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To
Prof. Jan Kratochvil

Report on the Thesis Manuscript of Fedir Borodavka :

"PFM and Raman spectroscopy of selected dielectric materials"

The thesis of F. Borodavka reports on Raman scattering (RS) and piezoelectric force microscopy (PFM) experiments performed on a series of ferroelectric materials. The thesis is divided in four chapters. The two firsts summarize basics on Raman scattering and atomic (and piezoelectric) force microscopy, from both theoretical (Chap. I) and experimental (Chap. II) point of vu. The third chapter is dedicated to the experimental results obtained in four family compounds: i) Guanylurea hydrogen phosphate ($C_2H_9N_4O_4P$), ii) Bismuth manganese oxide $BiMnO_3$, iii) $La_{1/2}Na_{1/2}TiO_3$ (LNTO) quantum paraelectric, and iv) $PbTiO_3$ (PTO) thin films deposited on $TbScO_3$ (TSO) and $SmScO_3$ (SSO) substrates. The Raman studies have been complemented by group theory analysis. PFM has been used essentially on PTO thin films in order to characterize the domain patterns. The last chapter summarizes the results and enumerates prospects for future works. The thesis is mainly experimental, and priority has clearly been given to study a large number of compounds each having their own particular interest, rather than focusing on a specific physical issue.

The Raman scattering experiments describe by F. Borodavka in the three first sub-sections of chapter III are complemented by careful selection rule analyses providing valuable information for the description of the structures and the phase transitions. The results are part of more comprehensive works which include infrared absorption data, dielectric and polarization measurements, etc. A complete description is given in the publications associated to the work but it would have been worth describing these additional information in the document. This would have given more weight to the discussions and to the conclusions drawn from the Raman data. However, each of these studies solves an important issue in the field as for example the absence of ferroelectricity in $BiMnO_3$ and an antiferrodistortive (non-polar) phase transition in $La_{1/2}Na_{1/2}MnO_3$ around 850K.
The section dedicated to PTO thin films constitutes the main part of the thesis. The choice of TSO and SSO as substrate is interesting because it provides an opposite sign of the misfit strain. In both systems (PTO/TSO and PTO/SSO) the PFM images show very nice stripes patterns. The analysis is complemented by the Raman spectroscopy of the films and reveals a/c/a/c domain structures of PTO films grown on TSO substrate and a/a/a/a arrangements in PTO deposited on SSO. The experimental results are convincing and document on the diversity of the domain structures accessible by strained PTO films. They also provide valuable information for domains and thin film engineering.

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The manuscript is clear and well written and I particularly appreciated the description of PFM in chapter I. It is very well documented and highlights the involvement of F. Borodavka in the development of this modern imaging technique in his laboratory, as well as a deep understanding in its fundamentals, drawbacks, and pitfalls. To my opinion, the bibliographic details on samples in chapter III are too briefs and deserved to be more detailed. Five articles have been published in the framework of the thesis but F. Borodavka is co-author of eleven publications.

The thesis and the publications prove the author ability for creative scientific work, and accordingly I issue a favorable opinion for the defense of this work.

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