Magnetic Coherent Diffraction of Domain Excitations in Sr_2IrO_4 Iridate

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I will report the results of ultrafast magnetic Bragg Coherent Diffraction Imaging (BCDI) experiments carried out on the MID instrument of the European X-ray Free Electron Laser (XFEL) facility earlier this year. We previously demonstrated magnetic BCDI on Sr_2IrO_4 samples prepared in block shapes by Focussed Ion Beam (FIB) methods [1]. Below its ordering phase transition at T=230K, Sr_2IrO_4 is antiferromagnetic (AFM) with a tetragonal structure [2]. The AFM structure breaks the 4-fold symmetry leading to 90° magnetic twin domains with a slight orthorhombic distortion. In the previous magnetic BCDI work, a single magnetic domain was found to fill the FIB block of 1.2x1.2x1.2 microns, as shown in the figure below [1], while scanning X-ray nanoprobe diffraction found side-by-side domains of both orientations up to 100 microns in size. In our XFEL experiment at MID, we located an isolated cluster of magnetic domains within a large single crystal while measuring the 106 magnetic diffraction peak on the Jungfrau detector on resonance at the Ir L_3 edge at 11.215 keV. This pattern was reconstructed using standard BCDI iterative phasing methods [3] to reveal an array of antiphase domains in real space. Upon laser excitation, the diffraction pattern was found to change significantly within the first picosecond and relax more slowly back to the original configuration, as seen in the two-time correlation function. A model of four phase domains was used to fit the data and image the time dependence as a movie. Interestingly, the AFM domains were found to move together and apart upon excitation without much change of their relative phase. This suggests a model where laser-generated free electrons interact preferentially with the AFM domain walls in the system.

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