Stoichiometry influence on physical properties of multiferroic $BiFeO_3$

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$BiFeO_3$ material is the subject for a lot of fundamental studies in multiferroic materials. This interest is mainly cause by the existence of two long range orders at room temperature : ferroelectricity and G type antiferromagnetism (this one is also no collinear with the presence of a weak ferromagnetism, and a cycloidal spin modulation with a wave length of 620 Å). So, it is possible to study coupling behaviour between electrical and magnetic properties.

This work is mainly about the synthesis, high temperature structures, and physical properties (principally electronic and magnetic one) in BFO material after sintering the bulk under different oxygen partial pressure. First step of this work concern the synthesis study in order to optimize the protocol of ceramic formation. Sintering under atmosphere are done in order to change oxygen stoichiometry of BFO, by this way, we expected to affect this physical properties. We saw some weak modifications of few properties, but Néel and Curie temperature are not altered.

Concerning the nature of BFO high temperature structures, β and γ phases, which are subject of many controversies in literature, were studied with X-rays and DSC analysis, in pure or in bismuth excess phase. At last, numerical simulation on the stoichiometric, bismuth or oxygen lacunar system are done to understand structural, electrical and magnetic evolution after the sintering.

The last part is a study the behaviour of pure phase BFO at low temperature in different form : ceramic and single crystal. We analysed electrical (impedance, pyroelectricity, and electrostriction), magnetic (magnetization function of temperature and magnetic field) and structural comportment (X-rays in θ-2θ and grazing incidence and DSC). It reveals that three temperatures show a specific behaviour : 140 and 200 K, which are link by several analysis technical and seems to be a surface transition (skin effect) in BFO. But also 180 K, where we found a non constant evolution in the thermal dilatation, and an electrostriction effect.