Topographic imaging of electrostrictive distortions in ferroelectric semiconductors: an unique new probe of conducting properties.

ESRF Report

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High-resolution monochromatic beam X-ray section topography *in-situ* with an applied electric field was used to study the electrostrictive distortions in $RbTiOAsO_4$ (RTA) single crystals. Previous experiments focused on *in-situ* white-beam section topography, results of which which suggested the presence of a depletion region in the near-surface under large electric fields. This implied that RTA should be treated as a semiconductor ferroelectric. However, the magnitude of the strain developed in this region under large fields was not determined directly in white-beam mode. The monochromatic work was highly successful and clarified a number of points regarding the semiconducting nature of RTA, including a direct measurement of the strain in the near-surface depletion region. A paper has been submitted to the Journal of Applied Crystallography (January 8th 2007, reference fe5019) entitled "*In-situ* investigation of the non-linear optical crystal Rubidium Titanyl Arsenate, $RbTiOAsO_4$, under applied electric field using X-Ray imaging". The abstract of the paper reads as follows:

Recent work on the nonlinear optical single crystal rubidium titanyl arsenate ($RbTiOAsO_4$, RTA) has shown that it exhibits behaviour consistent with a ferroelectric-semiconductor under large applied electric fields, with the development of a non-uniform field in the near-surface region. To confirm aspects of the proposed model, the behaviour of (0 0 1) slices of initially single-domain RTA, patterned with periodic Ag electrodes of spacing 38μm as for periodic poling in nonlinear optics, are investigated using synchrotron X-ray section topography with the electric-field applied in-situ *while under X-ray illumination at the ID19 topography beamline of the ESRF, Grenoble. The results of white-beam section topography as both a function of crystal to film distance, and under DC voltage are reported, confirming that there is a bending of the planes in the near-surface region. The strain in the near-surface region was examined directly using high-resolution monochromatic X-ray section topography. This revealed an extensive strain of 3(±1)* x 10^{-4} *at 1kV, indicating that the electrostrictive coefficient, γ_{3333}, in RTA is positive in sign.*