Deformation under the electric field of piezoelectric ceramics of the $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ relaxor-ferroelectric solid solution

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The $Pb(Mg_{1/3}Nb_{2/3})O_3$-$PbTiO_3$ (PMN-PT) relaxor-ferroelectric solid solution presents great interest from the fundamental and applied point of view. The establishment of the basis of the relaxor state, of the transition from the relaxor state to the ferroelectric state, which involves the development of long range order, and of the ultrahigh piezoelectricity and deformation under the electric field observed in rhombohedral single crystals and textured ceramics along the <001> direction, are issues that concentrate a lot of activity. The development of procedures for preparing textured ceramics of this system with electromechanical response higher than that of lead zirconate titanate (PZT) ceramics is also focusing a lot of attention, and must enable a new generation of high sensitivity electromechanical transducers (sensors, actuators, smart systems, ultrasonic and underwater acoustic devices…).

We present results on the electromechanical characterization of PMN-PT ceramics processed from powders synthesised by mechanochemical activation of precursors, with high compositional homogeneity, as a function of composition and temperature. The transverse piezoelectric coefficient and losses were obtained from the analysis of the radial resonance of discs by an automatic iterative method. Deformation under the field was measured with a linear variable differential transducer driven by a lock-in amplifier. The low frequency Young´s modulus and mechanical losses were obtained by dynamical mechanical analysis in three points bending configuration. Results are discussed in relation to the evolution of the microstructure with composition and temperature, supported by electrical characterisation. Emphasis is put on the behaviour of the different losses that reflects the dynamics of the polarisation domains.