Quasi-phase-matched frequency conversion with periodically poled Ti:$LiNbO_3$ waveguides

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In this thesis several kinds of frequency conversion processes in periodically poled Ti:$LiNbO_3$ waveguides will be presented. Detailed numerical investigations show that very efficient frequency converters based on long, homogeneously poled and low loss structures can be developed.
A detailed description of the microdomain generation in $LiNbO_3$ will be given. Our technology allows to fabricate periodically poled Ti:$LiNbO_3$ waveguides with a high yield rate. The domain pattern quality of our low loss single mode waveguides is excellent. Waveguide structures with lengths up to 9 cm enable the development of highly efficient nonlinear frequency converters with small thresholds. The same technology can be used to fabricate Ti:Er:$LiNbO_3$ waveguides. Different methods to reveal the microdomain pattern are presented.
Different frequency converters with outstanding properties have been realized:

- second-harmonic generators with a normalized efficiency of up to 935 $\%W^{-1}$
- selffrequency-doubling Ti:Er:$LiNbO_3$ waveguide laser
- difference-frequency generators with a normalized efficiency of up to 318 $\%W^{-1}$
- pulsed cascaded difference-frequency generators with an efficiency of up to 25 % in continuous wave operation
- pulsed cascaded difference-frequency generators with an efficiency of 213 % at 2 GHz and 35 % at 10 GHz
- cascaded difference-frequency generators with an additional erbium doping
- stimulated optical parametric fluorescence generators with a large tuning range ($1200\,\text{nm} < \lambda_{s,i} < 2000\,\text{nm}$)
- doubly resonant optical parametric oscillators with a pump threshold of 4.2 mW and a 400 nm wide tuning range.

key words: integrated optics, nonlinear optics, wavelength conversion, frequency conversion, quasi-phase-matching, QPM, second-harmonic generation, SHG, difference-frequency generation, DFG, cascaded difference-frequency generation, cDFG, optical parametric fluorescence, OPF, optical parametric oscillation, OPO, electric-field poling, lithium niobate, $LiNbO_3$, periodically poled lithium niobate, PPLN