Micro- and Nano-domain Engineering of Ferroelectrics Crystals

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The lithium niobate $LiNbO_3$ (LN), lithium tantalate $LiTaO_3$ (LT) and titanyl phosphate $KTiOPO_4$ (KTP) crystals with tailored periodically poled domain structure (PPLN, PPLT, PPKTP) created with nanoscale period reproducibility are used for second harmonic generation (SHG) and optical parametric oscillation (OPO) based on quasi-phase-matched (QPM) nonlinear optical wavelength conversion [1]. The study of the conductivity relaxation of charged domain walls allowed optimization of the poling process [2]. The domain-domain electrostatic interaction has been investigated [3].

Multiply pulse laser irradiation has been used for switching under the action of the pyroelectric field without application of the external field [4]. Formation of the quasi-regular submicron stripe domain structures has been realized in LT by laser beam scanning. Switching at the elevated temperatures opens the way to complicated fractal and dendrite domain shapes. The unique snowflake domains can be created by domain growth at the elevated temperatures in the plates with artificial dielectric layer [5]. The information obtained from the first *in situ* study of the domain kinetics with high temporal resolution allowed to obtain original important information about domain wall motion mechanism and to characterize KTP as the most appropriate crystal for sub-micron periodical poling [6]. The poling process at room and elevated temperatures has been studied by *in situ* optical observation [7].

The domain structure evolution has been studied in lithium-niobate-on-insulator (LNOI) wafers during local switching by the biased tip of the scanning probe microscope. The creation of the stable periodical domain structures with period down to 200 nm was demonstrated.

The obtained knowledge was applied for producing high-fidelity patterns: (1) PPLN:MgO for green and blue light SHG, (2) MgO doped stoichiometric LT for green and yellow light SHG with output power above 14 W for CW, (3) fan-out domain structures in 3 mm-thick MgO:LN for tunable OPO generation from 2,5 to 4,5 μm for 1053 nm pump.

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