In-situ real time structural response of relaxor ferroelectric PMN-(0.32)PT with an application of an applied external electric field..

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Ferroelectrics exhibit spontaneous polarisation below their Curie temperature and contain areas of uniform polarisation known as domains, which can be switched by the application of an electric field. Relaxor ferroelectrics exhibit frequency dependant behaviour. In a recent experiment at the XMaS beamline a single crystal of $Pb[Mn_{1/3}Nb_{1/3}]O_3$ -0.32$PbTiO_3$ (PMN-0.32PT) was mounted on an insulating substrate of sapphire and mounted on Al_2O_3. The electrical contacts were placed on the electroded (110) faces, the beam penetrated the (100) face. The crystal was poled long the <100> direction. An oscillating electric field was applied to the crystal, and the crystal response was measured, simultaneously at a point in reciprocal space reflected intensity data is collected. This process is repeated along a specified direction. Reflected intensity data was collected simultaneously to the electrical measurements with the MUUST card. Repeated PE loops enabled improved statistics. A Θ-2θ plot was then extracted from the data, to enable a single peak at each applied voltage (from 0-4kV in 0.2kV intervals) at 0.01Hz, 0.1Hz and 1Hz. Figure 1 show the (200) and (220) peak shift respectively with an applied voltage. These measurements were static and used to calculate the parameters/ reciprocal space which to examine the peak over dynamically.

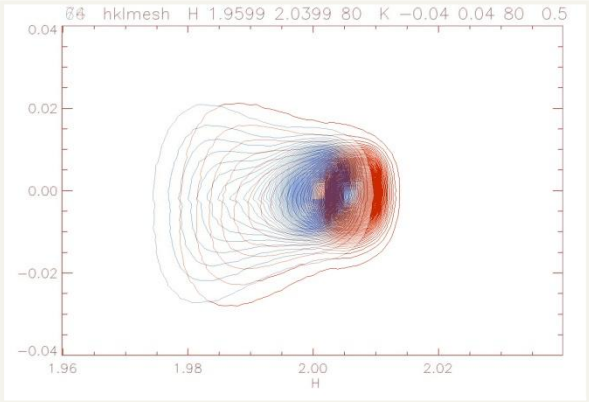

Figure 1 a)showing the 200 peak (blue) and the 200 peak with an applied voltage of 4kV/mm

The peaks were analysed with Rietveld refinement to obtain phase information. The single crystal was found to contain two phases, tetragonal P4mm and monoclinic Cm. Figure 3 shows the response of the crystal to the applied electric field, both the electrical and structural response. Hysteretic behaviour of phase change is exhibited at all three frequencies.(Figure 4) showing an increase in the tetragonal phase as there in an increase in voltage, this is accompanied by a decrease in the monoclinc phase.

Rate dependence behaviour was exhibited, showing the shift of the sample towards a tetragonal phase with the application of a bipolar field.

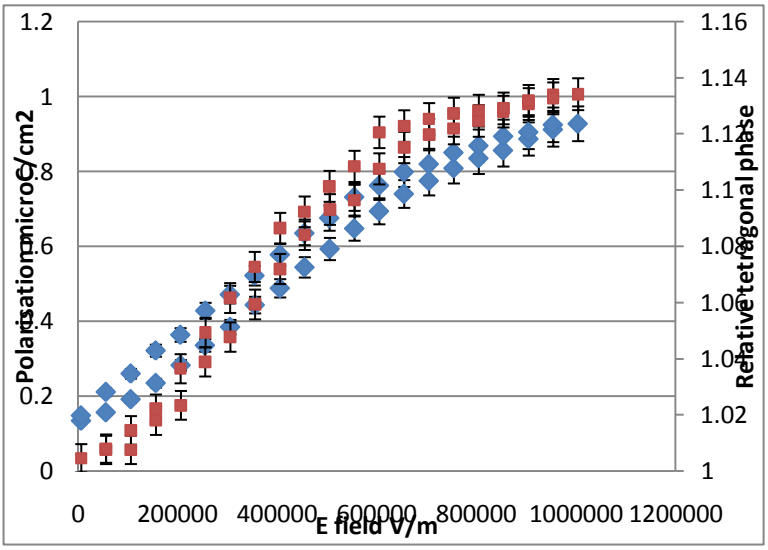

Figure 3 the change in applied electric field with a change in polarisation(blue) and a relative tetragonal phase increase, verses the crystal with no applied field (red).

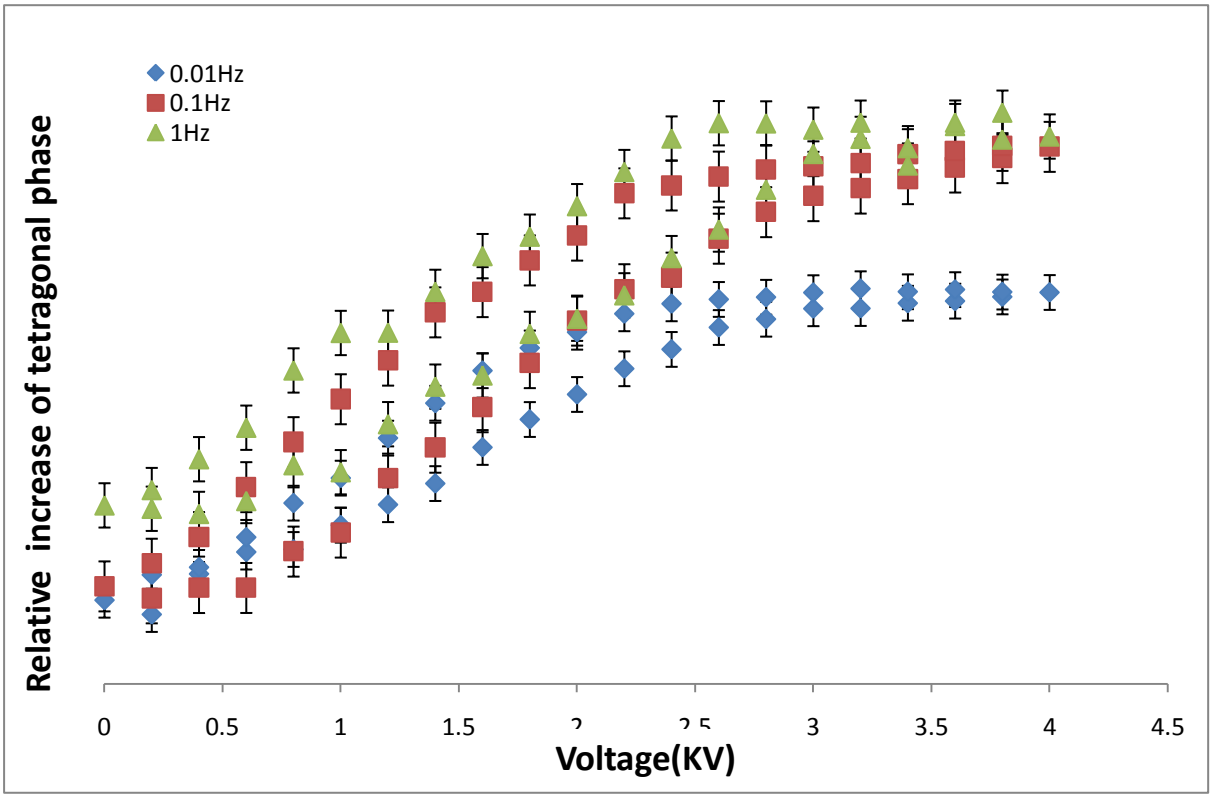

Figure 4 The change in composition with a change in applied voltage showing hysteretic behaviour.