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Minimising the distortive effects of diffraction on magnetic STEM-DPC imaging of monocrystalline thin films

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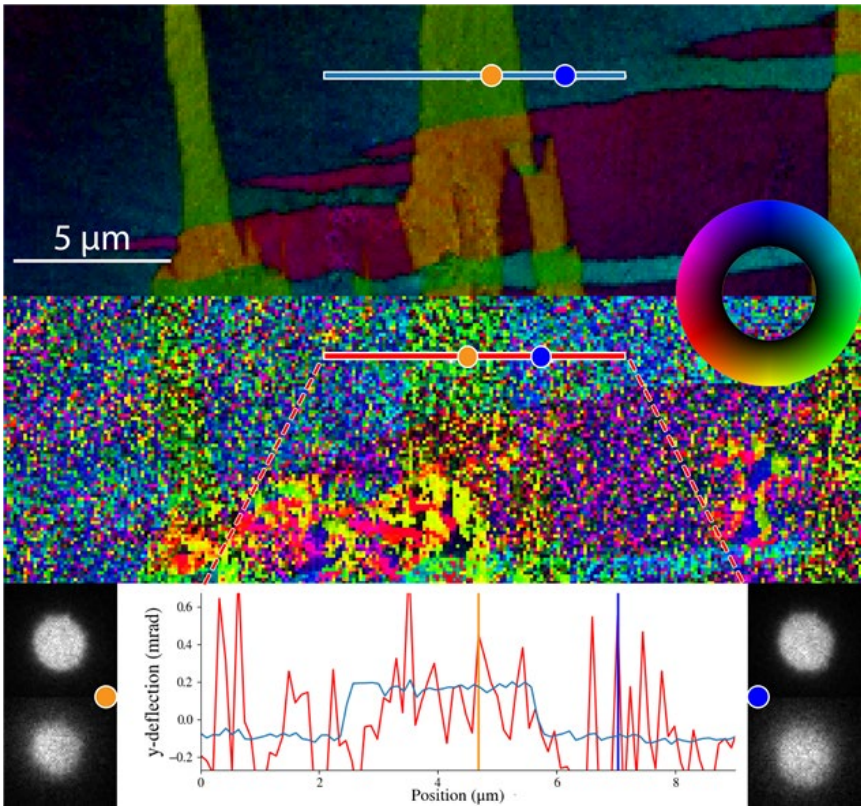
Development of state of the art electric and magnetic devices requires high resolution characterisation techniques, one such being scanning transmission electron microscopy – differential phase contrast (STEM-DPC), which gives quantitative magnetic information while allowing concurrent acquisition of structural and chemical information in the same sample area. Magnetic STEM-DPC characterization relies on detecting minute shifts of the electron probe, often in the range of a couple of microradians. At highly diffracting conditions, the electron probe can get heavily distorted, making it difficult to extract the small shifts caused by the in-plane magnetic field.

In this work, we acquired STEM-DPC datasets using a 4D-STEM detector on a monocrystalline magnetic freestanding La0.7Sr0.3MnO3 (LSMO) thin-film. We acquired several tilt orientations at a temperature of -150.0˚C, giving a systematic overview of diffraction induced distortions on probe shape and magnetic signal. Fig. 1 shows two STEM-DPC images from low- and high-diffraction conditions together with probes and line profiles as indicated on the figure, clearly demonstrating the distortive effects of diffraction. Tilt series were done at increasing angles away from the zone axis and with a constant off-axis angle but rotating around the zone axis. By examining the random variations in the STEM-DPC signal and comparing to the difference in signal between magnetic domains, a quantitative value for the signal to noise ratio was obtained.

This presentation will show which considerations and mitigation measures should be used to optimise STEM-DPC imaging in heavily diffracting samples, and how different data processing algorithms handle the distortions in the electron probe.

Graphic:



Keywords:

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