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Spatial and spectral properties of SHG in a PP-KTP waveguide

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The periodically-poled nonlinear waveguides have become widely used in the last years, especially due to its higher conversion efficiency compared with bulk crystals. However, these structures offer also some other advantages over bulk crystals which can be used to tailor properties of the nonlinear processes. The poling process, as way how to fulfill phase-matching conditions without birefringence, leaves well defined domains of the alternating sings inside the nonlinear material. The second order nonlinearity can thus be approximated by a dichotomic function that has significant coefficients at its first- as well as higher-order harmonics. This results in possibility of generating different nonlinear processes in a single waveguide. Since waveguides support the propagation of the fundamental as well as several higher-order modes, differing in wave vectors, the phase-matching conditions can be reached simultaneously for several combinations of these modes. This can also be useful in tuning a specific nonlinear process. Finally, due to the imperfections during the fabrication process, fluctuations in waveguide's parameters inevitably occur. These fluctuations may then considerably affect the generated fields.

Here, we present experimental characterization of periodically-poled KTP waveguide studying second harmonic generation. Spatial and spectral properties of three types of the nonlinear processes (type 0, I, II) have been observed simultaneously utilizing the first, second and third harmonics of the spatial nonlinear modulation. Experimental results have been interpreted using a model based on scalar finite elements method, which has been adopted in order to calculate spatial mode profiles, propagation constants, and frequencies of the interacting fields. Correlations between spatial and spectral properties of the fundamental and second-harmonic fields have been revealed. Individual nonlinear processes can be exploited combining spatial and spectral filtering. Also the influence of waveguide parameters to the second-harmonic spectra has been addressed.