Study of Surface Acoustic Wave Propagation Using Raman Spectroscopy

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Possibility of using Raman spectroscopy to study the properties of acoustoelectronic devices was discussed in several papers. It has been demonstrated that presence of a standing acoustic wave in the bulk acoustic waves resonator causes a change in the Raman spectrum[1]. Also, the method of Raman spectroscopy has been used for local temperature measurement in surface acoustic waves (SAW) device[2]. In this work Raman spectroscopy method was used for surface acoustic wave propagation characterization.

Studies were carried out on Y-cut of the lanthanum gallium silicate ($La_3Ga_5SiO_{14}$) single crystal. Interdigital transducer for SAW excitation with a wavelength of 60 microns was formed on the crystal surface. The excitation frequency was 38.5 MHz. SAW propagation direction coincides with the crystallographic direction X_1. In this study depolarized focused laser radiation with a wavelength of 785 nm, 100 mW, and the focal spot size of 3 microns was used.

The change in the Raman spectra can be caused by the following: heating of the SAW device; heating of the sample when exposed with a laser probe; deformation of the crystal lattice caused by the SAW propagation.

To separate these effects at various points of the SAW device Raman scattering spectra were obtained. Points were located in the area of SAW propagation, and outside it as shown on Fig.1. The laser probe at each point was focused at a different distance from the sample surface.

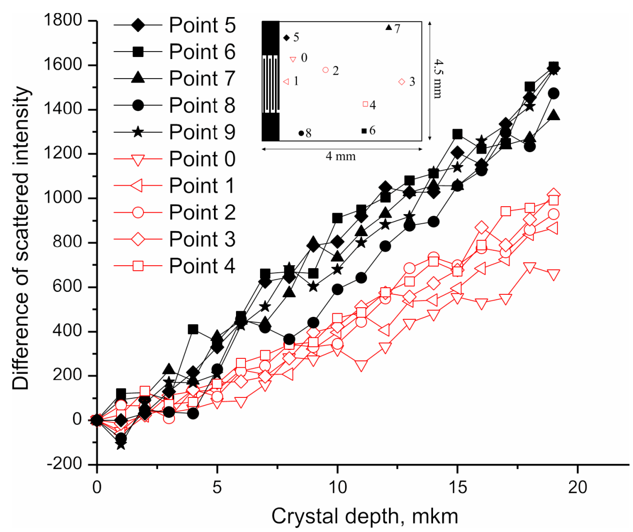

Fig.1: Difference of scattered intensity for 124 cm^{-1} Raman line. The inset demonstrates the distribution of measured points.

Fig. 1 demonstrates the difference of the scattered intensity for the line 124 cm^{-1}. Comparison was made with respect to the crystal surface. As a result, a difference between the points situated inside the acoustic path and outside it was found. This phenomenon can be explained by the presence of additional deformation of the crystal lattice which arises due to the SAW propagation.

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[1]A. N. Vtyurin, A. D. Schafer, A. S. Krylov, “Acoustic waves effects on Raman spectra of piezoelectric crystals”, Ferroelectrics, vol. 170, p. 181-186, 1995.

[2]M. Spindler, B. Uhlig, S. B. Menzel, C. Huck, T. Gemming, J. Eckert, “Local temperature determination in power loaded surface acoustic wave structures using Raman spectroscopy”, J. of Appl. Phys., vol. 114, p. 164317, 2013.