Surface Dependent Structural Phase Transition in $SrTiO_3$ Observed with β-NMR of ^{8}Li

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$SrTiO_3$ is an important material which is used extensively as a substrate for the growth of thin films. Additionally, the structural transformation it undergoes at T_c= 105K is widely regarded as a prototypical second order structural phase transition. However, the nature of this transition close to a free surface appears different than in the bulk, and in particular shows evidence for two length scales whose origins are not fully understood. In this paper we investigate this phenomenon using depth controlled β-NMR. The measurements were performed in zero external magnetic field and rely on the local electric field gradient (EFG) at the crystalline site of the ^{8}Li (I=2) to hold the nuclear polarization. The tetragonal distortion accompanying the phase transition leads to a non-axial EFG at the ^{8}Li site whenever the distortion is perpendicular to the principal axis of the local EFG. Consequently we expect the initial polarization to decrease by a factor of 2/3 well below T_c, since the distortion can arise either parallel or perpendicular to the local EFG. The figure below shows the dependence of initial asymmetry on temperature, and demonstrates that A_{tot} decreases by a factor of 2/3 as expected. However, the loss in polarization begins at a temperature T* = 150 K, indicating there is some loss of cubic symmetry well above the bulk T_c. The value of T* is unaffected by the range of implantation depths (10-100 nm) available at ISAC, but the sharpness of the transition does depend on surface preparation (see Figure).