

PROCESS DEVELOPMENT OF THE DEVICE
USING IN-HOUSE PLATE-TO-PLATE TOOL
WITH NANOIMPRINT LITHOGRAPHY
TECHNIQUE FOR BIOCHIP APPLICATION

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SUPERVISOR'S DECLARATION

We hereby declare that we have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Engineering in Electronics

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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TABLE OF CONTENT

DECLARATION	
TITLE PAGE	
ACKNOWLEDGEMENTS	ii
ABSTRAK	iii
ABSTRACT	iv
TABLE OF CONTENT	v
LIST OF TABLES	ix
LIST OF FIGURES	x
LIST OF SYMBOLS	xxiv
LIST OF ABBREVIATIONS	xv
CHAPTER 1 INTRODUCTION	1
1.1 Introduction	1
1.2 Problem Statement	3
1.3 Research Objectives	3
1.4 Scope	4
1.5 Overview of the Thesis	4
CHAPTER 2 LITERATURE REVIEW	6
2.1 Introduction	6
2.1.1 Substrate Preparation	7
2.1.2 Photoresist Spin Coating	8
2.1.3 Photoresist	9

2.1.4	Prebake	11
2.1.5	UV Exposure	11
2.1.6	Post-Exposure Bake	13
2.1.7	Development	14
2.2	Soft Lithography	15
2.3	Overview of Nanoimprint Lithography	17
2.3.1	Thermal Nanoimprint Lithography	18
2.3.2	UV Nanoimprint Lithography	19
2.3.3	Step and Stamp Imprint Lithography (SSIL)	20
2.3.4	Step and Flash Imprint Lithography (SFIL)	21
CHAPTER 3 METHODOLOGY		23
3.1	Introduction	23
3.2	Device Design for Master Mask Film Printing	39
3.3	Fabrication of emulsion mask	27
3.3.1	Emulsion Mask Exposure	27
3.3.2	Emulsion Mask Development	30
3.4	Fabrication of Device Pattern on Silicon Wafer (Master Mold)	31
3.4.1	Sample Preparation	32
3.4.2	Photoresist Coating	33
3.4.3	Soft Baking	35
3.4.4	UV Exposure	35
3.4.5	Post Exposure Bake	36
3.4.6	SU-8 Photoresist development	36
3.5	PDMS Mold Casting	37
3.6	Device Pattern Imprint	40

3.6.1	In-house Plate-to-Plate Imprint Lithography Tool	41
3.6.2	Sample Preparation for Device Pattern Imprint	42
3.6.3	In-house Plate-to-Plate Setup	43
3.6.4	Imprinting Unit	44
3.6.5	Imprint Force	46
3.6.6	UV Exposure on In-house Plate-to-Plate	47
3.6.7	Peel Off and Post Expose Baking	48
3.7	Demonstration of Imprinted Device Pattern on PET Film	49
CHAPTER 4 RESULTS AND DISCUSSION		50
4.1	Introduction	50
4.2	Device Pattern Master Mold Results	50
4.2.1	UV Exposure Curing Distance	53
4.2.2	UV Exposure Parameter	54
4.2.3	Post Exposure Baking Cooling Time	55
4.3	Device Pattern PDMS Mold Using Soft Lithography Results	56
4.4	Device Pattern Imprint Using UV-NIL Results	59
4.4.1	UV Exposure Distance for In-house Plate-to-Plate	60
4.4.2	In-house Plate-to-Plate Imprint Parameters	61
CHAPTER 5 CONCLUSION		65
5.1	Introduction	65
5.2	Recommendations	67

REFERENCES	68
APPENDIX A LIST OF PUBLICATION & AWARDS	75
APPENDIX B P2P-NIL CODING	76
APPENDIX C P2P-NIL CAD DRAWING	80
APPENDIX D TECHNICAL DATASHEETS	84

LIST OF TABLES

Table	Title	Page
Table 1.1	A tabulated comparison for Thermal NIL, UV-NIL, SSIL and SFIL	2
Table 2.1	A tabulated comparison between Soft Lithography and conventional optical lithography	16
Table 4.1	Device patterned master mold measurements	51
Table 4.2	Device patterned PDMS mold measurements	57
Table 4.3	Imprinted device pattern measurements	60
Table 4.4	Dimension measurement results device pattern for parameter (a, b, c and expected dimensions)	64

