Materials

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Structural, Magnetic, Dielectric and Piezoelectric Properties of Multiferroic $PbTi_{1?x}Fe_xO_{3??}$ Ceramics

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Abstract: $PbTi_{1?x}FexO_{3??}$ (x = 0, 0.3, 0.5, and 0.7) ceramics were prepared using the classical solid-state reaction method. The investigated system presented properties that were derived from composition, microstructure, and oxygen deficiency. The phase investigations indicated that all of the samples were well crystallized, and the formation of a cubic structure with small traces of impurities was promoted, in addition to a tetragonal structure, as Fe^{3+} concentration increased. The scanning electron microscopy (SEM) images for $PbTi1?xFe_xO_{3??}$ ceramics revealed microstructures that were inhomogeneous with an intergranular porosity. The dielectric permittivity increased systematically with Fe^{3+} concentration, increasing up to x = 0.7. A complex impedance analysis revealed the presence of multiple semicircles in the spectra, demonstrating a local electrical inhomogeneity due the different microstructures and amounts of oxygen vacancies distributed within the sample. The increase of the substitution with Fe^{3+} ions onto Ti^{4+} sites led to the improvement of the magnetic properties due to the gradual increase in the interactions between Fe^{3+} ions, which were mediated by the presence of oxygen vacancies. The $PbTi_{1?x}Fe_xO_{3??}$ became a multifunctional system with reasonable dielectric, piezoelectric, and magnetic characteristics, making it suitable for application in magnetoelectric devices.

Keywords : dielectric response, Fe-doped PbTiO3, Magnetic Properties, multiferroic ceramics, piezo- electric properties