



Universidade do Minho



MAP-fis Essay Proposal, 2015-2016

(please write in English)

Supervisor

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Title

Tunning properties in multifunctional transition metal oxide

Area

(Materials, Optics, Condensed Theory, High Energy Theory,...);

Materials

Summary of Proposal

Oxides offer unique opportunities to combine in a single system optical, electrical and magnetic properties, suitable for a wide range of applications [1]. Bismuth ferrite (BiFeO_3 , here after designated by BFO) is a very attractive perovskite material in the design of new multifunctional devices within spintronics, sensors and photovoltaic devices [2].

Bulk BFO however poses limitations such as high leakage current and difficulty in obtaining pure perovskite phase by normal solid state sintering, which has limited its commercial viability and has led researchers to investigate the substitution in BFO ceramics. From the literature survey, it has been observed that the A-site and/or B-site substitution in the perovskite structure, has been reported as the most effective way to reduce the leakage current and enhance magnetoelectric coupling constant.

Special attention has been dedicated to rare earth substitution on bismuth site, namely lanthanum substitution, which has been shown to lead to the decrease of leakage current and the suppression of the magnetic spin cycloid [3].

There is a particular interest in materials with composition close to structural phase boundaries because these may lead to materials with enhanced electronic and magnetic properties [4, 5]. Many contradictory crystal structures and physical behaviors are reported within the literature, so it is vital to understand the structural phase diagram of $\text{Bi}_{1-x}\text{La}_x\text{FeO}_3$ system [6].

The knowledge of the structural phases will allow the optimization of this system, permitting the



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develop of devices with potential technological applications.

In this essay we propose a critical literature reading in order to write a state-of-art of the proposed topic, highlighting the current outstanding problems. Based on the critical assessment of the literature, a research plan and the methodology to be follow will be designed, focus on the main objective: understand the structure-properties relationship of this system.

References

(to allow students first look at topic)

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- [1] Blank Dave, Rijnders Guus, Nanoelectronics: Oxides offer the write stuff. Nature Nanotechnology, 2009. 4: p. 279 - 280
- [2] J.T. Heron , et al., Deterministic switching of ferromagnetism at room temperature using an electric field. Nature, 2014. 516: p. 370.
- [3] A. Perejon, et al., Single phase, electrically insulating, multiferroic La-substituted BiFeO₃ prepared by mechanosynthesis. J. Mater. Chem. C, 2014. 2: p8398
- [4] G. Rispen , et al, Phase diagram of BiFeO₃/LaFeO₃ superlattices studied by x-ray diffraction experiments and first-principles calculations. Phys. Rev. B, 2014. 90: p.104106
- [5] C. E. Cheng, et al, Revealing the flexoelectricity in the mixed-phase regions of epitaxial BiFeO₃ thin films Scientific reports, 2015. 5: p.8091
- [6] Donna C. Arnold, Composition-driven structural phase transition in rare-earth-doped BiFeO₃: a review, IEEE Trans. Ultrason., Ferroelect., Freq. Control, 2015. 62(1)