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Confocal Raman study of electric fields in lithium niobate single crystals

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The influence of homogeneous electric fields of different orientations on the Raman spectrum of lithium niobate single crystal is studied. Obtained results were applied to determine the values of residual electric fields in the vicinity of neutral and charged domain walls.

External homogeneous electric field was applied to metal electrodes deposited at different cross-sections of lithium niobate single crystals. The applied voltage ranged from -7 to +7 kV. Raman spectra were measured using confocal Raman microscope Alpha300AR (WITec GmbH, Germany) equipped by solid-state laser with wavelength 488 nm. Spectral grating with 1800 gr/mm provided spectral resolution about 1.2 cm^{-1}. Raman spectra were studied in different polarization geometries.

Field dependence of parameters of spectral lines $E(TO_1)$, $E(TO_8)$, and $A_1(LO_4)$ was analyzed. It was found that the position of studied spectral lines was linearly dependent on the applied field and the corresponding coupling coefficients were determined. For Z-cut lithium niobate the coupling coefficients were close to those published by G. Stone et al. [1].

It was demonstrated earlier that the position of $E(TO_1)$ and $E(TO_8)$ spectral lines changed in the vicinity of the neutral and charged domain walls [2]. This effect was attributed to the action of residual electric fields existed near the walls [2, 3]. The coupling coefficients obtained in this work allowed us to quantitatively determine the values of residual electric fields.

The bulk conductivity increase with the sample temperature leads to effective electric field screening. This, in turn, leads to disappearance of the spectral lines shift.

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