ESRF	**Experiment title:** X-ray imaging and diffraction from surface phonons on GaAs	**Experiment number:** HS 706
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Report:

Using interdigital transducers, surface acoustic waves (SAW) were excited on GaAs (100). According to different transducer geometry, the wavelength of the SAW is 3.5 and 5 μm. The resulting periodic strain field inside the crystal can be demonstrated with different x-ray diffraction techniques.

The synchrotron source provides in 16-bunch mode 50 ps long x-ray pulses with a repetition frequency of 5.68 MHz. The driver frequency of the synchrotron was multiplied and used as excitation frequency for the SAW device. Thus, the surface wave is always in phase to the light pulses and one obtains a standing image of the wave with this stroboscopic technique.

For this purpose, a circuit containing a phase-locked-loop (PLL) was designed and constructed. It covers a frequency range from 50 MHz to 1.1 GHz and an amplitude range from 1V to 10V.

By a channel-cut Si (111) monochromator, the wavelength of the incident radiation was tuned to 0.1nm. The sample was aligned to the GaAs (400) reflection. Figure 1 shows an example for a topograph of sample surface during excitation of surface waves taken at the high-resolution topography beamline ID19. The period of the waves is imaged by a change in contrast. Additionally, a high contrast variation due to defects in the GaAs crystal becomes visible.

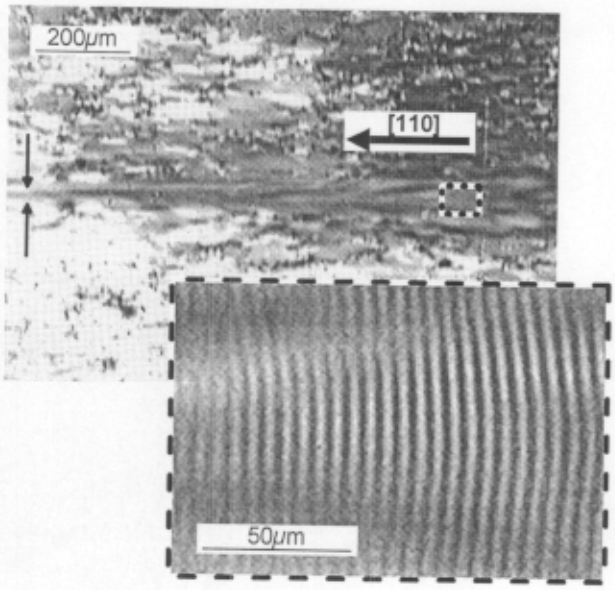

FIG. 1. Topogram of GaAs with SAW excitation, emitted from a focussing transducer on the right, propagating along [110].

Besides topography, which show the real-space image of the crystal under SAW excitation, also high-resolution diffraction using a triple-crystal setup was performed. With a Si (111)-analyser crystal, the angular distribution of the diffracted x-rays was scanned. In figure 2, the results of measured spacemaps without (left) and with SAW excitation (right) are shown.

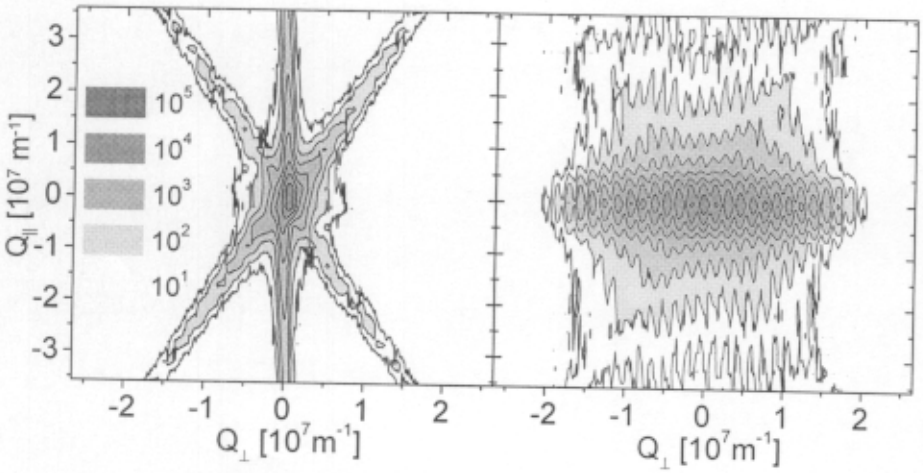

FIG. 2. Log.-scaled, reciprocal space intensity map at the GaAs (400) reflection without (left) and with (right) SAW excitation.

The figure shows the log-scaled intensity distribution around the GaAs (400) reflection, which appears in the center of each map. The halfwidth of the reflection is below 10 arcsec. The left image shows the resolution of the triple crystal setup with streaks of diffraction of the monochromator, the sample and the analyser. Under SAW excitation, the (400) peak at $\boldsymbol{Q} = \boldsymbol{K}$ is accompanied by phonon-induced peaks at the positions: $\boldsymbol{Q} = \boldsymbol{K} + \boldsymbol{q}_{SAW}$

Here $\boldsymbol{Q}$ denotes the wavevector of the diffracted x-ray, $\boldsymbol{K}$ the reciprocal lattice point (400) of GaAs and $\boldsymbol{q}_{SAW}$ the wavevector of the SAW-induced surface phonons.

The simulation of the obtained diffraction pattern is in work.