doc. Mgr. Adam Dubroka, Ph.D.
Ústav fyziky kondenzovaných látek
Přírodovědecká fakulta
Masarykova univerzita
Kotlářská 2
611 37 Brno

Prof. RNDr. J. Kratochvíl, CSc.
Univerzita Karlova
Matematicko-fyzikální fakulta
Ke Karlovu 3
121 16 Praha 2

Review of the doctoral thesis of Mr. Iegor Rafalovskyi
"Lead-based relaxor ferroelectrics by Raman scattering"

The thesis is devoted to perovskite relaxor ferroelectrics which are intensively studied materials. They attract interest in fundamental science since they exhibit phase transitions and at the same time in applied science because of their applications due to their high piezoelectric constant. The thesis presents results on a large number of different relaxors including lead magnesium niobite – lead titanite, lead iron niobite – lead titanite, lead scandium niobite, and three component solid solution lead indium niobite – lead magnesium niobite – lead titanite. Some of the materieals are monocrystals and some of them are thin films on a substrate.

The chosen method – Raman spectroscopy – is a well established technique and, in its simple form, it is often used for determination of phonon spectrum that reflect the structure and chemical composition. The thesis presents an advanced Raman study including spatial mapping, polarization and temperature dependent measurements. For example, the microraman mapping of lead magnesium niobite – lead titanite shown that the stripe pattern corresponds to alternating tetragonal and rhombohedral-like phases. The field induced rhombohedral to tetragonal phase transition of the latter compound was investigated and confirmed the two-phase scenario. The structure and symmetry of domains in lead iron niobite – lead titanite was investigated. Lead scandium niobite was examined with the help of detailed polarization dependent measurements. The latter revealed stark difference of some high frequency modes between single crystal and thin film that, as suggested, likely reflects a difference in the B-site order degree.

The presented work was published in a large number – in total six – peer reviewed publications including two of them in journals from American Physical Society. This clearly demonstrates that the PhD work yielded new and high-quality scientific results. The thesis is well organized with very good introduction to material properties, contemporary literature and used methods. I appreciate the introduction to group theory that could be useful for pedagogical purposes. The text is well understandable and the level of English is very high. I also appreciate the longer summary that attempts to find links between Raman spectra of the different studied compounds.

In conclusion, this thesis clearly demonstrates the author's ability to perform independent creative scientific research and obtain new high-quality results and thus I without any doubt recommend the dean to accept this work as a successful doctoral thesis.

For the discussion, I propose the following question:

- The attention was often focused on the high frequency bands between 600-800 cm^{-1}. One possible interpretation, as suggested in Phys. Rev. B **73**, 224401 (2006), is that these bands in species without local order (e.g. in alloys) correspond to local breathing vibrations of oxygen ions around one type of B-site ion surrounded by a different type of B-site ion. These modes have same symmetry as observed in the thesis, i.e, they are absent in the crossed polarization geometry. This interpretation could explain for example why the band is split in species with more components, or why the bands behave differently in ordered bulk PSN compared to PSN thin film which likely does not have a short range order. Please discuss whether this interpretation is plausible for you.

in Brno, 14.8.2017, doc. Mgr. Adam Dubroka, Ph.D.