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Influence of Sintering Condition on Electric and Dielectric Response of PFN Ceramics

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Abstract – In this work PFN ceramics were prepared through conventional oxide mixture technique. Green samples were sintered by conventional and fast sintering using different heating rates. Dc conductivity and dielectric response (1KHz – 2GHz) were measured as function of the temperature in the range of 4.2K – 800K. Experimental results show that fast sintering improves the sample densification compared to conventional (low heating rate) procedure. Sintering at oxygen atmosphere decrease the electrical conductivity and enhances (or improves) dielectric anomalies, sometimes not well observed after air sintering.

The continuous and crescent demand for electronic devices, with high performance, better versatility and small size, have extended the interest of studies and development of new materials that can compose two or more physics properties of technological interest [1-3]. These materials were denominated multifunctionals. Among this class of materials there are the multiferroic materials. The interesting effects introduced by the interaction of the ordered subsystems have great research value and application interests. The ability to coupling either electric or magnetic polarization add one additional degree of freedom in the devices designs as multiple-state memory elements, which allows the storing of data by the both electric and magnetic polarization. PFN is a single-phase multiferroic material that presents typical ferroelectric characteristics below Te ~ 387 K [4], which coexist with a antiferromagnetic ordering at temperatures lower than Tn ~ 143 K.

A technological problem working with pure PFN is due its large dielectric loss. Owing to the dependence of dielectric loss on many variables, i.e. chemical composition, microstructure, processing history, temperature and measuring frequency, a systematic study of the phenomenon would be non-straightforward. In this study, PFN powders were prepared by conventional oxides mixture technique. The Fe_2O_3 and Nb_2O_5 oxides were mixed and calcined at 1200°C for 4 hours. The phases of the $FeNbO_4$ (FN) precursors were characterized by XRD Rietveld refinements and confirm the presence of a symmetric orthorhombic structure. PFN prepared with orthorhombic FN presents higher dielectric properties, when compared with monoclinic FN structure obtained at low temperature [5]. To obtain PFN, FN and PbO powder were mixed and calcined at 800°C for 3 hours. Green samples were sintered by conventional and fast sintering process using different heating rates. The fast sintering process has been found to be capable of effective restriction of grain growth while the densification process can be enhanced [6-7]. The goal of this work was to investigate the effect of fast sintering on microstructure, electric and dielectric properties of PFN, and compare with those conventionally sintered. Experimental results showed that fast sintering limited grain growth, achieved relatively high densities and sintering at oxygen atmosphere decrease the electrical conductivity and improves dielectric anomalies, sometimes not well observed by air sintering.

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