



BioMEMS Photomask Aligner

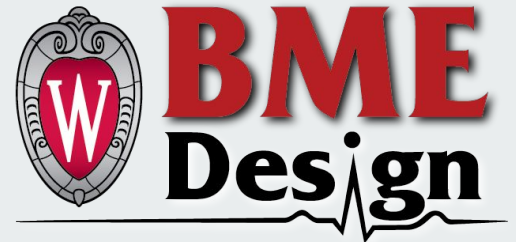
10/6/2023

Team: Jayson O'Halloran, Luke Waldhuetter, Emily Stoebe, George Moran, Paulie

Reuteman, Saketh Peddireddy

Advisor: Dr. Josh Brockman

Client: Dr. John Puccinelli



Overview

- Problem Statement/Client Description
- Background Material
- Initial summary of PDS
- Current Design Alternatives & Matrix
 - Rotating Tower
 - Arm Pin Alignment
 - Screw Idea
- Future Work
- References

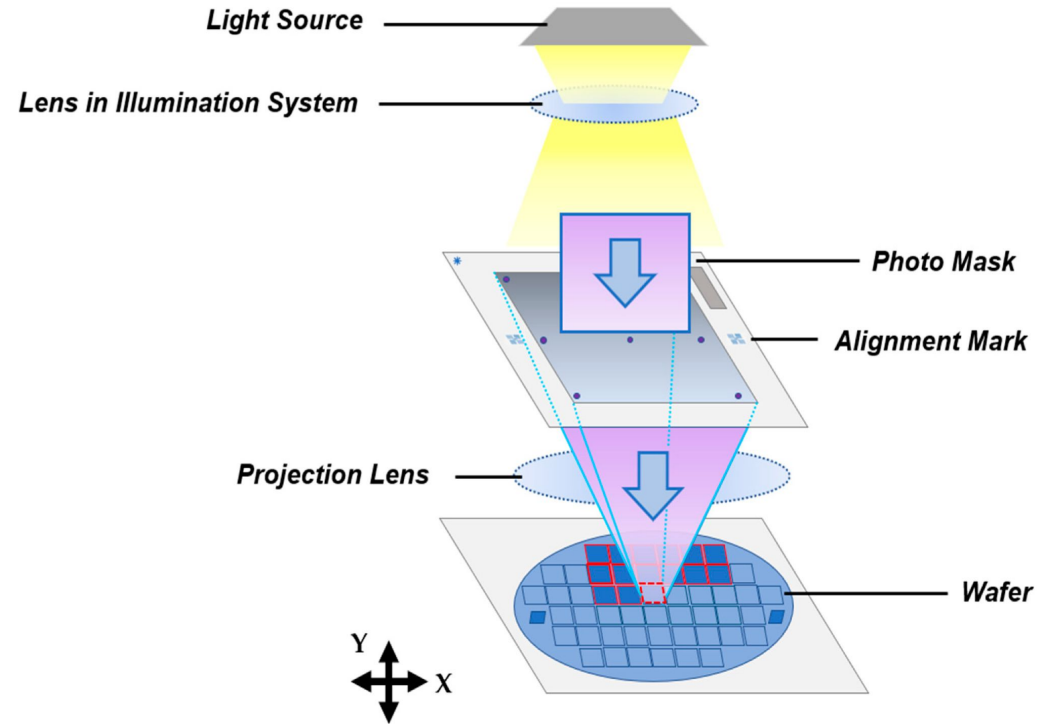


Figure 1 - Photomask Alignment [1]
<https://www.mdpi.com/2076-3417/12/5/2721>

Problem Statement

- Aligner is desired that will hold the master and photomask in place
- Accuracy is desired to be 10 μm resolution (with in 10 to 100 μm)
- Competing designs
- Low cost
- Compatible
- Human error

