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Electron-beam and AFM domain writing in the relaxor ferroelectric SBN

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The fabrication of ferroelectric domain patterns of a specified configuration belongs to practically important problems of ferroelectricity owing to the potential of these structures for various applications. Writing by electron-beam (EB) irradiation in SEM and by dc-voltages of an AFM-tip provides a possibility to fabricate domain patterns with small spatial periods up to submicron scale. We present the results of domain patterning by these techniques in uniaxial relaxor ferroelectric $Sr_xBa_{1-x}Nb_2O_6$ (SBN). These results provide a deeper insight into the mechanism of domain formation under these conditions, in particular in relaxor ferroelectrics.

Single domains and specified 1D and 2D domain patterns were written on the polar and non-polar crystal surfaces in field-cooled (FC) and zero-field-cooled (ZFC) samples.

The characteristics of domain formation and relaxation were investigated. A specificity of domain writing in SBN is accounted for by the relaxor origin of this material.

Figures 1-3 present the results of domain writing on the nonpolar (X-) crystal surface The formation of counter-propagating (head-to-head or tail-to-tail) domains in ZFC crystals was observed (the inset in Fig. 3) both under electron-beam irradiation and AFM-tip voltages.

An enhanced stability of these patterns as compared with ones written in FC crystals was found. In particular, EB-written domains in ZFC SBN are completely stable (Fig. 3, the upper line) and can be erased only by thermal annealing at T > Tc.

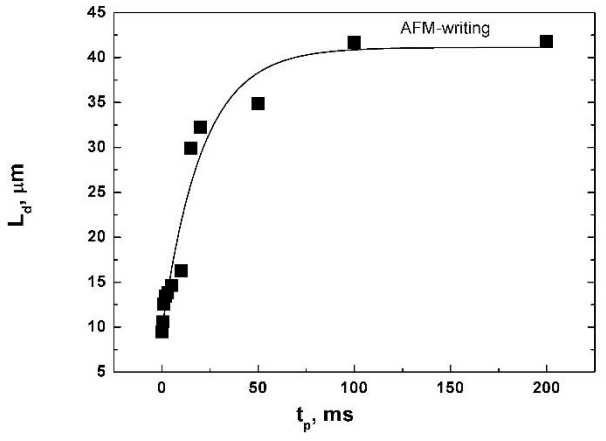

Figure 1. Domain length vs. pulse duration of the AFM-tip voltage (UDC = 40 V).

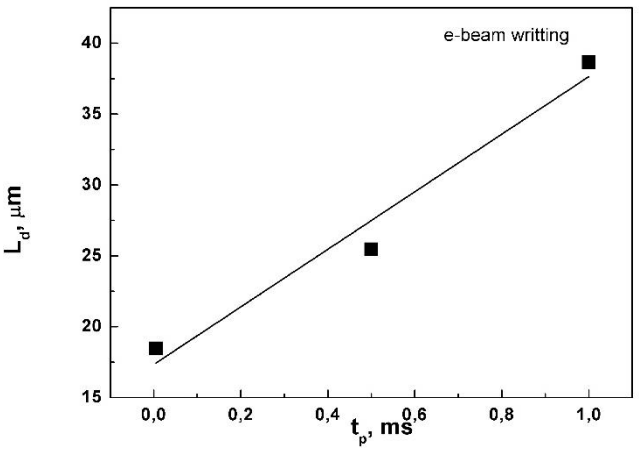

Figure 2. Domain length vs. EB irradiation time (accelerating voltage U = 25 kV, EB current I = 10 nA).

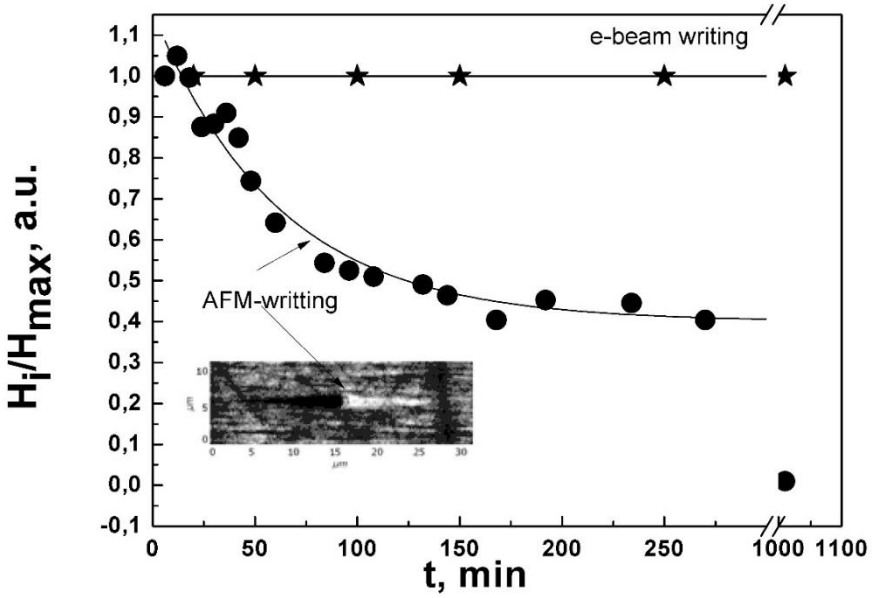

Figure 3. The lower graph presents the relaxation of AFM-written domains; the solid curve shows approximation by y=A*exp(-x/τ)+y0. The upper line demonstrates the stability of EB –written domains.

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2. T.R. Volk, L.S. Kokhanchik, Ya.V. Bodnarchuk, et al., *JAP*, in press (2018).