MS16-03 | Impact of Intense Electric Fields on the Structure of Centrosymmetric Relaxor Ferroelectric $Sr_{0.85}Pr_{0.15}TiO_3$

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Crystallography under electric field (EF) has been recently applied to reveal macroscopic and microscopic structural response of ferroelectric functional materials to intense EF. Here we focus on the effect of applied EF on the structure of a relaxor ferroelectric oxide. While in classic ferroelectrics clear signatures of polar distortion instabilities allow straightforward interpretation of diffraction data in terms of increased electric dipole moment, the centrosymmetric structure of relaxor ferroelectrics inhibits long-range polarization However, their susceptibility to distortion under EF points to local polar fluctuations and structural changes.

We present the case of Pr-doped strontium titanate ($Sr_{0.85}Pr_{0.15}TiO_3$.). Its structure shows high-temperature stabilization of the centrosymmetric antiferrodistortive (AFD) tetragonal phase observed in $SrTiO_3$ below 105 K. The structural modifications induced by applied EF were studied by synchrotron high-resolution diffraction combined with Pair Distribution Function analysis. EF induces inhomogeneous strain and preferential orientation. Concomitant increases of tetragonal strain and octahedral TiO_6 tilting angle do not break the initial long-range centrosymmetry. Conversely, PDF reveals that Ti is off-centered within its octahedral cage already at zero field, forming polar regions spanning up to 2 nm. The electric field enhances polarization within the polar nanoregions with no effect on their size, suggesting that they are pinned to charged defects introduced by Pr-doping. The large tetragonal strain found at the local scale may contribute to the ordering of the tilting angle at larger scales. This may imply a coupling between the local ferroelectric and the long-range AFD instabilities.