Fourier ptychographic DF-XRM

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DF-XRM[1] is typically assumed to follow an incoherent model of image formation, based on a geometric optics approach and the assumption of a locally perfect lattice. However, in some cases, a coherent model of image formation becomes appropriate. When this is the case, we can use coherent microscopy methods to analyze the data. Fourier ptychography(FP)[2] is a coherent computational microscopy techinique developed to exceed the resolution limit in NA-limited microscopes by translating the illumination (or equaivalently the lens position) and capturing multiple images at different lens position. The mathematical problem of recovering the (Fourier transformed) sample and lens functions from such images is equivalent to recovering the sample and probe functions in ptychography, and as such the same algorithms may be used. Ideally, FP is able to correct for lens aberrations and increase the resolution beyond the diffraction limit of the objective lens, which is a promising prospect for the aberration limited small-NA CRLs used in the ID06 microscope. In practice, there are a number of experimental non-idealities that make this difficult. The method does has difficulties representing the high-frequency errors present in CRLs, and the small registration errors caused by unkown positioning errors of the lens and/or detector need to be corrected for. The quantitative phase recovered by FP can, in some cases, yield additional information beyond the strains recovered by the usual analysis. One example is in the case of twinned polar materials. The twin boundaries are not assiciated with any strain but do generate contrast in the images due to a discrete jump in the phase of the scattering function.[3] Here we present initial results in bright-field mode using a resolution target and in dark-field mode for thin-films and thick single-crystals.

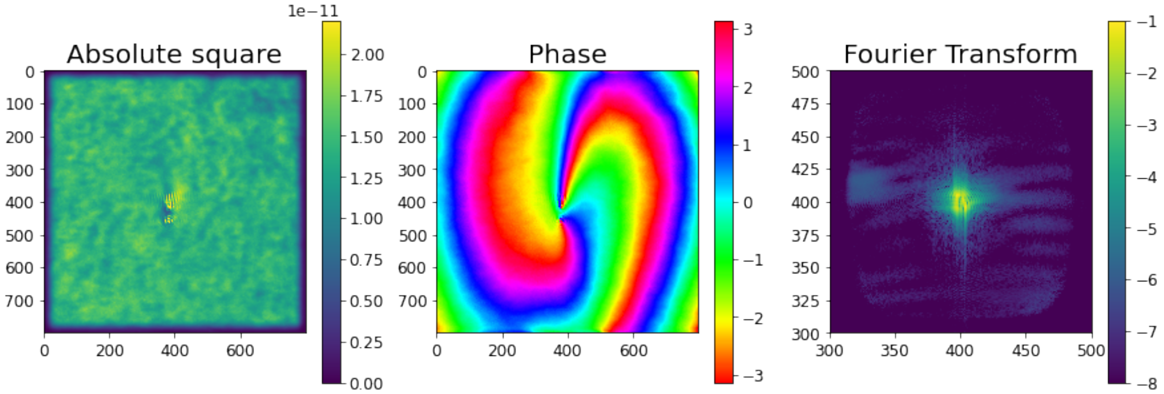

Figure 1: Recovered amplitude, phase and Fourier transform of an epitaxial $BiFeO_3$ containing a screw dislocation.

References

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