Advanced Ordered Piezoelectric $Ca_3NbGa_3Si_2O_{14}$ Crystal: Piezoelectric and Acoustic properties

Dmitry Roshchupkin[1], Olga Plotitcyna[1], Dmitry Irzhak[1], Evgenii Emelin[1], Oleg Buzanov[2], Sergei Sakharov[2]

[1]Institute of Microelectronics Technology and High-Purity Materials Russian Academy of Sciences, Chernogolovka, Russia
[2] FOMOS Materials, Moscow, Russia

Email: rochtch@iptm.ru

$Ca_3NbGa_3Si_2O_{14}$ (CNGS) crystal is a new promising piezoelectric crystal for acoustoelectronic applications based on surface acoustic waves (SAW) devices. CNGS is an ordered crystal of langasite family with a point group symmetry 32 the same as a piezoquartz. CNGS has a low density and higher values of the SAW velocities in comparison with $La_3Ga_5SiO_{14}$ crystal.
2-inch CNGS crystal was grown along axis {11.0} using the Czochralski technique (Fig. 1). The parameters of the crystal unit cell were measured by XRD: $a=b=8.1313$ Å, $c=5.0265$ Å.
Independent piezoelectric strain coefficients d_{11} and d_{14} were measured using high-resolution X-ray Bragg and Laue diffractions in the conditions of the opposite piezoelectric effect in the triple-axis x-ray diffractometer scheme[1]. In this case the applying of an external electric field to the crystal leads to the change of interplanar spacing, and as a result leads to the change of the angular position of the Bragg peak. All independent piezoelectric strain coefficients (d_{11} and d_{14}) in CNGS crystal were measured by using an X-cut.

Fig. 1: CNGS crystal grown along axis {110}

For investigation of the surface acoustic wave properties of CNGS crystal an X-ray diffraction technique was used in triple-axis X-ray diffractometer scheme[2]. SAW propagation leads to sinusoidal modulation of a crystal lattice and as a result leads to appearance of the diffraction satellites on the rocking curves on the both sides of the Bragg peak. The angular divergence between diffraction satellites on the rocking curve depends on the SAW wavelength and interplanar spacing, while the intensity of the satellites strongly depends on the SAW amplitude. From the diffraction spectra the velocities of SAW propagation were determined in the *Y*-cut (V_Y=2844 m/s) and *X*-cut (V_X=2844 m/s) of the CNGS crystal. The distribution of diffracted X-ray intensity on the crystal surface modulated by SAW was also examined which enabled obtaining a map of acoustic wave field distribution on the surface of *Y*-cut, *X*-cut, and *yxl*/+36º-cut of CNGS crystal. It was shown that no drift of acoustic energy flow occurs.

[1] D. Irzhak and D. Roshchupkin, "Piezoelectric strain coefficients in $La_3Ga_{5.3}Ta_{0.5}Al_{0.2}O_{14}$ and $Ca_3TaGa_3Si_2O_{14}$ crystals", AIP Advances, vol. 3, p. 102108(7), 2013.

[2] D.V. Roshchupkin, D.V. Irzhak, R. Tucoulou, and O.A. Buzanov, "X-ray Bragg diffraction from langasite crystal modulated by surface acoustic wave", J. Appl. Phys., vol. 94, p. 6692-6696, 2013.