Contents

Chapter 1

Introduction

1.1Optical path in rewritable system…….….3

1.2The development of pick-up head…….…….....5

1.2.1 Micro-opto-electric-mechanical-systems (MOEMS) ……....5

1.2.2 Integrated-optic implementation based on waveguides and holographic (diffractive) components……..…….….6

1.2.3 Planar pickup based on glass substrate light guide…….…..8

1.2.4 Free space three dimensional micro-optical bench……....9

1.3 Planar fiber-base optical head…….…10

1.4 Research objective…….…...11

1.5 Organization of this thesis……11

Chapter 2

Principle

2.1 Introduction…….…….12

2.2 Fiberlens……..……..12

2.3 Solid immersion lens (SIL) system…..……15

2.4 Si bulk micromaching……..19

2.5 Summary……...……23

Chapter 3

Simulation

3.1 Introduction……..24

3.2 Optimizing Process……...……25

3.2.1 Fiberlens……..…….26

3.2.2 Fiberlens & Solid Immersion Lens……...….29

3.3 Dimension & Alignment tolerance analyses...……34

3.3.1 Radius of Fiberlens……...…...34

3.3.2 Thickness of SIL……...……...36

3.3.3 Alignment tolerance……...37

3.4 Summary……...41

Chapter 4

Fabrication and Measurement

4.1 Introduction…….…….42

4.2 Fabrication……..……..42

4.2.1 Fabrication results…….……...…...44

4.3 Measurement.....….……46

4.3.1 Principle.…….……...…...48

4.3.2 Measurement equipments.……...…...50

4.3.3 Fiberlens measuring setup……...……...52

4.3.4 Fiberlens & Solid Immersion Lens measuring setup.……..53

4.3.5 Measurement results…….……...……...54

4.4 Summary……...……..……..60

Chapter 5

Conclusion……61

Reference……..64

Figure caption

Fig. 1-1 Optical path for a phase-change (PC) storage system……..…….3

Fig. 1-2 Optical paths for a magneto-optical (MO) storage system……..……..4

Fig. 1-3 Schematic of the integrated optic disk pickup (IODPU)……7

Fig. 1-4 Schematic of the planar optical disk pickup based on glass-substrate based: (a) side and (b) plane view……...8

Fig. 1-5 Optical module structure……..9

Fig. 1-6 Planar fiber-base optical head…….11

Fig. 2-1 Illustrated schematics of the microlens on the end face of the SMF……13

Fig. 2-2 Hemispherical SIL focusing at the bottom surface……..…….17

Fig. 2-3 (a) Super SIL and (b) the marginal ray angle approaches 90º with respect to the image space…….…..…18

Fig. 2-4 The diamond-type lattice can be constructed from two interpenetrating face-centered cubic unit cells. Si forms four covalent bonds, making tetrahedrons……21

Fig. 2-5 (100) silicon wafer with reference to the unity cube and its relevant planes……...22

Fig. 2-6 (a) V-groove formed by the mask opened parallel to (110)-flat(b) 90˚ V-groove formed by the mask opened parallel to (100)-flat……...……22

Fig. 3-1 Planar fiber-base pickup head setup……...……...24

Fig. 3-2 Schematics of optical module…….25

Fig. 3-3 Optimizing process flow…….26

Fig. 3-4 Fiberlens setup…….……28

Fig. 3-5 (a) Normal (b) Total reflection……28

Fig. 3-6 Fiberlens length vs. Spot size and NA……29

Fig. 3-7 (a) hemispherical SIL and (b) SSIL……30

Fig. 3-8 Absorption versus thickness of the AZ-4620……..30

Fig. 3-9 Fiberlens and SIL setup……...31

Fig. 3-10 Thickness of hemispherical SIL vs. effective NA & Spot size…….32

Fig. 3-11 Thickness of SSIL vs. effective NA & Spot size @ 564um fiberlens…...33

Fig. 3-12 Thickness of SSIL vs. effective NA & Spot size @ 700um fiberlens…..33

Fig. 3-13 Fiberlens length vs. (a) NA and (b) Spot size……...35

Fig. 3-14 radius of fiberlens vs. effective NA & Spot size @ 700um fiberlens…..35

Fig. 3-15 Definition of thickness variation……...36

Fig. 3-16 Thickness variation of SSIL vs. effective NA & Spot size @ 700um fiberlens……..36

Fig. 3-17 Definition of three misalignments……..…37

Fig. 3-18 (a) Distance between fiberlens and SIL is smaller then focal length(b) Distance between fiberlens and SIL is larger then focal length……..…...38

Fig. 3-19 Defocus vs. effective NA and spot size……..……..…38

Fig. 3-20 spot diagram of (a) offset Y, (b) offset X and (c) normal……...…….39

Fig. 3-21 Offset vs. Efficiency……..……..39

Fig. 3-22 spot diagram of (a) tilt 15 degree and (b) normal……..……..40

Fig. 3-23 Angular misalignment vs. Efficiency……....40

Fig. 4-1 Fabrication process of SIL with aperture; (a) Step 1: Deposit Ti layer, (b) Step 2: Deposit α - Si and Ni layer, (c) Step 3: Undercut Ti layer, (d) Step 4: Backside exposure and (e) Step 5: Reflow…….....43

Fig. 4-2 SEM of SIL @ aspect ratio (a) 1.25 and (b) 0.5…….45

Fig. 4-3 30 μm radius SIL profiles…….……...46

Fig. 4-4 SEM of SIL with aperture……...46

Fig. 4-5 Measuring System Setup……..……47

Fig. 4-6 Definition of output beam size……..……...48

Fig. 4-7 Focusing a beam with a lens at the beam waist……...…..49

Fig. 4-8 Focusing a collimated beam…….…….…...50

Fig. 4-9 Intensity of ambient…….……..…51

Fig. 4-10 Photograph of the fiberlens measuring system…….…...52

Fig. 4-11 Photograph of the fiberlens plus SIL measuring system…….53

Fig. 4-12 Fiberlens length vs. (a) NA and (b) Spot size…….……..55

Fig. 4-13 Photograph of fiberlens……..……55

Fig. 4-14 (a) 30 μm and (b) 35.2 μm radius SIL profiles…….……..56

Fig. 4-15 Beam profile of 650 μm fiberlens…….……57

Fig. 4-16 Beam profile of 650 μm fiberlens with 30 μm radius SIL…….....57

Fig. 4-17 Beam profile of 650 μm fiberlens with 35 μm radius SIL…….....57

Fig. 4-18 Seidel coefficient vs. spot size ratio……..……58

Fig. 4-19 The refractive index of (a) 30 μm and (b) 35.2 μm radius SIL vs. spot size……59

List of tables

Table 3-1 Axial, Lateral & Angular Tolerance Comparement……..….41

Table 4-1 Dimension variation…….45

Table 4-2 Specification of CCD camera……...51