# ACOUSTIC RULER MAKES CRYSTAL DISORDER VISIBLE

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Nowadays imaging and image analysis is becoming more and more popular in the field of scientific data acquisition and processing. The main benefits relate to the fact that a map contains much more information than a graph, and this information can be delivered even to non-experienced users in a very visual form. This trend led to fast development of new imaging techniques, such as acoustic microscopy, atomic force microscopy etc., in materials science, and to the penetration of mapping options within such well-established techniques as X-ray diffraction and X-ray and electron spectroscopies.

In this paper, a novel method for materials characterization - X-ray topography under surface acoustic wave (SAW) excitation - is described. It combines the best features of both X-ray diffraction and ultrasonic imaging. In this method, plane SAWs with a wavelength of 10 μm are introduced into the crystal, creating periodic long-range variations of elastic strain. X-ray topographs from well-ordered crystals, having such artificially modulated atomic structure, contain alternating blight and dark lines, passing like a ruler through the whole crystal area. Crossing crystal regions with defect-induced atomic disorder, the ruler is getting slightly bent, providing clear defect images, which are not visible without SAW. Contrast enhancement is caused by the wave front distortions due to the weak SAW scattering on the defect deformation fields. In other words, the phase velocity of SAW is slightly changed in strained areas surrounding a defect, that is immediately revealed along long-sized, initially flat SAW fronts. Geometrically, it is very similar to the optical principle of Moire contrast formation.

These general considerations are well illustrated by X-ray synchrotron topographs taken *in situ* from LiNbO3-based SAW devices with He-implanted waveguide layers. Measurements were performed at the European Synchrotron Radiation Facility (ESRF, Grenoble, France) in the stroboscopic mode, i.e. by synchronizing the electron bunch frequency with the resonant frequency (about 300 MHz) of the SAW device. X-ray diffraction images showed plane SAW propagation through the LiNbO3 crystals as well as wave front distortions, revealing otherwise invisible screw dislocations. Secondary spherical waves, similar to those produced by a stone plunged into the water, were observed for the first time as a result of the strong SAW interaction with the sub-micron He-bubbles, located 300-400 μm from each other.