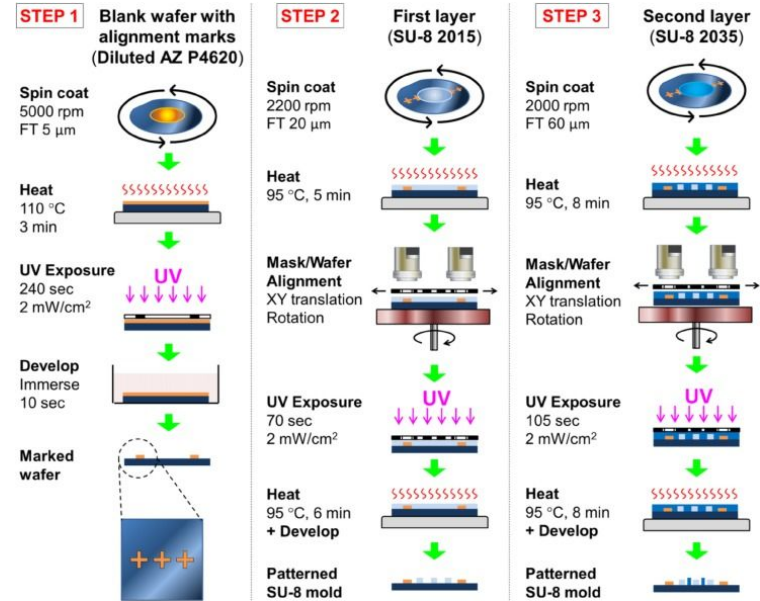


Figure 2 - Example of alignment process [2]
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6105338/>

Background Material

- What is BioMEMS?
 - Biological Microelectromechanical Systems
 - Can be used for various biomedical applications such as microsensors, pacemakers, etc.
- Photolithography Process / Photomask Alignment
 - Transfers Patterns onto a Silicon Wafers
 - Photoresist is applied
 - UV Light Exposure
 - Repeat

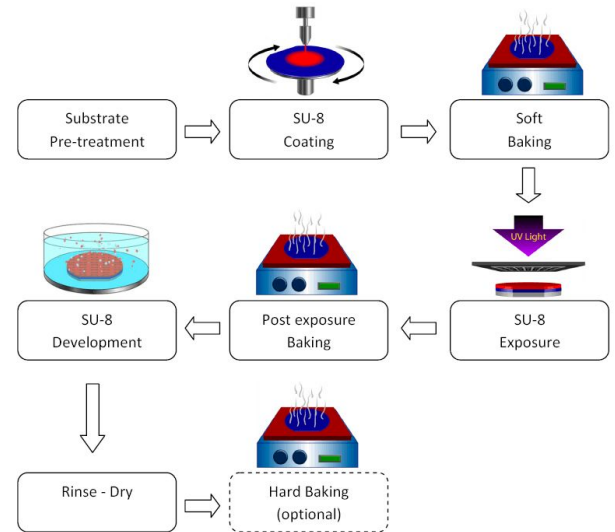


Figure 3 - Example of Photolithography Process [5]
<https://www.elveflow.com/microfluidic-reviews/soft-lithography-microfabrication/soft-lithography-definitions/>

Product Design Specifications

- For a teaching environment
 - Must be easy to use
 - Easily Reproducible
- Must be accurately aligned within 10-100 microns
- Wafers will be 3-6 inches
- Photomasks are used to align each layer
- \$100 budget

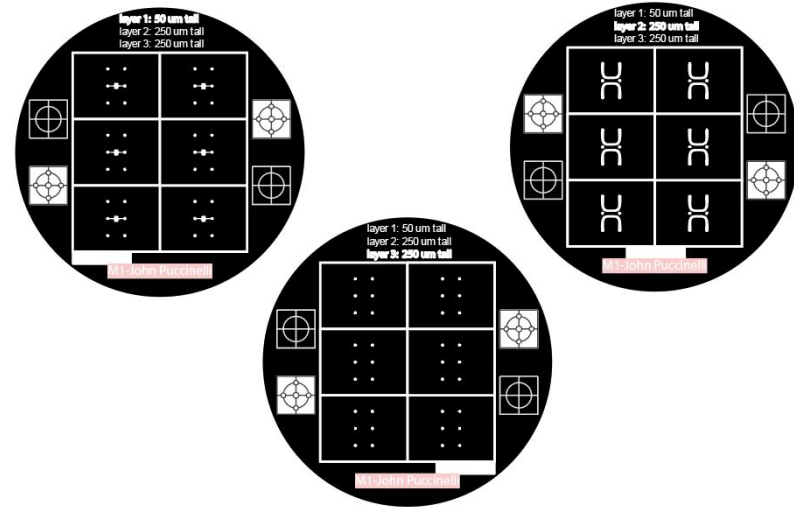


Figure 5 - [6] Examples of Photomasks used in multilayer photolithography



Design Alternatives Considered

Rotating Tower

Arm Pin Alignment

Screw Design

Rotating Tower

- Features 3 propositioned mask holders
- Masks are aligned using a notch cut-out in the upper right corner
- Mask holders can swivel
- Mask holder's height is adjustable
- Material is resistant to baking

