Domain structure and local piezoelectric properties of PMN-PT ceramics

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Lead magnesium niobate ceramic $Pb(Mg_{1/3}Nb_{2/3})O_3$ (PMN) and its solid solutions with lead titanate $PbTiO_3$ (PT) attracted an immense interest because of their superior dielectric and electromechanical responses. In particular, hysteresis-free electromechanical properties make these materials promising for fabrication of piezoelectric actuators and tunable transducers. In many respects the materials properties depend on the domain structure and its sensitivity to external electric field. In polycrystalline materials (ceramic, thin films) the domain pattern is closely related to the microstructure and should be studied at highest resolution possible. Recently, Piezoresponse Force Microscopy (PFM) has received significant attention due to its ability both to resolve fine domain features and to study local electrical properties (i.e., inside single grain or single domain). It is extremely important that this method allows establishing direct relationships between domain structure and microstructure.

The goal of presented work was to investigate the domain structure of PMN-PT ceramic samples (with 14% and 35% of titanium content) by means of PFM. In 65/35 ceramics both 180^o-degree and 90^o-degree domains were observed with 90^o-degree domains forming regular periodical pattern. The orientation of domain walls and the period of domain structure are found to vary from grain to grain. No regular domain patterns were observed in 86/14 ceramics. The local piezoelectric hysteresis loops were acquired inside of individual domains. The results of local measurements were compared to the macroscopic piezoelectric properties.