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 using the **Electronic Report Submission Application:**

http://193.49.43.2:8080/smis/servlet/UserUtils?start

Reports supporting requests for additional beam time

Reports can now 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 imaging of phonon interaction with dislocations**	**Experiment number**: HS-1618
Beamline: ID19	**Date of experiment**: from: 05 December 2001 to: 09 December 2001	**Date of report**:
Shifts: 12	**Local contact(s)**: **Dr. Juergen HAERTWIG**	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

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Report:

Current experiment HS-1618 continues a series devoted to the development of stroboscopic X-ray imaging of acoustic wave fronts propagating in single crystals. We were able to achieve two important goals formulated in the beginning of this project. The first goal is visualization of wave front distortions due to phonon scattering by dislocations, which have a crucial effect on thermal conductivity and related phenomena. Previously we showed, that stroboscopic X-ray topography synchronized with short surface acoustic waves (SAW) enables us to visualize individual acoustic wave fronts as well as their distortions when crossing the dislocation lines (Mat.Sci.&Eng.A **309**, 23 (2001)). Due to optimized contrast, the images taken during last beam session from piezoelectric LiNbO$_3$ crystals with inter-digital transducer on top of them, exhibited specific shapes of acoustic wave fronts in close vicinity to the dislocation line (see Figure 1 and 2). These specific wave front distortions are caused by the dynamic deformation field, which is produced by vibrating dislocation segments. Basing on computer simulations and comparison between simulated and experimental images (Figure 2) we were able to extract the amplitudes of dislocation vibrations, which indicate the strength of phonon/dislocation interaction. These findings will be published shortly.

The second goal is an extension of the application range of this new technique to non-piezoelectric and weakly piezoelectric crystals, with no deposited electrodes on top of them. We demonstrate successful X-ray diffraction imaging of high-frequency (0.29 GHz) surface acoustic waves propagating within Si and GaAs crystals (see Figure 3). In order to generate surface acoustic waves in semiconductor crystals the latter were coupled to LiNbO$_3$-based surface acoustic wave transducers via contact liquids. The maximum surface acoustic wave transmission is achieved for evanescent waves under optimized coupling conditions at liquid/sample interface. The developed technique opens a way to directly study phonon interaction with defects in non-piezoelectric and weakly piezoelectric crystals. A part of the obtained results is summarized in two papers, one published in SRN, **15**, No. 2, 21 (2002) and the second one submitted to APL.

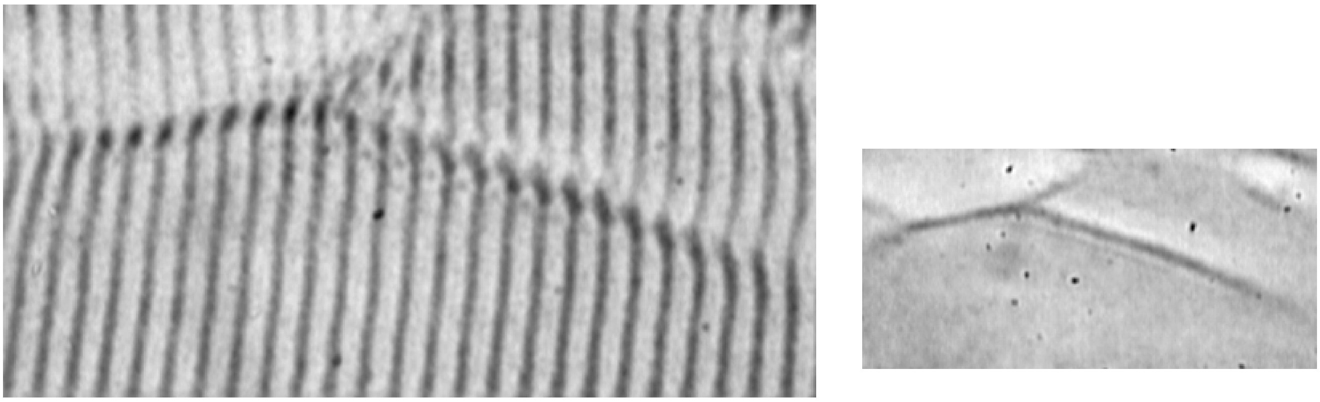

FIG 1. X-ray image (left panel) containing individual acoustic wave fronts of a 0.58 GHz SAW and their distortions when crossing the dislocation lines in $LiNbO_3$. Right panel - X-ray image of the same dislocation lines without SAW.

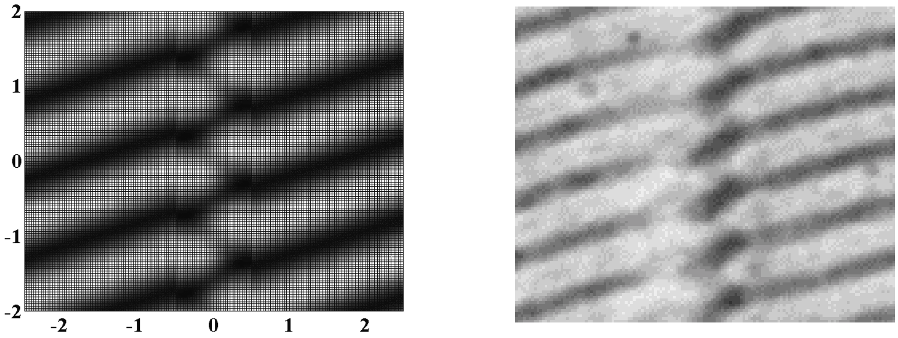

FIG 2. X-ray image (right panel) showing dynamic deformation field near the vibrating dislocation line, as compared with contrast simulations (left panel) based on the deformation field in the vicinity of the vibrating dislocation segment.

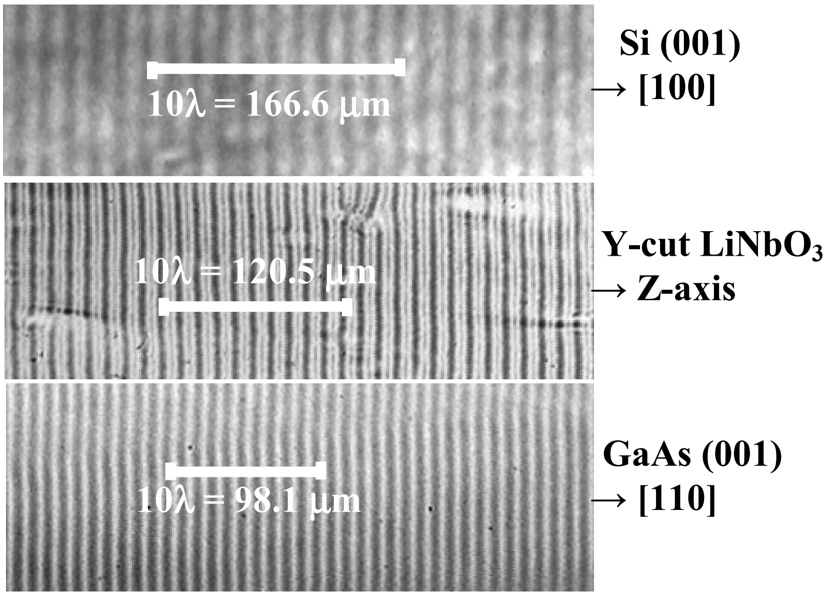

FIG 3. X-ray images of a 0.29 GHz surface acoustic wave fronts in GaAs and Si as compared to that ones in the $LiNbO_3$ transducer.