ESRF	**Experiment title:** Bragg-Magnified diffraction imaging of crystalline samples with 2D reciprocal space resolution	**Experiment number**: MA292
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Shifts: 12	**Local contact(s)**: Juergen Haertwig	*Received at ESRF:*

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Report:

Asymmetrically cut analyzer crystals as optical elements in X-ray imaging can provide image magnification by factors up to 200 and more. A dedicated instrument using two perpendicular analyzers to achieve magnification in both image dimensions (the “Bragg Magnifier”) was developed in our group [1]. First applications were successfully demonstrated in 2006 (ESRF-experiment MI827) in the field of direct-beam imaging (radiography, tomography). The aim of experiment MA-292 was to transfer the principle of Bragg-magnified imaging to new imaging geometries (diffraction topography, rocking curve imaging - RCI) and thus to explore diffraction contrast as an additionial contrast mechanism for the Bragg magnifier. Simultaneously, the spatial magnification was to be used to push the resolution in rocking-curve imaging below the micrometer limit.

Before the experiment, the existing Bragg-magnifier box was upgraded to include an additional degree of freedom of sample rotation (Bragg angle). The exit-beam optics with both analyzers was made rotatable around the sample position so that it could be placed into the diffracted beam at the corresponding total scattering angle. The finished “turnkey” instrument was brought to ESRF-ID19 and proved to work well.

Measurements were performed on two types of semiconductor samples with surface patterning: Gallium Nitride layers grown on SiC by epitaxial lateral overgrowth (ELO), and homoepitaxial Si lamellas grown by ELO on misoriented Si substrates. For both samples, scans in the rocking angles of the sample, the first and the second analyzer were carried out, and magnified images of the diffracted beam profile taken at each individual rotation angle. The resulting sequences of serial topographs were analyzed in-place with dedicated software [2]. The measurements were performed in two different diffraction geometries, with the diffraction plane once parallel and once perpendicular to the ELO seed windows.

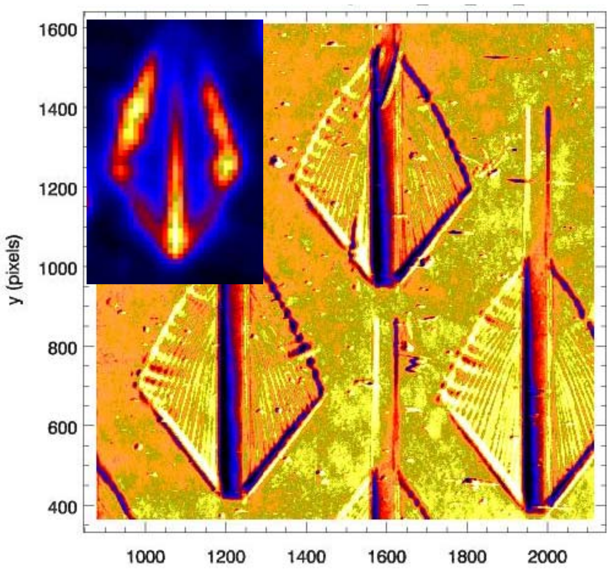

Figure 2: Distribution of local rocking curve widths (FWHM) in ELO-Si lamellae; scan of sample rocking angle with diffraction plane parallel to the ELO window. Comparison with similar data previously recorded in a laboratory setup (upper leftt) shows the unprecedented resolution achievable at the synchrotron in diffraction imaging with Bragg magnification. Many details, such as the diagonal contrast variations in the Si lamellas, were not previously observed.

