Efficient frequency doubling of near-infrared diode lasers using quasi phase-matched waveguides
# Contents

Abstract iii  
Kurzfassung v  
Acknowledgment vii  
Contents ix  

1 Introduction 1  

2 Design and selection of NIR diode lasers for frequency doubling 3  
2.1 Fundamentals of diode lasers 3  
2.1.1 Inversion and optical gain 3  
2.1.2 Optical cavity and laser threshold 5  
2.1.3 Longitudinal single-mode operation 7  
2.1.4 Lateral confinement 7  
2.1.5 Spatial properties of a diode laser beam 8  
2.2 Requirements for diode lasers intended for frequency doubling 9  
2.3 Single emitters design and selection 10  
2.3.1 Vertical design 10  
2.3.2 Resonator layout 11  

3 Waveguide structures for SHG into the green spectral region 15  
3.1 Introduction to integrated optics 15  
3.1.1 Propagation constant and effective refractive index 16  
3.1.2 Electric field distributions 17  
3.1.3 Loss 17  
3.2 Nonlinear optics 19  
3.2.1 Dielectric polarization and nonlinear coefficient 19  
3.2.2 Second-harmonic generation 21  
3.2.3 Quasi phase-matching 22  
3.2.4 SH power dependency on the fundamental power 26  
3.3 Design and selection of waveguide SHG devices 30  
3.3.1 MgO doped lithium niobate 31  
3.3.2 Ridge waveguide 32  
3.3.3 Planar waveguides 34
4 Diode laser frequency doubling in a ridge waveguide

4.1 Experimental setup

4.2 Diode laser characteristics

4.3 Experimental results

4.4 Development of a tailored theoretical model

4.4.1 System of coupled equations

4.4.2 Quasi phase-matching condition

4.4.3 Heat and temperature distribution

4.5 Exemplary simulation models

4.6 Comparison between results of experiment and simulation

4.7 Summary

5 Diode laser frequency doubling in planar waveguides

5.1 Frequency doubling of a near-Gaussian beam

5.1.1 Experimental setup

5.1.2 Near-Gaussian beam characteristics

5.1.3 SHG with a near-Gaussian beam

5.1.4 SH beam characteristics

5.2 Frequency doubling of a DBR-TPL beam

5.2.1 Experimental setup

5.2.2 Diode laser characteristics

5.2.3 SHG process subject to pump beam parameters

5.2.4 High-power generation

5.2.5 SH beam characteristics

5.3 Summary

6 Final conclusions and perspectives

6.1 Summary and conclusions

6.2 Future directions

Appendix

A.1 Equipment used for measurements

A.2 Propagation of uncertainty

List of publications

Bibliography