Center for Optical Technologies

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All-Optical Functionalities
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Light induced effects for the fabrication of nonlinear optical structures in $LiNbO_3$

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Goals:

Replace current photolithography based technologies for the production of integrated optical devices by methods that just use light and allow direct writing of the device features. Understand and utilize the modification of defects that are the basics for the techniques

Required key technologies:

- Non-destructive imaging of waveguides and ferroelectric domain patterns √ us
- In-situ feedback of writing process √ us
- Light induced domain inversion √ us
- Production of stable photorefractive gratings √ us
- Laser writing of waveguides √ others

Waveguide and domain imaging

The luminescence of rare earth ion and the intrinsic Raman effect are sensitive to the perturbation induced by Ti- ions and the non-equilibrium defect distribution induced by a room temperature domain inversion. This can be used to image waveguides and domain patterns.

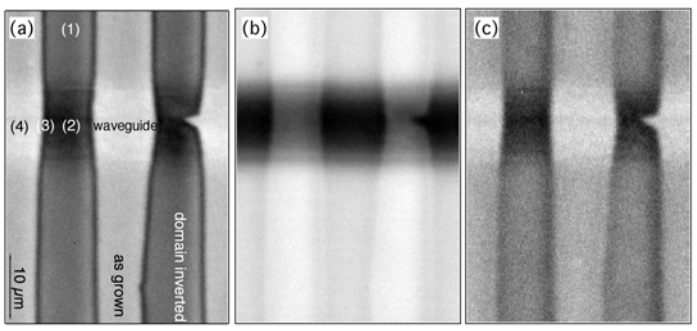
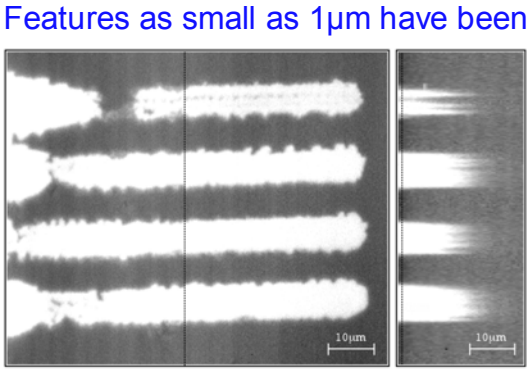


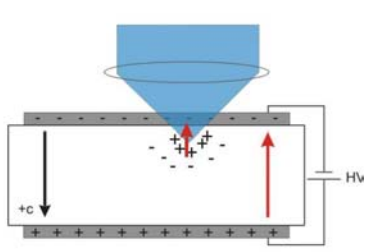
Image of a PPLN device obtained by evaluating Er^{3+} emission spectra in three different ways. (a) First moment of the complete spectra, (b) first moment of a single spectral peak, (c) second moment of another single peak.

Presence of Ti inhibits domain growth

Light induced domain inversion

Intense light illumination induces strongly inhomogeneous space charge fields due to photo-ionization of remnant defects. If illumination is timed and placed properly this effect can be used to directly domain patterns with arbitrary features onto a sample. Features as small as 1μm have been achieved so far

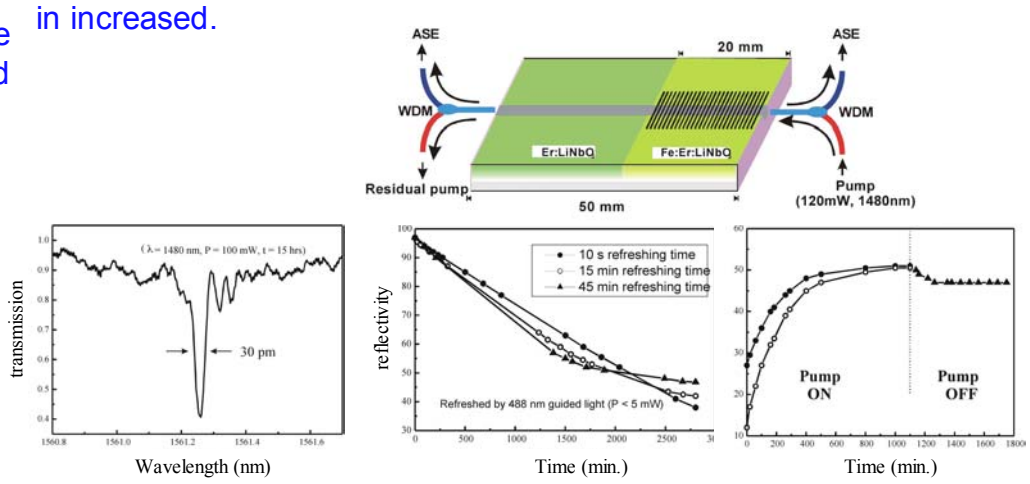




Funding: NSF, ARO

Luminescence induced stabilization of photorefractive gratings

Even thermally fixed photorefractive gratings decay over time due to non-zero dark-conductivity that allows the compensation of the space-charge fields by electrons. We find that such gratings can be refreshed by the green luminescence present in pumped Er-doped devices. Moreover, by spatially controlling the Fe2+/Fe3+ ratio dark conductivity is locally reduced and the stability of the gratings in increased.



Real-time Diagnostic of Domain inversion

The changes that occur during domain inversion in the luminescence of rare earth ions can be used for active feedback of light and e-beam induced domain inversion.

Example: Growing and shrinking domain