BME Design 301
Microfluidic Device

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Client Overview

- Studies the alterations of the ECM in cancers and connective tissue disorders
- 3D Nano/Microfabrication using modified laser rastering [1]
  - modeling of ECM

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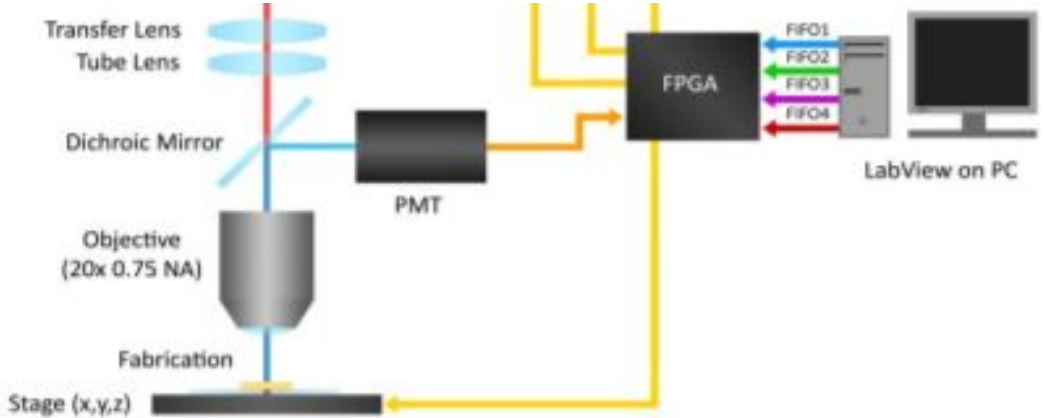
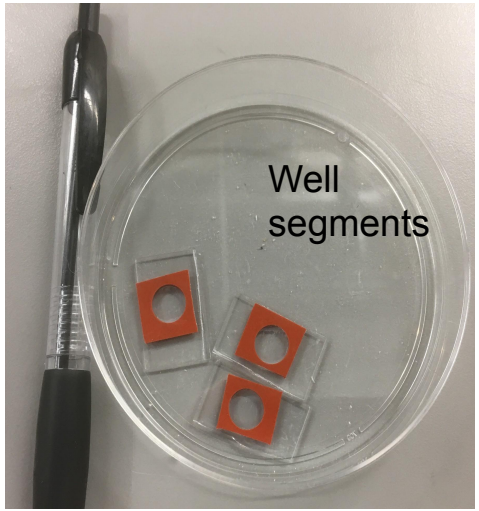
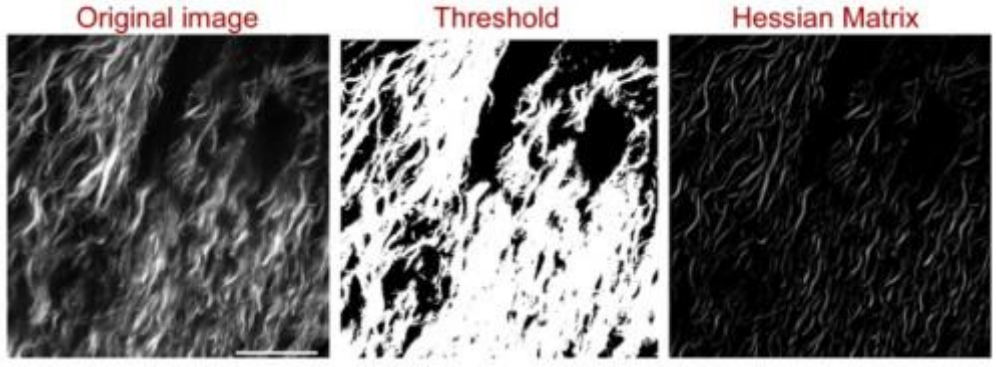


Background - From Grayscale to ECM

- Images are taken of sample tissue
  - converted to grayscale image
- Protein solution with photoactivator added to well
  - laminin, collagen fibronectin
- Areas of higher contrast in grayscale image are reflective to degree of polymerization





