

# Contents

<b>1</b>	<b>Introduction and motivation</b>	<b>1</b>
<b>2</b>	<b>Theoretical background</b>	<b>7</b>
2.1	Second order nonlinear optics in organic materials . . . . .	7
2.1.1	NLO-effects on the macroscopic scale . . . . .	7
2.1.2	Microscopic origin of NLO-effects in organic materials . . . . .	9
2.2	Photonic crystals . . . . .	14
2.2.1	Photonic crystal slabs . . . . .	16
2.3	Cavities and resonators . . . . .	18
2.4	Simulation concepts . . . . .	21
2.4.1	Guided mode expansion . . . . .	21
2.4.2	Finite integration technique . . . . .	22
<b>3</b>	<b>Low dielectric contrast photonic crystals</b>	<b>25</b>
3.1	Resonators in periodic ridge waveguides . . . . .	25
3.2	Omnidirectional photonic bandgap . . . . .	29
3.3	Microcavities in 2D low index photonic crystals . . . . .	33
3.3.1	H1 and L3 cavities . . . . .	34
3.3.2	Double heterostructure cavity . . . . .	37
3.3.3	Limits of low index contrast microcavities . . . . .	37
3.3.4	Cavity definition by photobleaching . . . . .	45
3.4	Conclusion . . . . .	46
<b>4</b>	<b>High dielectric contrast hybrid silicon-organic photonic crystals</b>	<b>49</b>
4.1	Photonic bandgap in infiltrated systems . . . . .	49
4.2	Photonic crystal waveguides and resonators . . . . .	51
4.3	Slotted photonic crystal waveguides and resonators . . . . .	53
4.3.1	Unloaded resonator performance . . . . .	55

4.3.2	Injector section . . . . .	57
4.3.3	Sensitivity of slotted photonic crystal waveguides . . . . .	62
4.3.4	Cavity definition by photobleaching . . . . .	63
4.4	Conclusion . . . . .	66
<b>5</b>	<b>Broadband electro-optic modulation</b>	<b>67</b>
5.1	Fabrication process of photonic SOI nano structures . . . . .	67
5.2	High field poling in nano-slots . . . . .	69
5.3	Modulation at low frequencies . . . . .	72
5.4	Modulation at GHz frequencies . . . . .	76
5.5	Conclusion . . . . .	82
<b>6</b>	<b>Conclusion and outlook</b>	<b>83</b>
6.1	Conclusion . . . . .	83
6.2	Outlook . . . . .	84
	<b>List of Publications</b>	<b>99</b>
	<b>Supervised Student Projects</b>	<b>101</b>
	<b>Acknowledgements</b>	<b>102</b>
	<b>Curriculum Vitae</b>	<b>104</b>