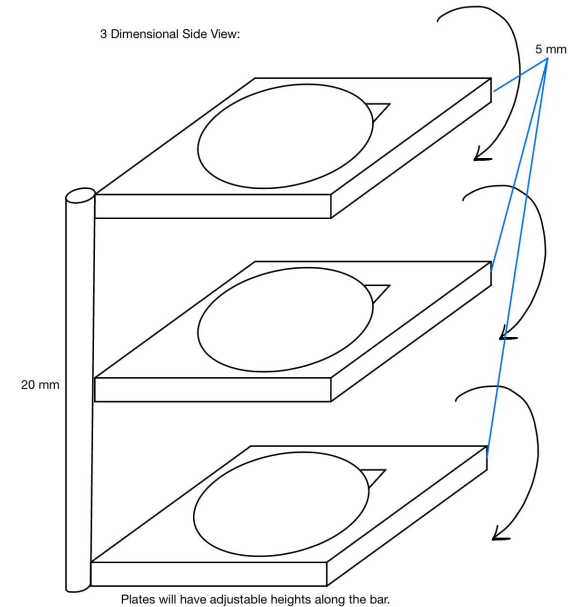
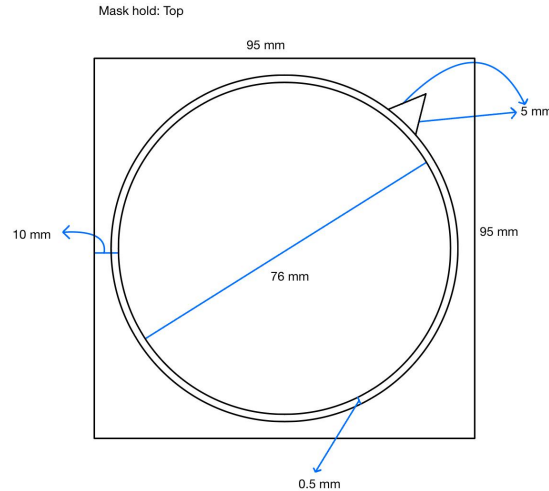


Figure 3 - Top and 3D side view of the Rotating Tower

Arm-Pin Alignment

- The board has 4 distinguished sections:
 - One fourth for laser-cutting holes in 3 in. wafers
 - One fourth for laser-cutting holes in 6 in. wafers
 - One fourth for an arm with a pin measured to insert into the 3 in. wafer's hole
 - One fourth for an arm with a pin measured to insert into the 6 in. wafer's hole
- On the laser-cut side, leaves a hole to cut through photomask (twice per mask)
- Vertically adjustable arm with pin fitting diameter of hole in photomask