Problem Statement

Develop a mechanism that can automate the process and facilitate a more efficient production of ECM

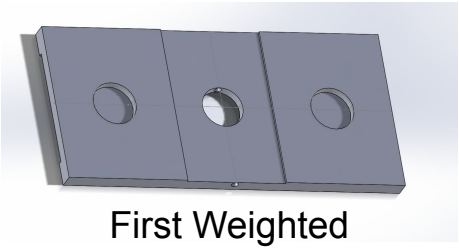
- A filtration mechanism should be incorporated to separate any large solute particles that break off from the ECM
- The protein solution and photoactivator should be recaptured to be reused

What has been accomplished thus far

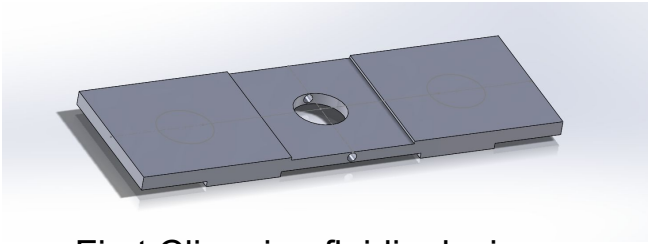
Two different microfluidic chamber designs from Midwest Prototyping

Weighted and clip designs

- EPU 40 & SIL 30 [2]
- Testing for protein adsorption done on each material
- Purchased other materials:
  - Tubing, filter, pump



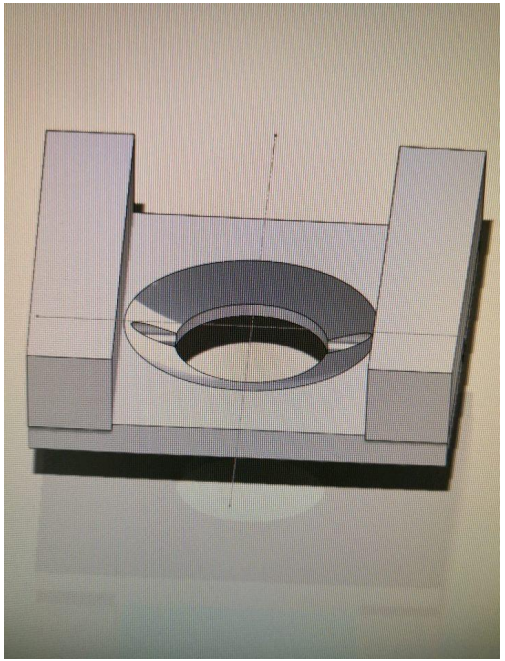
First Weighted microfluidic design



First Clip microfluidic design

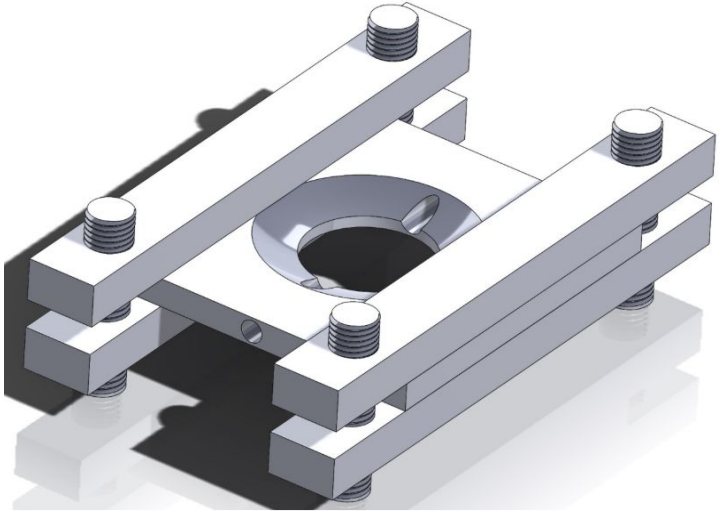
Design Idea 1 - Weights

- Weight pieces would be placed along the edges
- Advantages
  - Ease of Fabrication
  - Cost
  - Ease of Use
  - Durability
- Disadvantages
  - Sealing Capabilities