LIST OF FIGURES

Figure	Title	Page
Figure 2.1	Contact angles of water droplets on a wafer: (a) hydrophilic surface, 20°, (b) hydrophobic surface, 95° and (c) super-hydrophobic surface, 150°	7
Figure 2.2	Photoresist spin coating process: (a) a controlled volume of photoresist dispensed on the substrate surface, (b) slow acceleration spread the photoresist across the substrate, (c) fast spin to create a uniform layer, (d) A thin layer was produced	8
Figure 2.3	Photoresist spin speed curve for resist viscosity	9
Figure 2.4	Polymer reaction during the exposure process: (a) Polymer Chain scission on the positive photoresist, (b) Polymer cross-link on the negative photoresist	10
Figure 2.5	Types of photolithography in exposure system: (a) Contact lithography, (b) Proximity lithography, (c) Projection lithography	13
Figure 2.6	Image of standing waves effects on the sidewalls of resist features	14
Figure 2.7	Wet etching difference between the negative photoresist and the positive photoresist	15
Figure 2.8	Schematic illustration of the procedure for casting PDMS replicas from a master mold with the structure on the silicon wafer surface	16
Figure 2.9	Schematic of nanoimprint lithography process	18
Figure 2.10	A typical process in thermal nanoimprint lithography: (a) heating and pressing, (b) cooling, and (c) releasing	19
Figure 2.11	UV-NIL process: (a) patterned mold and substrate prepared, (b) resist is dispensed on the substrate surface, (c) contact and UV exposed on the resist, (d) lift off and (e) pattern is imprinted on the substrate surface	20
Figure 2.12	SSIL Process: (a) Mold is heated up above T _g and in contact	21

	with the polymer, (b) after cooling down, the mold is lifted up and move to next position, (c) the mold repeat the process from (a) to (b), (d) the mold is lifted up and move on	
Figure 2.13	SFIL Process: (a) transfer layer is spin coated on the substrate surface, etch barrier is dispensed on top of transfer layer, (b) gap between release layer and transfer layer are closed, trapping etch barrier and exposed to UV light, (c) the mold is lifted off while imprinted structure formed on the base layer, (d) residual etch barrier is etched using plasma etch and transfer layer is etched using oxygen reactive ion etch	22
Figure 3.1	Overall methodology flow chart used in the present study	23
Figure 3.2	Examples of photomask polarities: (a) Clear field photomask (b) Dark Field photomask	24
Figure 3.3	Mask and photoresist polarity results.	25
Figure 3.4	Proposed device pattern design	26
Figure 3.5	Tilted image of master mask film for device pattern	27
Figure 3.6	MM605 simple mask fabrication machine	28
Figure 3.7	Stage of mask fabrication machine (MM605)	29
Figure 3.8	Pattern from master mask film projected 5 times smaller and inverted on frosted glass	29
Figure 3.9	Developed device pattern emulsion mask	31
Figure 3.10	Flow chart for device pattern on silicon wafer preparation	32
Figure 3.11	The image of water droplet formed before and after the surface cleaning process: (a) hydrophobic shows surface (b) shows hydrophilic surface	33
Figure 3.12	Laurell WS-400B-6NPP-Lite resist spin coater	34
Figure 3.13	SU8-2010 is dispensed on a blank silicon wafer	34
Figure 3.14	SU-8 spin speed (rpm) vs. thickness	35
Figure 3.15	One side mask aligner setup for UV exposure	36
Figure 3.16	PDMS mold casting process	37
Figure 3.17	Sylgard® 184 from Dow Corning	38
Figure 3.18	Vacuum chamber for degassing operation	39

Figure 3.19	PDMS mold with device pattern	40
Figure 3.20	Flow chart for device pattern imprint	41
Figure 3.21	Proposed in-house plate-to-plate tool drawing	42
Figure 3.22	In-house plate-to-plate setup: (i) top plate removed, (ii) PDMS mold and coated PET substrate placed accordingly, (iii) Top plate was placed back, force is applied by tightening the nuts, (iv) UV exposure	44
Figure 3.23	In-house plate-to-plate experiment setup	44
Figure 3.24	Plate-to-plate imprint setup	45
Figure 3.25	Jig screws and nuts on the imprint tool	46
Figure 3.26	Force plate with force sensor in the four corners	47
Figure 3.27	UV exposure on the in-house plate-to-plate tool	48
Figure 3.28	Imprinted device pattern	48
Figure 3.29	S-34000N Scanning Electron Microscope (SEM) Hitachi	49
Figure 4.1	SEM image of device patterned master mold	51
Figure 4.2	SEM image of line width study based on different dimension size	52
Figure 4.3	Log graph for line width dimension vs error percentage difference	53
Figure 4.4	Graph measured UV intensity of one side mask aligner LA4100_R1	54
Figure 4.5	Effect of UV exposure energy and time on the feature. Features (a and b) are shown in the image	55
Figure 4.6	Cracked region in device pattern master mold	56
Figure 4.7	SEM image of device pattern PDMS mold	57
Figure 4.8	Dimension comparison between the master mold and PDMS mold	58
Figure 4.9	Error percentage between master mold and PDMS mold	58
Figure 4.10	SEM image of imprinted device pattern on flexible substrate	59
Figure 4.11	Dimension comparison between PDMS mold and imprinted biochip pattern	60
Figure 4.12	Graph measured UV intensity of UV LED	61
Figure 4.13	SEM image of comparison between imprint biochip pattern	63

	for parameter (a and b)	
Figure 4.14	Dimension comparison between imprint device pattern for parameter (a,b, c and expected dimensions)	64
Figure 5.1	Recommended process development of the device using in-house plate-to-plate tool with nanoimprint lithography technique	66

