ESRF	**Experiment title:** High-frequency stroboscopic X-ray topography	**Experiment number**: HS-707
Beamline: ID 19	**Date of experiment**: from: 12-Nov-98 to: 15-Nov-98	**Date of report**: 24-Fev-99
Shifts: 11	**Local contact(s)**: Juergen Hartwig (PLUO E)	*Received at ESRF:*

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Report:

X-ray topography measurements were performed in a stroboscopic mode in order to study high-frequency periodic deformation fields in nearly perfect crystals. Periodic modulation of the crystal lattice was achieved by an excitation of surface acoustic waves (SAW), having the frequencies of 290 , 355, and 580 MHz, which correspond to SAW wavelengths equal 12, 9.8, and 6 μm, respectively. SAW were generated with the aid of high-frequency SAW devices fabricated on the polished surfaces of the Y-cut, $LiNbO_3$ wafers, 3 inch in diameter and 0.5 or 1 mm thick. For device fabrication a system of sectioned interdigital electrodes, consisting of 200 nm thick Al fingers, has been deposited using a photolithography procedure and specially designed masks. Three different electrode configurations were fabricates with a width of individual electrode equal 3, 2.2, and 1.5 μm.

Two sets of samples were used in these measurements. The first one included the SAW devices themselves. X-ray diffraction images were taken from the (060)$LiNbO_3$ atomic planes, *in situ* , under SAW excitation. The second set consisted of Si crystals and Si-based structures, attached to the $LiNbO_3$ devices by means of different contact materials . In this case diffraction profiles were taken from the Si(004) and Si(008) reflections through a special window in the sample holder (see Ref. [1]).

In order to stop SAW in time the X-ray diffraction measurements were performed in a stroboscopic regime, the storage ring being operated in a 16-bunch mode with a bunch repetition frequency of ν_r = 5.68 MHz. This frequency was used in order to drive SAW devices in phase-locked mode via computerized frequency synthesizers, which were designed for two frequency ranges: 270 - 370 MHz and 560 - 600 MHz. Diffraction images under SAW excitation were detected by using monochromatized radiation (λ=0.6888 Å) and high-resolution Kodak films exposed for 200-500 sec. It was found that positioning of a X-ray film parallel to the sample surface, at distances equal 3-5 cm, provides best imaging conditions.

In this study we focused on two experimental problems: 1) visualization of high-frequency traveling SAW and their interaction with structural defects in piezoelectric crystals; 2) possibility to transmit enough acoustic power from external transducer to attached sample for wavefront imaging in non-piezoelectric crystals. A first part is a continuation of our previous experiment SI-280, in which we succedeed, for the first time, in visualization of the 10 μm SAW and their interaction with linear dislocations and post-implantation He-bubbles (see Ref. [2]). In this study we received new images containing plane individual wavefronts of 12 μm-SAW, propagating across the large area of $LiNbO_3$ crystals. In other types of SAW devices the obtained topographs allowed to visualize dynamic deformation fields having expected periodicity of 10 μm and 6 μm. These images provide important information about SAW scattering processes at dislocation lines. Thus, the abilities of stroboscopic X-ray topography to SAW visualization were expanded up to the frequencies of 600 MHz. The obtained results will be a subject of forthcoming publication.

The second part of this experiment was less successful. Clear indications of SAW influence on X-ray diffraction, i.e. SAW-induced modifications of the X-ray topographic contrast, were observed from narrow Si areas, being in a direct contact with $LiNbO_3$ transducers. In the one image only we were able to detect subtle contrast changes due to SAW propagation in free-of-contact area of the sample. It seems that the methods used to provide the SAW transmission to non-piezoelectric samples are not effective enough. Since, during this beamsession various contact materials (epoxy resines, greases etc.) in combination with different springs for gentle manipulation of sample loading were tested, we think that more strong mechanical coupling between piezoelectric and non-piezoelectric species, like mechanical bonding, should be used in future experiments.

[1] E. Zolotoyabko and D. Shilo, Ultrasonics, **36,** 403 (1998).

[2] E. Zolotoyabko, D. Shilo, W. Sauer, E. Pernot and J. Baruchel. Appl. Phys. Lett. , **73**, 2278 (1998).