ESRF	**Experiment title:** GaN layers grown by epitaxial lateral overgrowth study using Rocking Curve Imaging with high spatial resolution	**Experiment number**: HS-2542
Beamline: ID10B	**Date of experiment**: from: 28. 1. 2005 to: 1. 2. 2005	**Date of report**: 1. 3. 2005
Shifts: 12	**Local contact(s)**: Federico Zontone	*Received at ESRF:*

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Report:

The aim of experiment HS-2542 was to investigate epitaxially laterally overgrown gallium nitride (ELO-GaN) samples using spatially resolved X-ray diffraction alias Rocking Curve Imaging (RCI) method with very high spatial and angular resolutions. ELO is a well established crystal growth method, but still suffers from the problem of crystallographic misorientation of the laterally overgrown regions (wing tilts), whose origins remain largely unknown. A scheme of the investigated samples is shown in figure 1. The lateral wire periodicity was 40 μm, the ELO-GaN structures were grown on Al_2O_3 and SiC substrates.

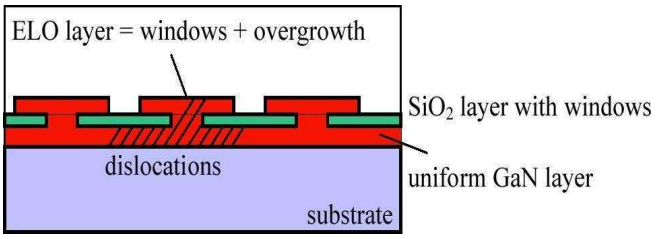

Figure 1. Cross-sectional view of the ELO structure. The lateral periodicity is 40 μm.

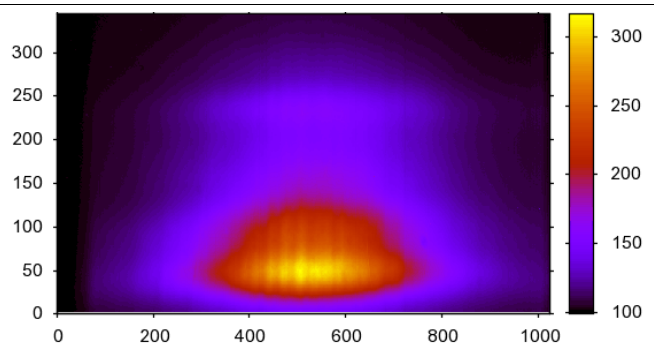

Figure 2. Shape of the primary beam at ID10B (except for the stripe artefacts). Spatial axes in micrometers.

This experiment has been performed at beamline ID10B at wavelength 1.246 Å. There, compared to previous experiments at ID19, we intended to profit from: 1. small millimeter-size beam (parallel, without focussing) with very high flux density, and 2. high-precision horizontal diffractometer. It should be noted that this was the first experiment with FreLoN camera on this beamline. The FreLoN setup was borrowed from ID19 and successfully integrated into the beamline control system of ID10B. We could demonstrate that an imaging experiment is indeed feasible here.

The high flux density available at ID10B allowed us to make large scans spanning the complete angular range of local wing misorientation of the studied samples (up to 1.5°) with a very high number of steps (step width 0.001°). Due to the very high flux density, the spatial resolution of the Frelon camera system could be set to a value of 1.0 µm without requiring unreasonably long exposure times, compared to a best value of 1.4 µm in previous experiments.

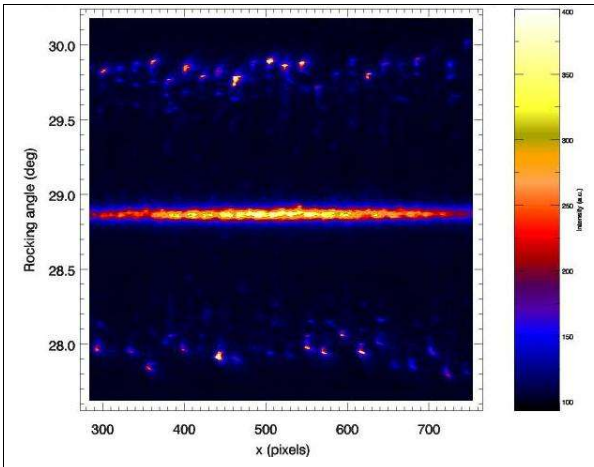

Figure 1: Experimental x-ω-map from an GaN-ELO sample grown on sapphire.

