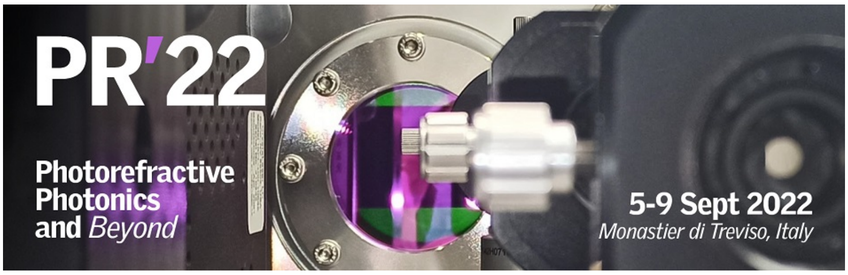

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Pyroelectric field-assisted domain engineering in lithium niobate and lithium tantalate using femtosecond laser pulses

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Domain-engineered structures play an essential role in nonlinear optics for quasi-phase-matched parametric processes. Recently, we have discovered a pyroelectric field-assisted domain inversion approach that can be used to switch ferroelectric domains in magnesium doped lithium niobate without using an external applied electric field. The process works as follows. First, permanent defects are induced along the polar axis by focused femtosecond laser pulses. Then, the crystal is heated up above 200 ℃. During cooling, the domain inversion is driven by a space-charge field that locally exceeds the threshold field of domain nucleation. After this heating-cooling cycle, ferroelectric domains are inverted below and above the defects that act as seeds. Domain inversion occurs if certain pulse energy and defect length are exceeded.

Here, we fabricate two-dimensional lattices of ferroelectric domains by patterning lithium niobate and lithium tantalate crystals with femtosecond laser pulses and then heating them to elevated temperatures. We investigate the effect of temperature and seed spacing on the number and size of inverted domains in magnesium-doped lithium niobate. To this end, we create 2D nonlinear photonic structures with periods of 15 µm x 6.3 µm. Čerenkov second-harmonic generation microscopy allows visualizing the generated ferroelectric domains and laser-induced seeds in 3D. Measurements with different electrical terminations of the crystal surfaces reveal the influence of surface charges during the domain formation process. Finally, we present the conversion efficiencies of quasi-phase-matched second-harmonic generation in our two-dimensional nonlinear photonic structures.

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