Abstract Title

Imaging domain structures and measuring mechanical properties of $BaTiO_3$ and $(K_{0.5}\ Na_{0.5})NbO_3$ using scanning probe microscopy and nanoindentation

Symposium Track

4. Constitutive Equations of Special Nano/Microsystems

Authors' names

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Abstract body

Nanoindentation tests in a- and c- domains of an {001} orientated barium titanate single crystal were performed in order to investigate the elastic, plastic and ferroeleastic response of the material. The indentation size effect was studied by using 4 different precisely calibrated conical tips with radii between 61nm – 1.9µm. The topography and the polarization vectors of the indented areas were imaged by both atomic force and piezoresponse force microscopy (PFM), respectively. FIB was used to prepare thin sections of areas underneath the indentations for TEM studies. The measured elastic modulus is independent of the indenter radius. After “pop-in” the $BaTiO_3$ shows plastic deformation with a constant mean pressure which increased with decreasing indenter radius. TEM micrographs show dislocations with {110} glide plains. These dislocations can also be visualized by topography images of edged surfaces. The indenter radius dependence of the hardness support the concept of geometrically necessary dislocations” proposed by Nix and Gao (1999) and its extension to spherical tipped indenters by Swadener et al (2002). The PFM images of indented in-plane domains revealed an almost quadratic arrangement of the domains around the indent, which can be explained by residual circumferential tensile stresses around a residual impression and was unambiguously correlated to the crystal orientation.

A second part of the talk presents the imaging of domains in KNN and the investigation of their mechanical properties on the nano- to micrometerscale applying nanoindentation.

Keywords

ferroelectric domains, lead free ferroelectric ceramics, PFM, nanoindentation

References

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