Report on HS903

Beamline ID22

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Time: 9 shifts 14/12/99-17/12/99

The original application HS903 was not awarded beamtime (15 shifts requested), despite being well-received by the committee. This proposal sought to do an extended study of a short-period (5 microns) array of inversion domains in $LiNbO_3$, building upon previous work on periodically-poled crystals with A.Snigirev's team[1-2]. The application was to use magnifying optics together with the high-resolution camera to take diffraction images in reflection from the crystal surface whilst sweeping through the rocking curve. This was to be teamed with microbeam diffraction from the domain wall regions themselves.

Ultimately, 9 shifts only of beamtime were obtained for the experiment and it was decided to undertake a feasibility study for magnification of the image from the domains. An $LiNbO_3$ crystal with a domain period of 5 microns was examined. The magnifying optics were provided by a Fresnel Zone Plate, with a focal distance of 620 mm at 13 keV, which was the energy selected. The Fresnel Zone plate was constructed from gold zones having a thickness of 1.15 microns deposited on a transparent SiN substrate of thickness 10 microns. We worked with a mirror-reflected undulator harmonic and used the 006 reflection of single-crystal $LiNbO_3$ for monochromation to match exactly the sample diffraction in a parallel geometry. This geometry was required in order to achieve a long beam path for later magnification of the topograph. The aim was to take some topographs in Bragg geometry for the 006 reflection from $LiNbO_3$ without the lens and then with the lens in place. It was hoped to achieve a magnification of 7 times and a spatial resolution of 0.3 μm.

Standard topographs were taken and then topographs with the lens in place. When trying to perform the magnification, the lens broke. We were able to save and reconstruct part of the lens, but the images resulting from this were of a small area of the sample and were not of the highest quality. Nevertheless, magnified images (e.g. Fig. 1) *were* obtained using this method, thus demonstrating proof of concept.

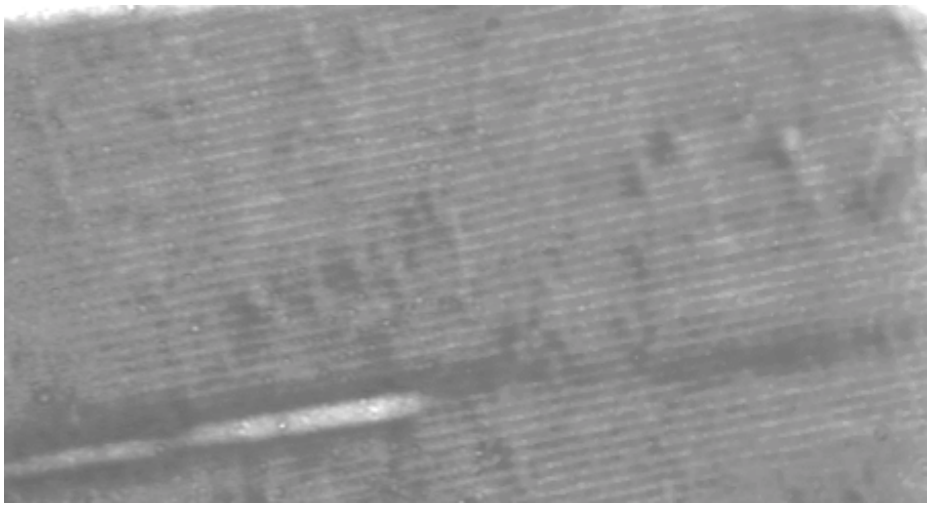

Figure 1. A magnified x-ray image in Bragg reflection of a 5 μm period array of domains in $LiNbO_3$. The domain boundaries, which occur every 2.5 μm, are seen as the white lines. On the equivalent unmagnified image they are not resolved.

References

[1] *****Z.W.Hu, P.A.Thomas, A.Snigirev, I.Snigireva, A.Souvorov, P.Smith, G.Ross & S.J.Teat *Phase Mapping of Periodically Domain-inverted LiNbO3 with Coherent X-rays* Nature (1998) **392**, 690-693.

[2] *****M.Drakopoulos, Z.W.Hu, S.Kuznetsov, A.Snigirev, I.Snigireva & P.A.Thomas *Quantitative X-ray Bragg Diffraction Topography of Periodically Domain-Inverted $LiNbO_3$* J.Phys.D. (1999), **32**(10A), 160-165