INVESTIGATION OF ORTHORHOMBIC-HEXAGONAL PHASE TRANSITIONS IN HIGHLY SUBSTITUTED $Lu_{1-x}Sc_xFeO_3$ SYSTEM

Andrius Pakalniškis[1]*, Ramūnas Skaudžius[1], Alexander Zhaludkevich[2], Anton Turygin[3], Denis Alikin[3], Dmitry Karpinsky[2], Aivaras Kareiva[1]

[1]*Institute of Chemistry, Vilnius University, Naugarduko 24, LT-03225 Vilnius, Lithuania*
[2]*Scientific-Practical Materials Research Centre of NAS of Belarus, 220072 Minsk, Belarus*
[3]*School of Natural Sciences and Mathematics, Ural Federal University, Russia*
**andrius.pakalniskis@chgf.vu.lt*

Multiferroic materials are classified compounds that exhibit at least two of the primary ferroic order parameters. Over the last couple of decades, they have been widely studied due to their interesting physical properties. This is especially true for materials with both magnetic and electric orderings [1]. The ability to control magnetic ordering with electric field and vice versa opens a lot of new fields of application. However, for the most part, due to the conflicting nature of these properties, the coupling between the electrical and magnetic properties is relatively weak. Since magnetic properties usually require the 3d layer to be partially filled by electrons, while electrical properties arise from empty 3d shells [2]. To solve this conundrum, materials with new mechanism for the origin of their ferroelectric properties were discovered, such as lone pair and spin driven mechanisms, that do not require empty electron shells. The second issue that multiferroic compounds suffer from is the fact that most orderings only occur below room temperature. Only few room temperature multiferroics are known, with the main research being focused on $BiFeO_3$ [3].

Recently a new class of hexagonal rare earth ferrite perovskite compounds has been found to exhibit multiferroic ordering, with a mechanism and structure similar to that of hexagonal manganites, making them a new avenue for potential research [3]. However, the in many cases the hexagonal ferrite compounds are relatively unstable due to their expanded lattice. Stabilization of the mentioned hexagonal structure is usually performed by thin film fabrication on some substrates, but the additional strain and interface interactions can cause substantial changes to their intrinsic physical and chemical properties [4]. As such, it is essential to analyze the bulk samples of such materials. One important candidate for further in-depth analysis is Sc doped $LuFeO_3$, since via the doping effect it is possible to stabilize the hexagonal structure with a P_6cm space group [5]. However, further characterization on the exact compositional ranges and synthesis conditions on the phase formation as well as the effect of dopant on the ferroic properties still needs further research.

Hence, in this work we explore the sol-gel synthesis conditions for suitable preparation of $Lu_{1-x}Sc_xFeO_3$ in the entire concentration range ($0<x<1$) and investigate the structural transitions together with particle morphology and magnetic properties.

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References

1. K. F.Wang, J.M. Liu, and Z. F. Ren, Adv. Phys. **58** (2009). 321
2. Fiebig, M., Lottermoser, T., Meier, D. et al. Nat. Rev. Mater. **1** (2016) 16046.
3. D. Arnold IEEE Trans. Ultrason. Ferroelectr. Freq. Control. **62** (2015) pp. 62-82.
4. A. S. Gibbs, K. S. Knight, and P. Lightfoot, Phys. Rev. B. **83** (2011) 094111.
5. J. A. Moyer, R. Misra, et al. APL Mater. **2** (2014) 012106.