Martin used large number of experimental techniques to reach the planned goals of the thesis. He participated at the deposition of the samples (including the fabrication of special devices for strain application), he used X-ray analysis to characterize the crystal structure of investigated samples, magnetometry for magnetic characterization, AFM and MFM for surface and domain analysis. Finally, he optically and magneto-optically investigated the materials.

The first part of the thesis is devoted to the study of strain induced changes in electronic structure of LSMO. These changes were induced by the use of substrates with different lattice mismatch. Experimental data revealed differences in magneto-optical spectra for different types of strain. This was addressed to the changes in electronic structure by the comparison with ab-initio calculations. Moreover, the experiments demonstrated that the lattice deformations have bigger influence on magneto-optical response than coherent oxygen octahedra rotations. These results have been published in Physical Review B.
Afterwards, an influence of dynamically applied strain was studied using special devices with PZT underlayer. Experimental data showed high sensitivity of magneto-optical spectroscopy to small changes in the thickness of LSMO layer due to the strain deformation.

The second part of the experimental results is devoted to domain dynamics in SRO. Using low temperature MFM and SQUID magnetometry it was demonstrated that magnetic properties of this material are strongly influenced by crystallographic defects, such as antiphase boundaries. These can act as domain nucleation centers as well as pinning centers. Therefore, to avoid these structural defects and to obtain single variant sample a substrate with higher miscut is necessary. These results are concluded in the manuscript which is now with referees in Journal of Magnetism and Magnetic Materials.

In conclusion, the thesis is well written with logically ordered chapters and minimal typing errors. During his Ph.D. study Martin showed himself as highly motivated student with deep knowledge of basic physical phenomena. He proved that he can do the research almost

independently and he can write scientific manuscripts very well. Since Martin Zahradnik reached all planned goals of the thesis, I strongly recommend jury to award him with Ph.D. title.

Prague 18 .6. 2019

Martin Veis
Supervisor of the thesis