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Manganese Influence in the PLZT (9/65/35) relaxor.

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Abstract – Lead lanthanum zirconate titanate (PLZT) is one of the most studied ceramics by its dielectrics properties. In this paper is analyzed the dielectric permittivity behavior in pure and Mn-doped PLZT samples. The dielectric permittivity was measured in the frequency and temperatures range between 100 Hz and 10 MHz, and 15 K and 700 K, respectively. The frequency dispersion and relaxor nature decreased with Mn doping increase. The dielectric responses of pure and Mn-doped PLZT were analyzed with the Santos-Eiras empirical model and the spin-glass model. In addition Mn doping accentuates a low temperature dielectric anomaly near to 150 K.

(Pb,La)(Zr,Ti)O_3 (9/65/35) system have perovskite structure type ABO_3 with cubic symmetry at room temperature. The ions Pb^{2+} or La^{3+} are localized in A site while the ions Zr^{4+} or Ti^{4+} are localized in the B site, the oxygen ions are situated in the cube phases [1]. The PLZT as ferroelectric materials is characterized by a diffuse phase transition with relaxor character. Many models have been developed to explain the relaxor behavior with diffuse phase transition of ferroelectrics materials [2]. Nevertheless there are not successfully models to accurately explanation the observed phenomena. The analyses are based fundamentally on the behavior of the dielectric properties with the temperature in the frequency domain.

The aim of this study is investigate the dielectric response of the pure and Mn-doped PLZT (9/65/35). Possible causes of the anomalous behavior of the dielectric permittivity and the frequency dispersion are discussed.

Figure 1 shows that the frequency dispersion at 300 K in pure PLZT sample (A) is higher than 3.0 % mol Mn-doped PLZT sample (B). The missing of the frequency dispersion should be caused by the high manganese content in the Mn-doped PLZT samples, which can enable that manganese ions are occupying lanthanum sites within the structure. At temperatures near to 150 K an anomalous dielectric behavior is observed in the Mn-doped PLZT samples.

The deviation of Curie-Weiss behavior was estimate using the Sherrington and Kirkpatrick model to evaluate the local order parameter q(T). This parameter holds an important role in determining the dielectric properties of relaxor and represents the correlation degree of neighboring cluster-sized moment [3] (normally defined as Burn temperature). Figure 2 shows the calculated order parameters as function of temperatures at different manganese content (100 kHz). The q(T) behavior is not influenced by manganese content.

Phase transition diffusivity does not change with Mn doping. Also pure and Mn-doped PLZT samples have the same Curie and Burn temperatures.

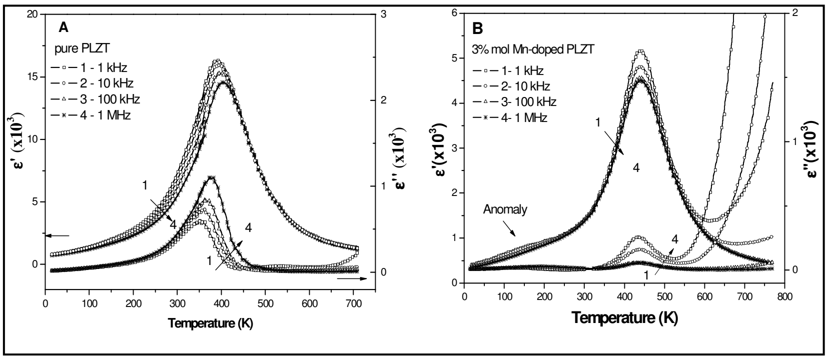

Figure 1: Temperature dependence of the dielectric permittivity for pure PLZT (A) and 3%mol Mn-doped PLZT samples. The pure PLZT sample has more significant frequency dispersion than 3%mol Mn-doped PLZT sample. Anomalous dielectric behavior is observed at 150 K.

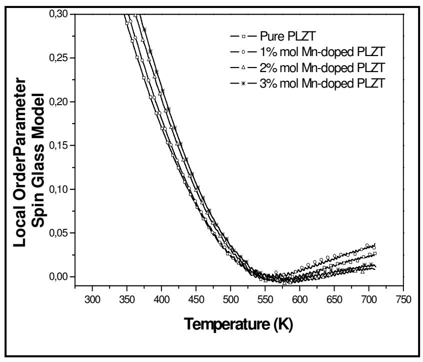

Figure 2: The local order as a function of temperature for different Mn content by using the spin-glass model for pure and Mn-doped PLZT ceramics.

References

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