ESRF	**Experiment title:** Interaction of surface acoustic waves with structural defects in He-implanted waveguide layers of $LiNbO_3$	**Experiment number:** SI-280
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Report:

The stroboscopic X-ray topographic experiments were performed with high-frequency SAW devices, having a thin near-surface waveguide layer, which serves to improve device characteristics. SAW devices were 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. The distances between pair of adjacent electrodes, i.e. the SAW wavelengths, λ_S , were λ_S =12 μm and λ_S =9.8 μm, for the two types of devices used, which corresponds to the SAW frequencies of ν=290 MHz and ν=355 MHz, respectively.

In order to produce a waveguide layer with modified refraction index, He ions with an energy of 320 keV were implanted at room temperature into the $LiNbO_3$ samples up to a dosage of $2 \cdot 10^{16}$ cm-2. Unfortunately, an implantation procedure is accompanied by an arising of extended defects, which deteriorate optical properties of SAW devices and lead to the dissipation of acoustic energy due to the parasitic scattering of the SAW.

A goal of this study was to visualize traveling SAW and its interaction with structural defects in $LiNbO_3$. During the stroboscopic measurements the storage ring operated in 16-bunch mode with a bunch repetition frequency of ν_s = 5.68 MHz. This frequency was used in order to drive SAW device in phase-locked mode via computerized frequency synthesizer. Diffraction images from (060) $LiNbO_3$ atomic planes under SAW excitation were detected by high-resolution Kodak film with an exposure of 200-300 sec. These images showed a periodic contrast in a 10 μm-scale due to lattice deformation, induced by traveling SAW. Traveling SAW served to visualize extended defects, such as dislocations, even if they are invisible otherwise. The mechanism of contrast's enhancement is conditioned by a weak distortion of the SAW wave fronts due to the scattering, when propagating through the defect's area.

Secondary spherical waves were observed for the first time as a result of the strong acoustic wave interaction with post-implantation sub-micron He-bubbles, having a density which differs considerably from that of the matrix. The distance between neighboring bubbles was found to be 300-400 μm, which renders problematic an observation of such objects by other techniques.

In summary, stroboscopic X-ray topography under 10 μm SAW excitation has been found to be very sensitive to extended defects in nearly perfect crystals, including the defects which are invisible without SAW. Additional contrast is caused by the wave front distortions in the plane SAW due to the defect-influenced SAW scattering processes. In other words, the phase velocity of SAW is changed due to the modifications of the elastic properties and of the local density of material in the defect's surrounding areas, that is immediately revealed along long-sized, initially flat SAW wave fronts.

Experimental procedures and obtained results are described in details in Ref. [1].

[l] E. Zolotoyabko, D. Shilo, W. Sauer, E. Pernot and J. Baruchel. Stroboscopic X-ray topography in LiNb03-based surface acoustic wave devices. Appl. Phys. Lett. , 1998 (submitted).