

論文 / 著書情報
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Type(English)	Outline

Thesis outline

Thesis title:

Study of cobalt ferrite thin films on silicon photonic platforms for monolithically integrated optical isolators.

Thesis overview:

So far, most attempts to realize an integrated magneto-optical isolator in silicon photonics have been done using garnet ferrites. However, garnets and silicon are two incompatible materials for epitaxy. In this study, the use of cobalt ferrite films as novel magneto-optical material for silicon nonreciprocal applications is proposed. CFO films can be deposited on silicon by means of a buffer layer with relative ease. Furthermore, the MO activity of spinel ferrites is much larger than the effect of garnets at communication wavelengths. Finally, CFO films typically have a strong hysteresis with large magnetic remanence, making them suitable for the development of self-biased nonreciprocal devices for silicon photonics.

Thesis organization:

This thesis is organized in 6 chapters as shown in Figure 1. The first chapter introduces integrated photonics on silicon platforms, with a focus in nonreciprocal devices. A brief overview of the importance of Lorentz nonreciprocity and the state-of-the-art about mechanisms to break it suitable for integration on silicon photonics. Then, the current state-of-the-art of magneto-optical materials for silicon nonreciprocal devices is described.

Chapter 2 focuses on the integration of cobalt ferrite films on silicon substrates. The experimental methods for CFO growth used in this study are described. Optimization of deposition conditions based on material structure, magnetic properties and Faraday rotation are discussed.

Chapter 3 describes basic concepts of magneto-optical effects, focusing on the nonreciprocal phase shift effect and its generation in magneto-optical waveguides. The nonreciprocal phase shift effect is derived in 1D and 2D simulation models. The theory and calculations investigated here are used in the subsequent chapters.

Chapter 4 studies the operation principle of integrated optical isolators based on resonant waveguide structures. This chapter describes the design and experimental demonstration of a TM mode optical isolator based on a micro ring resonator Si waveguide structure with a cobalt ferrite cladding.

Chapter 5 describes an ultra-compact silicon ring isolator for TE modes based on a cobalt ferrite inner cladding. The nonreciprocal phase shift effect of Chapter 3 for straight waveguides is further studied for ultrasmall structures with sharp bent waveguides. The proposed ring structure is optimized in terms of ring radius, and prospective optical properties suitable for practical devices of cobalt ferrite films are discussed.

Finally, Chapter 6 summarizes the obtained results and discussions of this study. Future work for the device and material development sides of this research are described.

