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Synthesis and phase transition determination of R-doped $BiFeO_3$

J. A. Munevar Cagigas(1)*, D. R. Sanchez-Candela(2) and E. M. Baggio-Saitovitch(1)

(1) Centro Brasileiro de Pesquisas Físicas, Rua dr Xavier Sigaud 150, Urca. CEP 22290-180, Rio de Janeiro, Brazil. Email:munevar@cbpf.br

(2) Instituto de Física, Universidade Federal Fluminense, Niterói, Brazil.

* Corresponding author.

Abstract – Were prepared and characterized multiferroic $Bi_{1-x}R_xFeO_3$ polycrystalline compounds (R=La,Gd,Y) through several techniques as X-Ray Diffraction, Magnetic Hysteresis curves obtained with a SQUID magnetometer and ^{57}Fe Mössbauer spectroscopy, looking for evidence of the consequences and correlation of spin and lattice in these compounds and its magnetic structure distortion. It is found a crossover between the magnetic cycloid structure characteristic of $BiFeO_3$ compounds and an antiferromagnetic ordering, as well as a progressive suppression of the lattice distortion that causes the ferroelectricity in such perovskites. All the measurements were performed at room temperature.

$BiFeO_3$ has been subject of intense research due to its room-temperature multiferroicity, showing ferroelectric behavior due to 6s² lone pair electrons on Bi atom that distorts the lattice, antiferromagnetic G-type ordering of spins and no linear magnetoelectric effect due to a cycloidal spin modulation incommensurable with the lattice (620 A). This last property doesn't make possible the use of this compound in potential applications as magnetoelectric sensors and electrically controlled magnetic storage devices. One promising way to remove this cycloid coupling is making substitutions with rare-earth ions on Bi site, where a magnetoelectric effect has been evidenced and has been found a dependency of the magnetic response with the rare-earth ionic radius. We synthetized $Bi_{1-x}R_xFeO_3$ polycrystalline compounds with R being Gd, Y (x<0.3) and La (x<0.7), in order to determine the structural phase transition, expected to be between the R3c and Pbnm symmetries but with a crossover from R3c symmetry to $Pbn2_1$ polar orthorhombic symmetry, being different those crossovers between the former (Gd,Y) and the latter case (La). This phase transition has as a main consequence the suppression of the cycloid spin coupling in the magnetic structure, reflected from room temperature magnetic hysteresis curves and ^{57}Fe Mössbauer spectroscopy, from where is possible elucidate a nonzero magnetic response as well as the evolution of the magnetic structure and to follow the presence of the magnetic cycloidal ordering. It is also established the influence of the doping with a magnetic rare-earth, provided that the Gd ion has magnetic moment and the Y ion has similarities with Gd ion except for the magnetic moment. The importance of this work lies on the possibility of follow and establish the evolution and correlation of the lattice and the spin degrees in these perovskites, giving us a local insight of the physical behavior and consequences of the substitutions on $BiFeO_3$.

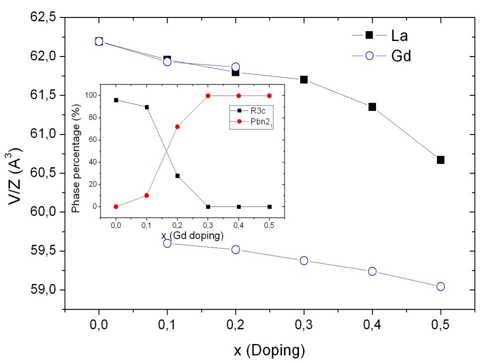

Figure 1: V/Z for La doped and Gd doped $BiFeO_3$.

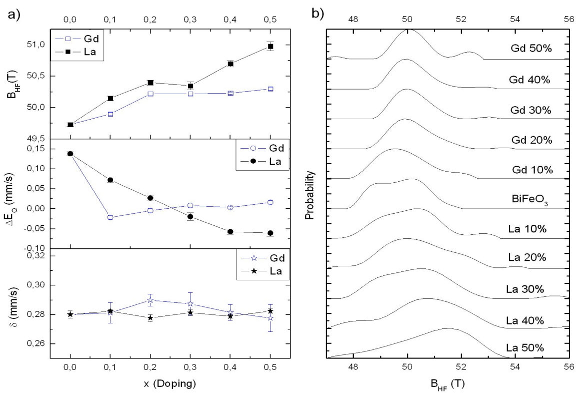

Figure 2: Hyperfine parameters obtained from Mössbauer Spectroscopy fits.

References

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