Abstract

This thesis is a detailed analysis of nonlinear interactions in titanium diffused channel waveguides emphasizing the generation of radiation and the frequency conversion, respectively.

For this purpose the theoretical fundamentals are derived from the Maxwell equations. From this it follows the time independent Helmholtz equation to describe the amplitude and phase fronts of a wave propagating in a waveguide. The solution of the Helmholtz equations builds a complete orthonormal system with that a arbitrary phase front cam be described. Assuming adequate narrow spectrums and long pulse durations this phase front can be taken for propagating pulses. Like the Schrödinger equation of the quantum mechanics this leads to e set of equations describing the propagation of optical waves. In Analogy to the time calculation of perturbations the theory of coupled modes was developed to describe interactions in channel waveguides

The second order nonlinear polarisation is used as perturbation. The permutation of the second order nonlinear polarisation yields sum and difference frequency generation and its degenerated cases. All this is called three waves mixing. A main point to obtain frequency conversion is the phase matching. The meaning of phase matching is, that the partial waves send by the dipoles of the nonlinear polarisation interfere constructive with a travelling wave. The main condition is, that the wave vectors of the participating waves have the right relationship to each other. One possibility to fulfil this condition is to exploit birefringence of the substrate. Quasi-Phase-Matching exploits the fact that the susceptibility of second order is correlated with the orientation of the optical axis. In this thesis performing phase matching via QPM is assumed.

In chapter 2 simple up and down conversion processes like sum frequency mixing, difference frequency mixing and second harmonic generation in titanium diffused channel waveguides are analysed. Due to the low-loss propagation and the high focusing the interaction can be realised very efficient. For this an object oriented windows program was developed. Developer focus simple usage for the experimentations.

In chapter 3 cascaded nonlinear interactions are analysed. With the underlying interaction with principally infinite interacting waves can be analysed. Well known is the cascading of the second harmonic generation and the difference frequency generation, with which a broad band and low-noise amplifier and frequency converter can be realised. A further possibility is the cascading of sum and difference frequency generation, which can improve the tune ability compared to the first case

In chapter 4 a semi classical numerical Model to describe the nonlinear parametric

Generation was developed, which allows the calculation of the spectral characteristics and the generated power of the parametric fluorescence in the high power regime. The calculation shochaows, that due to the special dispersion of the group velocity in Lithiumniobate the parametric back conversion is strongly increased. The reason is, that the difference of the group velocity between pump and signal or idler wave becomes very small. From this a strong incoherent 0 broadening of the pump wave follows. By this process, up to 20 % of the pump wave power can be back converted incoherently. This process yields very broad, incoherent fluorescence spectra.

In the last chapter optical parametric oscillations would be analysed. Optical parametric oscillators can provide tuneable coherent radiation in many spectrums. The first part of the chapter introduces a rigorous model which allows an exact numerical description of the tuning behaviour. It could be shown, that the nonlinear back conversion of signal and idler wave to the pump wave splits the fine tuning behaviour. Further it could be shown, that the nonlinear phase can not explain the discrepancy between the theoretical result and the measured result. The second part analyses on the basis of the results from the previews chapter the behaviour of synchronously pumped OPOs. The model can predict the build up dynamics. From the differences of the group velocities follows, that a small detuning of the pump pulse repetition rate compared to the round trip time of the resonant pulse increase the internal parametric gain. The reason is, that this increases the interaction length, because the pump pulse has to övertakethe resonant generated pulse.