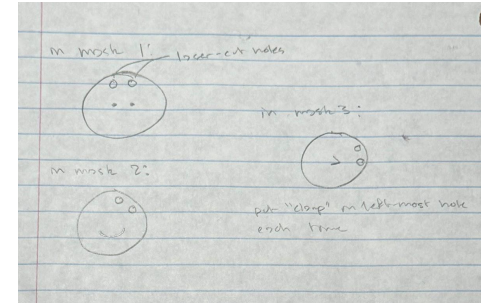
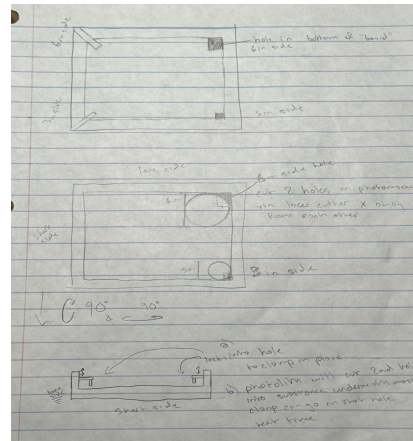
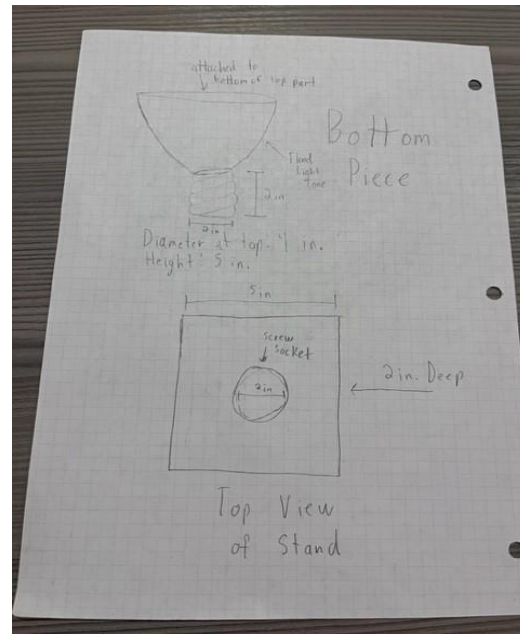
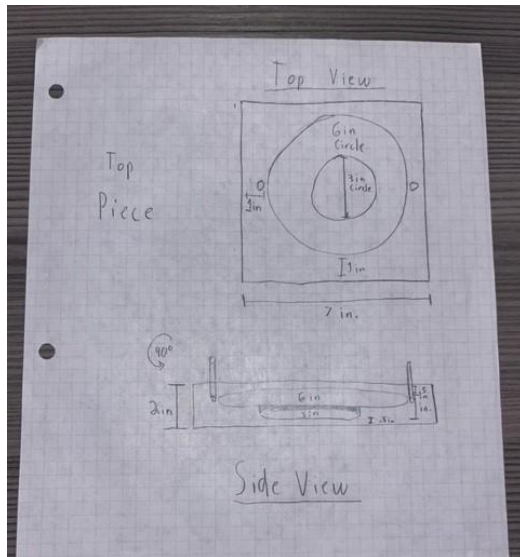


Figure 4 - Arm-Pin Alignment Diagram

Screw Design



- Looks almost like a floodlight
- Circle on top that aligns and holds the three layers in both 3 in and 6 in dimensions
- Circle in box design to have ridge to go in a well
- Simple design
- Platform with screw well as well

Figure 5 - Screw Design Diagram



Design Matrix

Current Design Matrix	Weight	Rotating Tower		Laser Cut Alignment Holes		Screw Idea	
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Accuracy	25	3/5	15	4/5	20	3/5	15
Cost	20	4/5	16	3/5	12	5/5	20
Ease of Use	20	5/5	20	3/5	12	3/5	12
Ease of fabrication	15	5/5	15	3/5	9	4/5	12
Size	10	5/5	10	5/5	10	5/5	10
Durability	10	3/5	6	3/5	6	4/5	8
Total		82		69		77	

Figure 6 - Design Matrix



Future Work

- Finish New PDS
- Create base plate for mask aligner
- Start conducting tests with rotational elements
- Reach out to the Williams Lab for further fabrication advice concerning photomask aligners



References

- [1] J. Park and J. Jeong, "Improved MSRN-based attention block for mask alignment mark detection in photolithography," MDPI, <https://www.mdpi.com/2076-3417/12/5/2721> (accessed Oct. 2, 2023).
- [2] Q. L. Pham, N. A. N. Tong, A. Mathew, S. Basuray, and R. S. Voronov, "A compact low-cost low-maintenance open architecture mask aligner for fabrication of multilayer microfluidics devices," *Biomicrofluidics*, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6105338/> (accessed Oct. 2, 2023).
- [3] R. Comer, P. Fossum, N. Retzlaff, and W. Zuleger, *BioMEMS Photomask Alignment Device*, BME 400, 2011
- [4] "Multilayer photolithography with manual photomask alignment - Chips and Tips." https://blogs.rsc.org/chipsandtips/2017/06/05/multilayer-photolithography-with-manual-photomask-alignment/?doing_wp_cron=1696603062.9699950218200683593750 (accessed Oct. 06, 2023).
- [5] S. Cargou, "PDMS & microfluidics: Soft-lithography definitions," *Elveflow*, Dec. 2020, Available: <https://www.elveflow.com/microfluidic-reviews/soft-lithography-microfabrication/soft-lithography-definitions/>
- [6] "BME Lab - 1002 ECB - Biomedical Experimental Teaching Lab," *sharedlab.bme.wisc.edu*. <https://sharedlab.bme.wisc.edu/labs/1002/> (accessed Oct. 06, 2023).



Questions?
Thanks for listening!