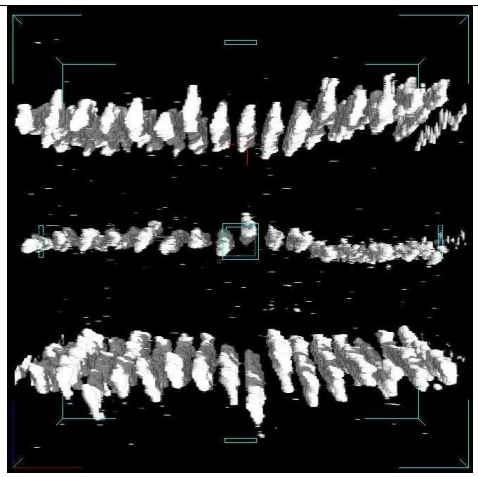

Figure 2: Three-dimensional representation of local lattice misorientation in a GaN-ELO structure. The horizontal (x and y) axes represent spatial dimensions, while the vertical (z) axis is the angular (crystallite orientation) scale. The upper and lower layer are from the wing regions of the ELO structure, while the central band of peaks is related the ELO windows. This method of visualization facilitates the analysis of local orientation fluctuations and clearly shows the strong correlation of orientations along a stripe as well as the absence of correlation between wings and window.

The high flux density available at this beamline further allowed us to study a new type of samples by RCI: InGaN superlattices grown on bulk GaN substrates. To reveal the defect structure of the layers, we restricted the incoming beam by slits in one dimension. The recorded camera picture is then representative of one spatial dimension (vertical pixel axis) and one angular dimension (horizontal pixel axis). An angular RCI scan is therefore equivalent to thousands of conventional omega-2theta scans from sample surface areas of few µm. Fig.s 3 and 4 show two typical results from this study; a full evaluation is under way.

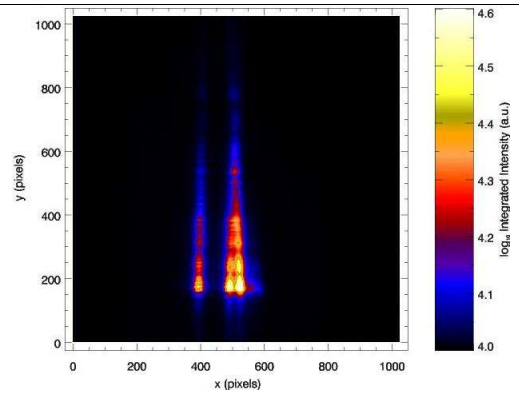

Figure 3: Integrated intensity map from the substrate reflection.

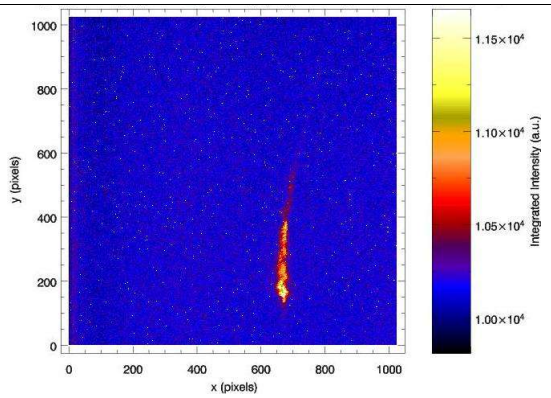

Figure 4: Integrated intensity map from the corresponding layer reflection. Not the different curvature of the high-intensity features in the two figures.