EUROPEAN SYNCHROTRON RADIATION FACILITY

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ESRF

Experiment Report Form

The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.

Once completed, the report should be submitted electronically to the User Office via the User Portal:

https://wwws.esrf.fr/misapps/SMISWebClient/protected/welcome.do

Reports supporting requests for additional beam time

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

Reports on experiments relating to long term projects

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

Published papers

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

Deadlines for submission of Experimental Reports

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

Instructions for preparing your Report

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.

ESRF	**Experiment title:** X-ray nanodiffraction from individual defects in GaN crystallites	**Experiment number**: HC2002
Beamline: ID01	**Date of experiment**: from: 7.10.2015 to: 13.10.2015	**Date of report**: 28.12.2015
Shifts: 16	**Local contact(s)**: Tobias Schuelli	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Prevalent defect type in non-polar (11-20)-oriented a-GaN epitaxial layers are basal stacking faults (SFs) in (0001) planes. Acoording to the analysis published in our previous paper [1], diffuse x-ray scattering from these stacking faults is concentrated along [0001] rods parallel to the sample surface. For the investigation of the type of the SFs (intrisic types called I1, I2, I3 and extrinsic SFs denoted E – see [1] for details) non-coplanar symmetric diffractions H0-H0 are suitable, the defect rods disappear for any H=3n.

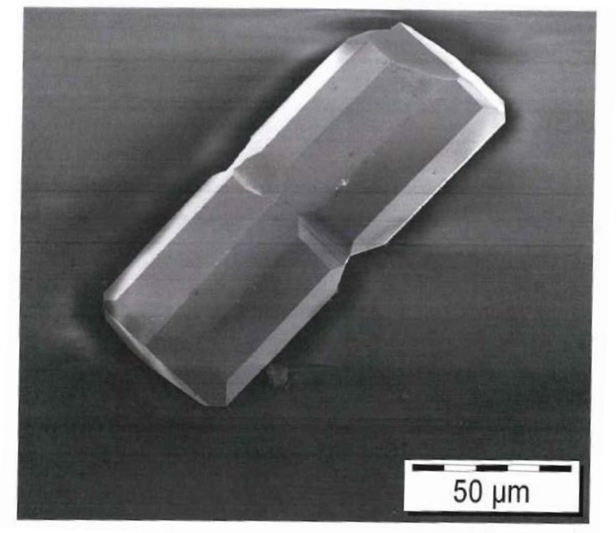

Fig. 1 Optical micrograph of a typical GaN microcrystal.

The aim of the beamtime was to study individual stacking faults using a narrow primary x-ray beam with the diameter around 200nm and energy of 8.5 keV. For this purpose we investigated microcrystalline a-GaN layers with the size of individual crystals around 10-50µm. Figure 1 shows an optical micrograph of a typical microcrystal consisting of two single-crystalline grains with well-developed facets.

The position of individual stacking faults in a selected microcrystal was determined by means of the fast K-mapping technique. In this method the 20-20-diffracted radiation was detected by a fixed two-dimensional detector during x-y scanning of the sample. Figures 2a,b show the results of the K-mapping of the crystal depicted in Fig. 1.

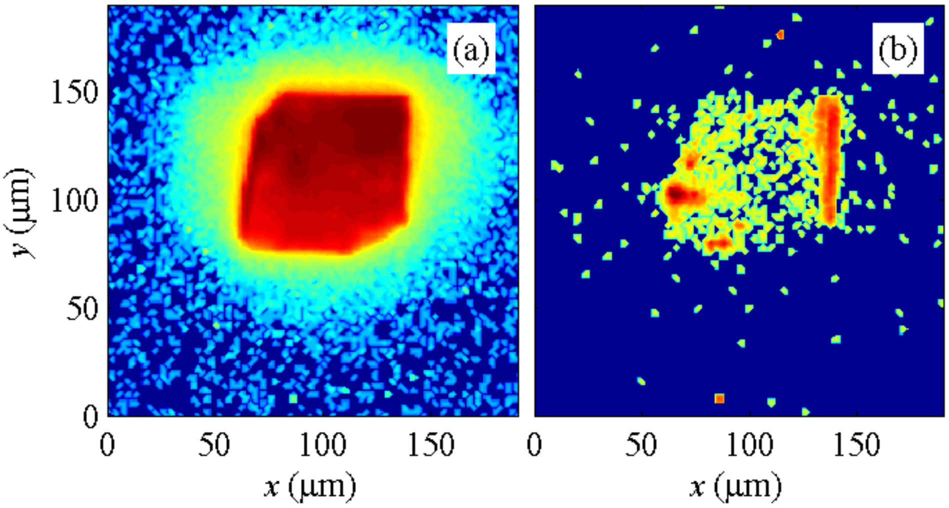

Fig. 2 The space distribution of the diffracted intensity measured by the K-mapping method, the same microcrystal as in Fig. 1. (a) Intensity integrated over the whole two-dimensional detector, (b) intensity taken from the region of interest at a [0001]-oriented rod outside the main diffraction maximum.

In the panels (a) and (b) we plotted the intensity integrated over the entire detector window (a) and taken from a suitably chosen region of interest (b), which corresponds to a defect-induced [0001] rod outside the main diffraction maximum. While the shape in (a) corresponds to the shape of the diffracting grain of a microcrystal, the maxima in (b) correspond to the positions of individiual stacking faults.

We have chosen a distict intensity maximum in Fig. 2b at x = 65 µm, y = 105 µm and perfomed a detailed measurement of three-dimensional reciprocal map. Figure 3 (upper panel) shows a detail of the reciprocal-spae map, in which the [0001]-oriented intensity rod is visible; the lower panel displays the intensity distribution along the rod.

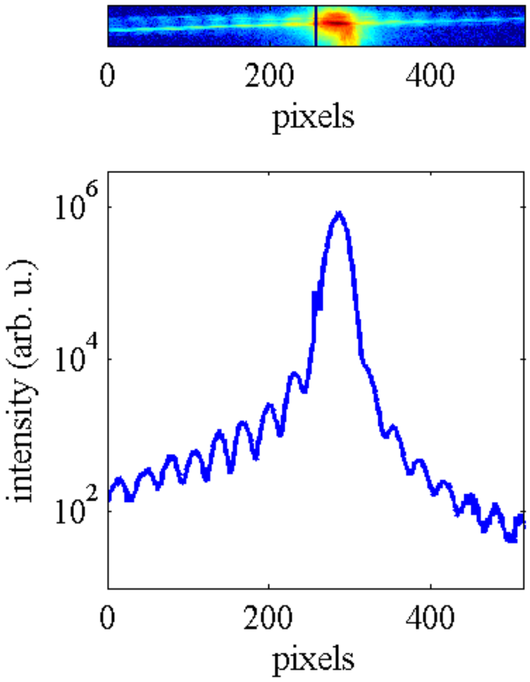

Fig. 3. Part of the reciprocal-space map measured in the selected sample position (upper panel) and the intensity distribution along the [0001] rod (lower panel).

The oscillations along the rod are caused by the interference effect of two adjacent stacking faults; a detailed numerical simulations revealed that both stacking faults are of the type I1 and their distance is (20±5) nm.

[1] M. Barchuk et al., Phys. Rev. B **84**, 094113 (2011).