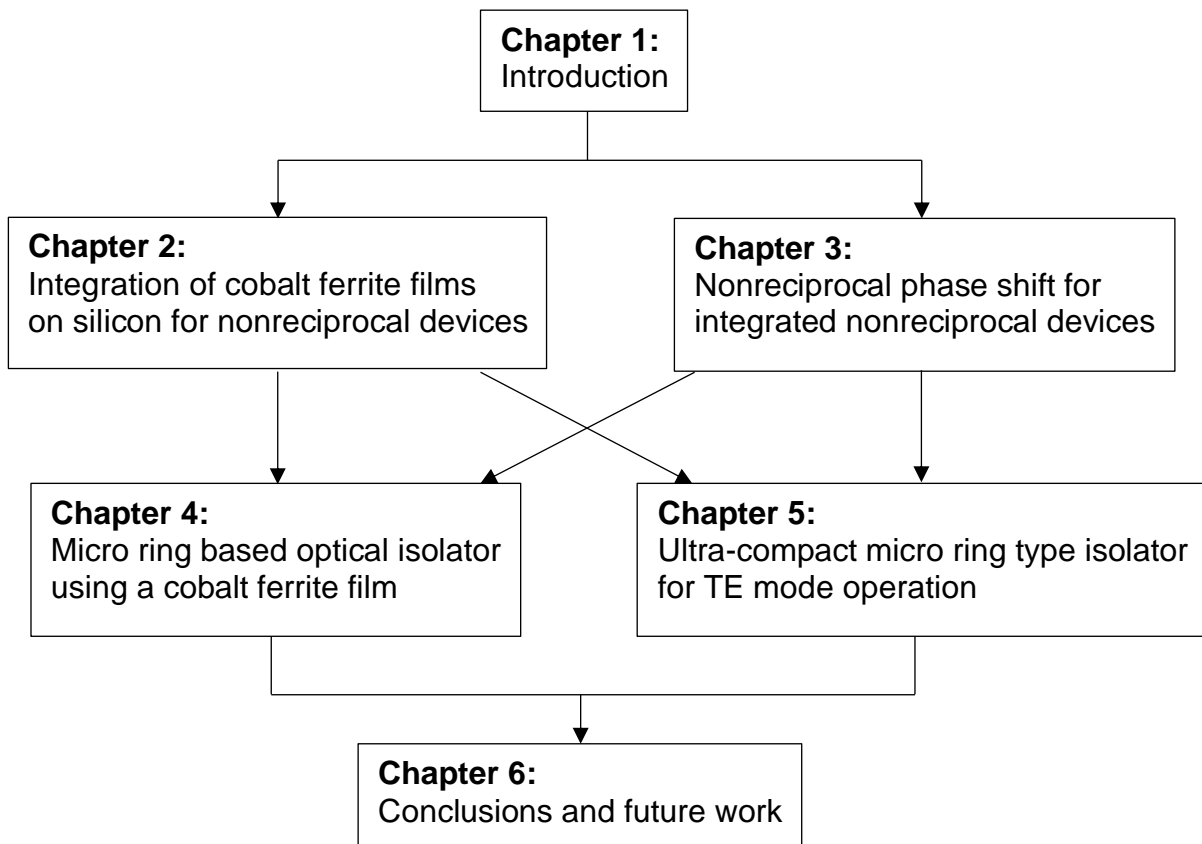


Figure 1. Organization of the present research thesis.

Thesis organization:

Chapter 1 Introduction	1
1.1. <i>Integrated optics</i>	1
1.2. <i>Silicon photonics</i>	3
1.3. <i>Integrated optical isolators on silicon</i>	6
1.3.1. Spatial-temporal modulation (STM) of material refractive index	8
1.3.2. Optical nonlinear (NL) effects	9
1.3.3. Magneto-optical (MO) materials	11
1.4. <i>Magneto-optical materials and its integration on silicon</i>	16
1.4.1. Hybrid integration	17
1.4.2. Monolithic integration	19
1.4.3. Spinel ferrites	22
1.5. <i>Dissertation objective and organization</i>	23
1.6. <i>References</i>	27
Chapter 2 Integration of cobalt ferrite films on silicon for nonreciprocal devices	36
2.1. <i>Introduction</i>	36
2.2. <i>Deposition of cobalt ferrite films on silicon</i>	37
2.3. <i>Cobalt ferrite films integration on silicon using an MgO buffer layer</i>	48
2.4. <i>Magneto-optical effect of crystal cobalt ferrite films on silicon</i>	58
2.5. <i>Conclusions</i>	67
2.6. <i>References</i>	68
Chapter 3 Nonreciprocal phase shift for integrated nonreciprocal devices	72
3.1. <i>Introduction</i>	72
3.2. <i>Basic concepts of magneto-optical effects</i>	73
3.2.1. Solution for two-dimensional waveguide model	78
3.2.2. Perturbation theory with 3-dimensional waveguide model	84
3.3. <i>Simulation of silicon strip waveguide structure with a cobalt ferrite film</i>	89
3.4. <i>Conclusions</i>	96
3.5. <i>References</i>	97
Chapter 4 Micro ring based optical isolator using a cobalt ferrite film	98
4.1. <i>Introduction</i>	98
4.2. <i>Basic concepts of micro ring resonators</i>	98
4.3. <i>Micro ring optical isolator</i>	104
4.3.1. Device design and operation principle	105
4.3.2. Device fabrication	112
4.3.3. Device characterization	119
4.4. <i>MO waveguide transmission loss</i>	124
4.5. <i>Conclusions</i>	132
4.6. <i>References</i>	134

Chapter 5 Ultra-compact silicon micro ring type isolator for TE mode operation	139
5.1. <i>Ultra-compact TE mode micro ring isolator overview</i>	140
5.2. <i>Effect of bends on nonreciprocal waveguides</i>	142
5.2.1. Basic concepts of transformation optics in magneto-optical bend waveguides.....	142
5.2.2. Simulation of curved magneto-optical waveguides	149
5.3. <i>Design of ultra-compact ring isolator structure</i>	155
5.4. <i>Conclusions.....</i>	163
5.5. <i>References</i>	165
Chapter 6 Conclusions and future work	168
6.1. <i>Conclusions.....</i>	168
6.2. <i>Future work</i>	171
6.2.1. Substitution of Fe ³⁺ with trivalent nonmagnetic cations.....	172
6.2.2. Cobalt ferrite nanocrystals	174
6.3. <i>References</i>	177