ME 450 Project 5
Alignment Platform for Multilayer Soft Lithography

Nitesh Alve, Andy Dun, Akshay Kini, Karan Patel, Roberto Shu
Project Sponsor: Professor J. Fu **Section Instructor:** Professor N. Chronis

Abstract

Multilayer Soft Lithography (MSL) has the ability to generate complex 3D structures, and is extensively used in the fabrication of microfluidic valves, pumps, and filters. Albeit a widely used technique in microfluidic research, there are a lack of methods which work quickly, accurately, and are convenient to use for aligning the microstructures in different PDMS layers before they are bonded – the critical step in MSL.

Objective

To design and build an alignment platform for MSL that will allow users to align two microfluidic layers quickly and with an accuracy of less than 20 microns.

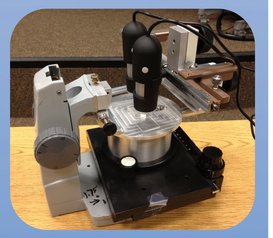
Engineering Specifications

Functional Requirements	Operational Requirements	Engineering Specification	Source
Accuracy		20-50 Microns	Sponsor
	Alignment Device	Resolution <15 microns	Team
	Imaging Device	20x magnifications	Sponsor
		Resolution < 10 microns	
Less tedious		< 15 minutes total time	Sponsor
	Pre-activation time	< 10 minutes	Team
	Post-activation time	< 5 minutes	
	# of inputs	< 14 inputs	Team
Adjustability		Fit 6 PDMS Layers	Sponsor
		Fit layers < 2”x 3”	Sponsor
	Height Adjustment	> 7 cm	Team
Cost		< $2000	Team
Portability	Weight	< 40lb	
	Size	< 14” x 14” footprint	

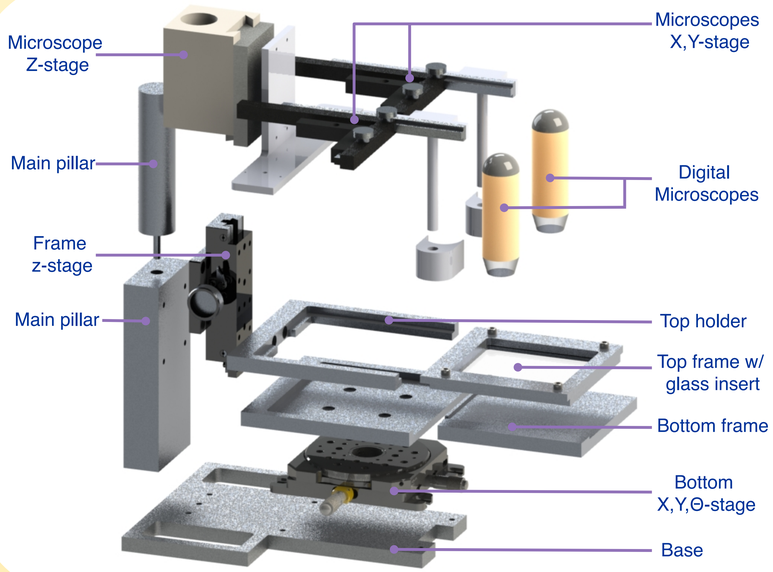
Existing Prototype Issues

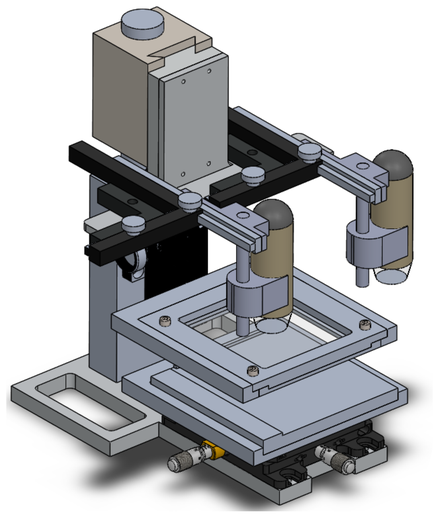
A current prototype of an alignment platform exist but does not meet user requirements

- Alignment accuracy > 100 micron
- Low imagining device resolution
- Low accuracy X,Y,Z stages
- Large number of user inputs
- Very susceptible to vibrations