LIST OF SYMBOLS

θ	Angle
ℓ	Litre

LIST OF ABBREVIATIONS

2-D	2-dimensional
3-D	3-dimensional
CAs	Contact angles
Cr	Chromium
DED	Dimension error difference
IPA	Isopropyl alcohol
MEMS	Micro-Electro-Mechanical Systems
NFM	Nanofabrication and Functional Material
NIL	Nanoimprint imprint lithography
P2P-NIL	Plate-to-plate imprint lithography
PDMS	Polydimethylsiloxane
PEB	Post-exposure bake
PET	Polyethylene terephthalate
PR	Photoresist
PSI	Pound-force per square inch
RCA	Remote Chemical Analysis
RPM	Revolutions per minute
SEM	Scanning Electron Microscope
SFIL	Step and flash imprint lithography

Si	Silicon
SSIL	Step and stamp imprint lithography
Tg	Transition temperature
T-NIL	Thermal Nanoimprint Lithography
UV	Ultraviolet
UV LED	Ultraviolet Light emitting diode
UV NIL	Ultraviolet Nanoimprint imprint lithography

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ABSTRAK

Biocip merupakan sejenis peranti yang mampu melaksanakan proses pengasingan, pemerangkapan dan pemeriksaan sampel biologikal dalam bilangan yang banyak dengan masa yang singkat. Pemfabrikatan corak biocip membawa kepada kajian pembukaan penghasilan biocip yang berfungsi. Kelemahan utama proses fotolitografi tradisional adalah mencapai pemprosesan yang tinggi untuk pemfabrikatan corak biocip. Dalam kajian ini, proses pemfabrikatan corak biochip telah dihasilkan dan parameter cetakan untuk corak biocip telah di kaji dengan menggunakan alat plat-ke-plat. Corak biocip disediakan dengan menggunakan teknik pantulan litografi untuk menghasilkan acuan. Dengan menggunakan teknik litografi lembut, corak biocip telah dihasilkan secara terbalik pada acuan PDMS. Acuan PDMS dan alat plat-ke-plat buatan sendiri memenuhi keperluan UV-NIL untuk mencetak corak biocip di atas permukaan substrat yang fleksibel. Perbezaan ralat dimensi (DPR) merupakan perbezaan antara dimensi reka bentuk asal dan dimensi reka bentuk yang dihasilkan. (DPR) telah dicirikan dan disiasat untuk pemindahan corak yang tepat. Pendedahan UV sebanyak 140 W mampu mencetak corak dalam pemfabrikatan acuan corak biocip. Namun begitu, kuasa UV yang tinggi boleh menyebabkan pendedahan UV secara berlebihan pada resist, dan mengakibatkan penglebaran yang lebih luas dan perapatan. Selain daripada itu, kesan retak muncul apabila parameter pemanasan tidak dioptimumkan. Perbezaan DPR antara acuan corak biocip dan acuan PDMS adalah kurang berbanding dengan corak acuan biocip dalam proses fotolithografi. Dimensi kritikal dalam corak biocip dapat dikekalkan dalam proses pencetakan. Akan tetapi, daya pencetakan yang tinggi akan menyebabkan resist melimpah dari substrat, sejurusnya mengakibatkan corak struktur yang kurang memuaskan. Parameter yang dicadangkan untuk pencetakan corak biocip dengan menggunakan alat plat-ke-plat buatan sendiri ialah lebih kurang 80 N dan pendedahan sinaran UV sepanjang 20 saat.

ABSTRACT

Biochip is a promising device with capabilities of performing sorting, trapping and screening a large number of biological samples in a short time. Fabrication of biochip pattern process leads to an opening study towards the development of a working biochip. The traditional photolithography process have a limitation in achieving high throughput for biochip pattern fabrication. In this research, the fabrication process of biochip pattern was developed and the imprint parameter for biochip pattern using an in-house assembled plate-to-plate tool was investigated. The biochip patterns are prepared from existing projection lithography to create the mold. Using soft lithography technique, the biochip pattern was replicated invertly in the PDMS mold. The PDMS mold and in-house plate-to-plate fulfilled the requirement for UV-NIL to imprint biochip patterns on a flexible substrate. Dimension error difference (DED) is the difference between the original design dimensions to fabricated design dimensions. DED was characterized and investigated for precise pattern transfer. UV exposure of 140 W was able to produce the satisfied imprint pattern in biochip pattern mold fabrication. However, higher UV energy caused overexposure in the resist, resulting wider width and bridging. Besides that, crack regions were found when post bake exposure parameters are not properly optimized. The DED between biochip pattern mold and PDMS mold are less compared to biochip pattern mold fabrication in the photolithography process. Critical dimension in the biochip pattern was maintained in the imprint process. However, the higher imprint force will cause an overflow of the resist on the substrate, resulting unsatisfied pattern structure. The proposed parameters for imprinting biochip patterns using in-house plate-to-plate tool are 80 N range and 20 seconds of UV exposure.

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