PPLN ridge waveguides for frequency conversion of high power CW beams

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$LiNbO_3$ has one of the highest quadratic nonlinear optical coefficients that makes it a material of choice for the development of frequency conversion systems and more generally nonlinear optical functions. This crystal can be periodically poled (PPLN) to allow quasi-phase matching for various combinations of wavelengths mixing in its wide transparency window (0.4-5 µm). In addition, efficient nonlinear conversion can be reached even with moderate power CW beams taking advantage of the light confinement provided by $LiNbO_3$-based optical waveguides. However, waveguides made by conventional fabrication techniques such as titanium in-diffusion or proton exchange still suffer from unstable behavior due to photorefractive optical damage especially when visible wavelengths are concerned. In this study, we present recent developments of ridge PPLN waveguides with promising characteristics even when operating at high average power.

More specifically, the design, fabrication and characterization of nonlinear PPLN waveguides for second harmonic generation (SHG) of telecommunication wavelengths are presented. Fabrication is based on wafer bonding, grinding-polishing steps and carving with use of a precision dicing saw. The components show efficient SHG with normalized conversion over 200%/W. The components performances will be presented along with their long-term stability when pumped with Watt-level optical signals. Optical damage threshold of the input face is also investigated to determine the maximum usable power. Undoped and MgO doped $LiNbO_3$ are considered. We will also emphasize the specificity of the ridge waveguides that allows stable frequency conversion at high power. The perspectives offered by this specific waveguide geometry will also be tackled.