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Domain patterning by focused electron beam in wide temperature range in lithium niobate crystal with surface dielectric layer

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We have studied the domain formation induced by electron beam irradiation in wide temperature range in congruent lithium niobate (CLN) crystals with artificial surface dielectric layer. The results were explained in terms of kinetic approach [1].

The samples represented the 0.5-mm-thick Z-cut CLN plates. The irradiated polar surface was covered by various artificial dielectric layers (e-beam resists, parylene N, SiO_2), while the opposite surface was covered by the solid copper electrode grounded during irradiation. The domain structures have been produced by irradiation of the Z- polar surface using scanning electron microscopes Auriga Crossbeam and Merlin (Carl Zeiss). The irradiation parameters and beam positioning were controlled by electron beam lithography system Elphy Multibeam (Raith). The irradiation at the elevated temperatures (up to 250^{o}C) was carried out using thermal stage C1003 (Gatan Inc.). The static domain structures were visualized by scanning electron microscopy (SEM) after selective chemical etching.

We have measured the dose dependence of the isolated domain shape and size, and the temperature dependence of the threshold dose after dot irradiation. The hexagonal domains appeared at the room temperature, while the temperature increase led to lack of the domain shape stability and to formation of self-assembled domain structures. The obtained effects were explained by discrete switching during switching in highly non-equilibrium conditions caused by artificial dielectric layer and temperature dependence of its dielectric permittivity.

We have distinguished four types of domain structures appeared after stripe irradiation at the room temperature: (1) isolated nanodomains; (2) isolated domain rays oriented along Y+ directions; (3) solid domains with jagged walls (“fish-bone” structure); (4) continuous solid stripe domains. Thee domain patterns have been considered as a subsequent stages of domain structure evolution [2]. The threshold dose necessary for formation of solid stripe domain has been revealed. The influence of the temperature on stripe domain formation was discussed.

The dependences of the domain sizes on dose and accelerating voltage were measured for various dielectric layers. The non-linear increase of domain sizes with dose and accelerating voltage was obtained. The formation of quasi-regular domain fingers (“fingering”) in front of the plane domain wall, mainly oriented along the Y-crystallographic direction has been revealed. The detail study of the domain structure evolution allowed to determine the irradiation parameters for formation of the stripe domains with flat wall. This knowledge will be used for creation of the periodically poled crystals for light frequency conversion [3].

The equipment of the Ural Center for Shared Use “Modern nanotechnology” Ural Federal University was used. The research was made possible by the Russian Science Foundation (grant № 17-72-10152).

1. V.Ya. Shur, *J. Mater. Sci.* **41**, 199 (2006).
2. E. Vlasov, D. Chezganov, M. Chuvakova, V.Ya. Shur, *Scanning* **2018**, 7809826 (2018).
3. V.Ya. Shur, A.R. Akhmatkhanov, I.S. Baturin, *Appl. Phys. Rev.* **2**, 040604 (2015).