Use of Focussed Ion Beam sample preparation for domain imaging with BCDI

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Structural symmetry breaking and recovery in condensed-matter systems are closely related to exotic physical properties such as superconductivity, magnetism, spin density waves, and charge density waves. Fluctuation-driven domain formation on the nanometer length scale is expected to be a central feature that provides experimental evidence of symmetry breaking. Bragg Coherent Diffraction Imaging (BCDI) in the cryogenic temperature range has been employed to visualize the domain structures associated with these symmetry changes during the structural phase transition of $La_{1.875}Ba_{0.125}CuO_4$ high-temperature superconductor between its high-temperature tetragonal (HTT) and low-temperature orthorhombic (LTO) phases [1]. Focussed Ion Beam (FIB) was used to cut a representative micron-sized block from a grown crystal which was imaged as a function of temperature with BCDI. The number of domains was found to follow the order parameter near the transition. Both the 103 and 114 Bragg peaks were found to split in the LTO phase and the domains associated with each of the split pairs, imaged by BCDI, was found to fill the crystal asymmetrically, congregating towards one end of the sample, as shown in the figure below.

[1] Scaling Behaviour of Low-Temperature Orthorhombic Domains in Prototypical High-Temperature Superconductor $La_{1.875}Ba_{0.125}CuO_4$ T. A. Assefa, Y. Cao, J. Diao, W. Cha, R. Harder, K. Kisslinger, G. D. Gu, J. M. Tranquada, M. P. M. Dean and I. K. Robinson, Physical Review B **101** 054104 (2020)