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Polarization reversal in lithium niobate with compositional gradients

B.I. Lisjikh, E.D. Greshnyakov, V.I. Pryakhina, V.Ya. Shur

School of Natural Sciences and Mathematics, Ural Federal University, 620000 Ekaterinburg, Russia
lisjikh.boris@yandex.ru

The polarization reversal under application of the electric field in $LiNbO_3$ (LN) single crystals with inhomogeneous spatial distribution of Li concentration along polar axis has been investigated.

Vapor transport equilibration (VTE) process (high temperature annealing in Li-rich atmosphere) was used to change Li concentration from congruent (48.8 mol.%) to stoichiometric (50 mol.%) composition [1]. *Z*-cut 1-mm-thick plates were annealed at 1050 °C. Spatially inhomogeneous distribution was obtained by variation of VTE duration. The VTE temperature lower than T_C allowed to preserve the initial single domain state.

Two configurations of unilateral gradients were used, SLN@Z+ and SLN@Z-, which presents unilateral gradient with stoichiometric composition at the correspondent polar surface. Both configurations were obtained by polishing of annealed plates to half-thickness. Spatial distribution of Li along polar axis was measured by Confocal Raman spectroscopy (Alpha AR300, Witec) [2].

Polarization reversal was carried out using liquid electrodes (LiCl water solution). Domain kinetics was observed by *in situ* imaging during polarization reversal using polarizing optical microscope with high-speed video camera. Polarization reversal was performed in forward and backward directions, sequentially. Electrical pulses had rectangular shape with constant voltage or triangular with rising by 200 V. After switching in one direction opposite sign voltage pulse was applied.

It was shown that creation of Li concentration gradient in the surface layer resulted in appearance of a built-in bias field E_{bias}. The value of E_{bias} was defined as a difference between «forward» (E_f) and «backward» (E_b) switching fields, required for polarization reversal of complete area under electrode:

$$E_{bias} = \frac{E_f - E_b}{2}. \quad (1)$$

The variation of VTE duration led to different Li concentration gradients (dC_{Li}/dz) and, hence, to different values of E_{bias}. Bias field dependence on dC_{Li}/dz in 100 μm thick surface layer was obtained for all samples – SLN@Z+ and SLN@Z- (Figure 1). The linear dependence was revealed for gradients up to 5 mol.%/mm:

$$E_{bias} = 0.5 + 0.41\, {dC_{Li}}/{dz}\,. \quad (2)$$

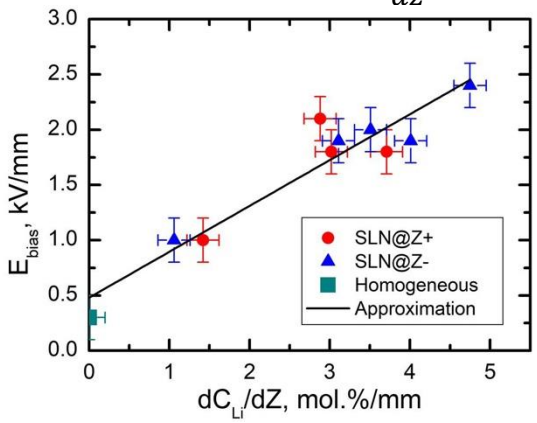

Figure 1. Dependence of the bias field on Li concentration gradient.

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2. M.D. Fontana, P. Bourson, *Appl. Phys. Rev.* **2**, 040602 (2015).