Effect of Fe Doping on Ferroelectric and Ferromagnetic Properties of $Sr_xBa_{1-x}Nb_{2-y}Fe_yO_6$ Ceramics

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Abstract–Tungsten bronze structured $Sr_xBa_{1-x}Nb_{2-y}Fe_yO_6$ (SBNF) ceramics for two values of x (0.33 and 0.50) and two values of y (0.02 and 0.03) was prepared using the co-precipitation and Pechini methods, and their dielectric constant, ferroelectric and ferromagnetic hysteresis loops were measured. The presence of single phases of SBNF ceramics was confirmed by applying X-ray diffraction to the different stoichiometries. The effects of Fe doping on the dielectric, ferroelectric and ferromagnetic properties of $Sr_xBa_{1-x}Nb_{2-y}Fe_yO_6$ ceramics were investigated.

In recent years there has been an increasing interest in a new class of materials, in which both electrical and magnetic ordering can coexist simultaneously. Such so-called magnetoelectric materials are rarely found in nature, but they have many potential applications including new memory and sensor devices.
In this work we investigated the magneto-electric response of SrxBa1-xNb2-yFeyO6 ceramics for two values of x (i.e. 0.33 and 0.50) and two values of y (i.e. 0.02 and 0.03). The ceramics powders were prepared by co-precipitation and Pechini methods. The raw materials were SrCO3 (99.9 %), BaCO3 (99.9 %), FeC2O4*2(H2O) (99.9 %) and two precursors for Nb: NH4[NbO(C2O4)2(H2O)](H2O)m (99.9 %) and Nb2O5 (99%). The powders were calcined at temperatures between 1100 and 1200 °C for a maximum of 6 h under air atmosphere according to their respective stoichiometry.
The phase formation and crystal structure of the SBNF ceramics were examined by X-ray diffraction (XRD) and the elemental analysis was made through EDAX . A secondary phase was detected to SBNF for x=0.50, however, using x= 0.33 the single phase of SBNF ceramics with tungsten- bronze structure was formed.
Particle morphology of calcined powder was irregular in shape, having around 100 nm average particle size.
Figure 3 shows the M-H hysteresis loops of the $Sr_{0.5}Ba_{0.5}Nb_{1.97}Fe_{0.03}O_6$ ceramics measured at room temperature. The ferromagnetic properties were caused by low Fe ion doping.

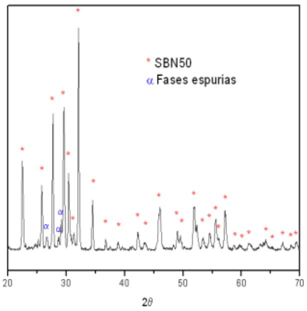

Figure 1. DRX of SBNF powders for x=0.5 and y=0.03 obtained from the co-precipitation method.

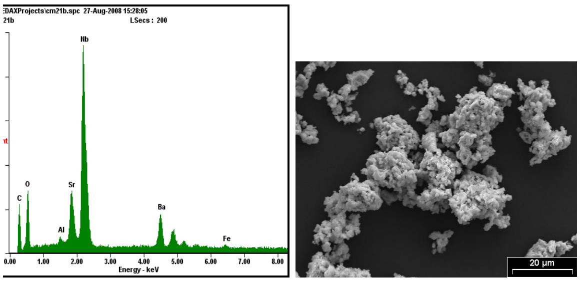

Figure 2. EDAX and MEB of SBNF powders for x=0.5 and y=0.03 obtained from the co-precipitation method.

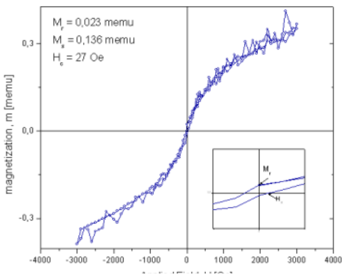

Figure 3. M-H hysteresis loop of SBNF powders for x=0.5 and y=0.03 obtained from the co-precipitation method.