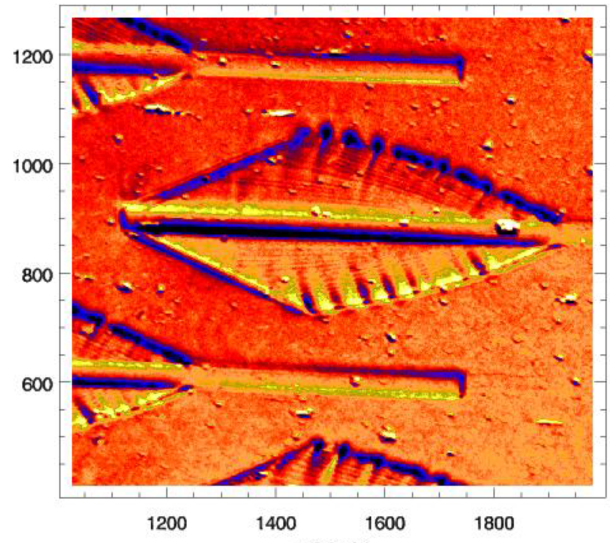

Figure 3: Map of local Bragg angle changes in ELO-Si lamelae; scan with diffraction plane perpendicular to the ELO windows. This geometry, unlike the parallel one, is directly sensitive to the tilt of the lateral lamellae. The combination of both measurements is useful to dinstiguish strain effects from the effects of two tilt components.

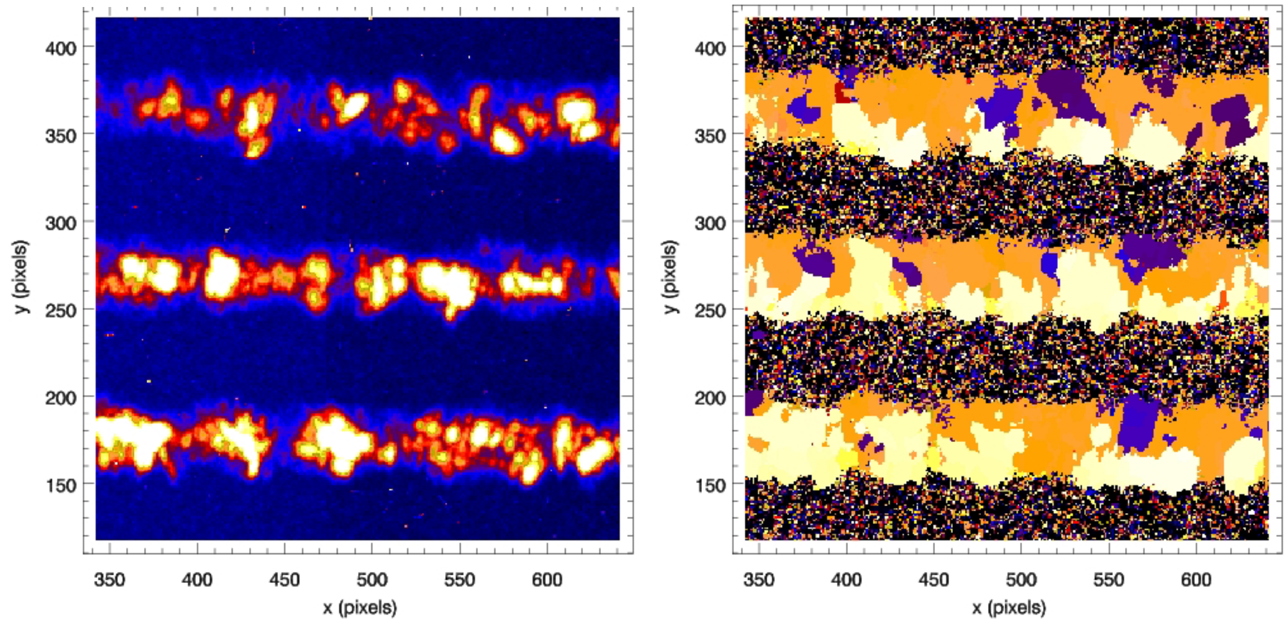

Figure 1: Maps of local diffraction intensity (left) and local Bragg angle changes (right) in ELO-GaN structures; scan of sample rocking angle with diffraction plane perpendicular to the ELO lines. The spatial resolution is considerably improved with respect to previous RCI experiments on similar samples. This allows e.g. to clearly resolve the grain structure and mosaic blocks inside the individual ELO windows and wings (distance scale: 40 µm between adjacent periods).

References

[1] P. Modregger, D. Lübbert, P. Schäfer and R. Köhler, Phys. Rev. B 74 (2006) 054107.
[2] D. Lübbert, T. Baumbach. J. Appl. Cryst. 40 (2007) 595–597.