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

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Master of Engineering (Electronic)

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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

LIST OF TABLES

LIST OF FIGURES

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 pembukaanpenghasilan 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 menggunkan 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 subsrat 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 mencetakan corak dalam pemfabrikatan acuan corak biocip. Namun begitu, kuasa UV yang tinggi boleh menyebabkan pendedahan UV secara berlebihan pada resist, danmengakibatkan 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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