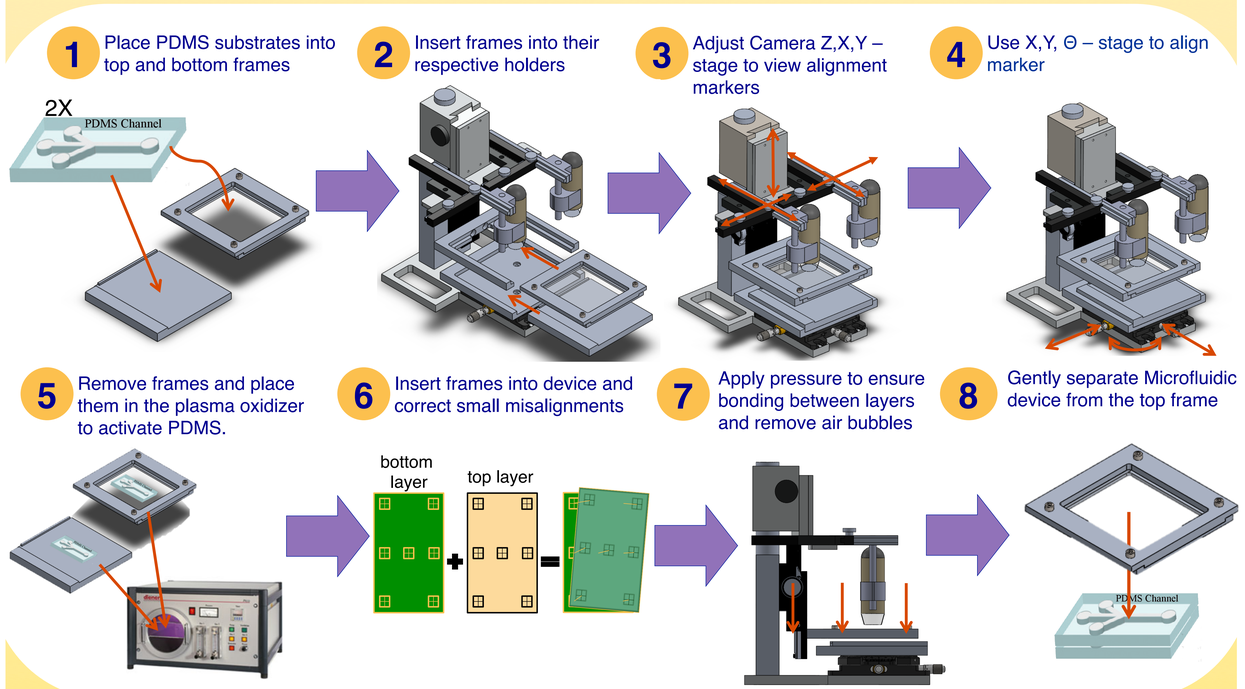


Final Design





Alignment Process



Validation Tests

Thus far we have conducted 5 tests:

- Imaging device resolution identification
- Alignment of PDMS layers with 20 micron pattern accuracy Deflection testing
- Portability tests, weight and footprint
- Height adjustment

Future validation tests:

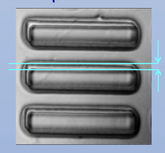
- Ease of device use, time taken to align two layers
- Repeatability test

Results and Conclusion

Functional Requirements	Operational Requirements	Design Value	Tested Value
Accuracy		12.5 micron	5~40 micron
	Alignment Device	5 micron resolution	5 micron
	Imaging Device	20x magnifications	250x
		10 micron resolution	6 micron
		0 deflection under double its weight	0 deflection
Adjustability	Height Adjustment	8cm Z-axis translation	
Cost		$2000	$2100
Portability	Weight	14 lbs	21 lb
	Size	8” x 10”	8” x 10”

Exceeds design value | Fails to meet design value but exceeds engineering specification | Fails to meet design and engineering specification

From the results in the table above we can conclude that our device meets and exceeds most of our design specifications. Primary testing shows that we can successfully align two PDMS layers with pattern features of ≤ 30 microns which are within the engineering specification set by our sponsor. Through testing we identified that some of the standard components did not meet the manufacturer’s specification affecting our final alignment accuracy.



Future Work

We will continue working on this project to meet all the user requirements

- Develop user manual
- Develop software to overlay still image and real time video
- Integrate LCD screen and computer
- Improve camera mount
- Improve control of bottom holder rotation

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