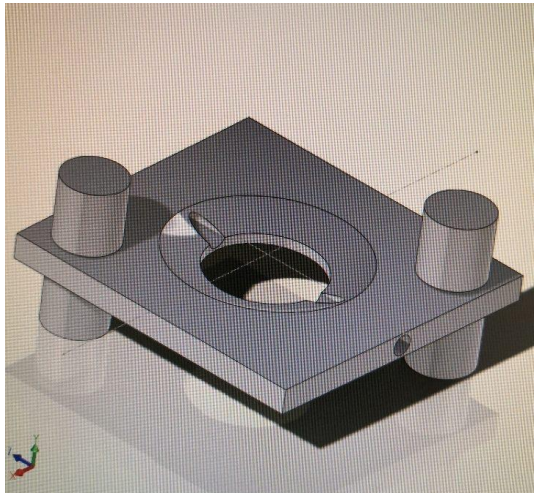
Design Idea 2 - Clamp

- Weight pieces would be placed along the edges
- Advantages
  - Ease of Fabrication
  - Sealing Capabilities
  - Cost
  - Durability
- Disadvantages
  - Ease of Use

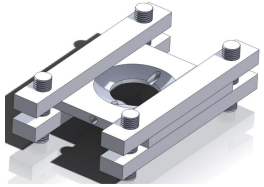
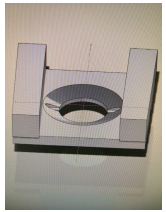


Design Idea 3 - Magnets

- Weight pieces would be placed along the edges
- Advantages
  - Ease of Fabrication
  - Ease of Use
  - Durability
- Disadvantages
  - Sealing Capabilities
  - Cost

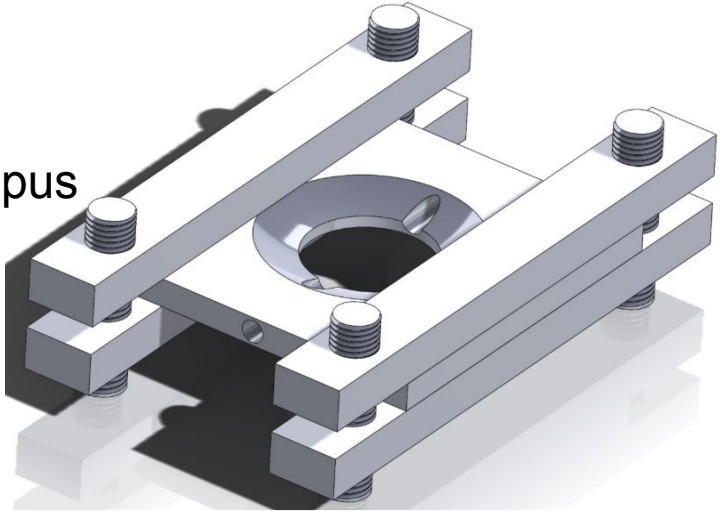


Design Matrix

Weight	Criteria	 Weights		 Clamp		 Magnets	
35	Ease of Fabrication	4	28	4	28	4	28
25	Sealing Capabilities	1	5	5	25	3	15
20	Ease of Use	4	16	3	12	4	16
15	Cost	4	12	4	12	3	9
5	Durability	5	5	5	5	5	5
100	Total (100)	66		81		74	

“Final” Design

- Addresses issue of sealing hybridization chamber
- Inexpensive
- Easily fabricated
  - Majority of parts are obtainable on campus
- Dimensions: 25mm x 25 mm x 2mm



Testing

- Protein Adsorption Tests
  - Measured optical density
  - Fluorescence testing
- Future testing- pump flow rate

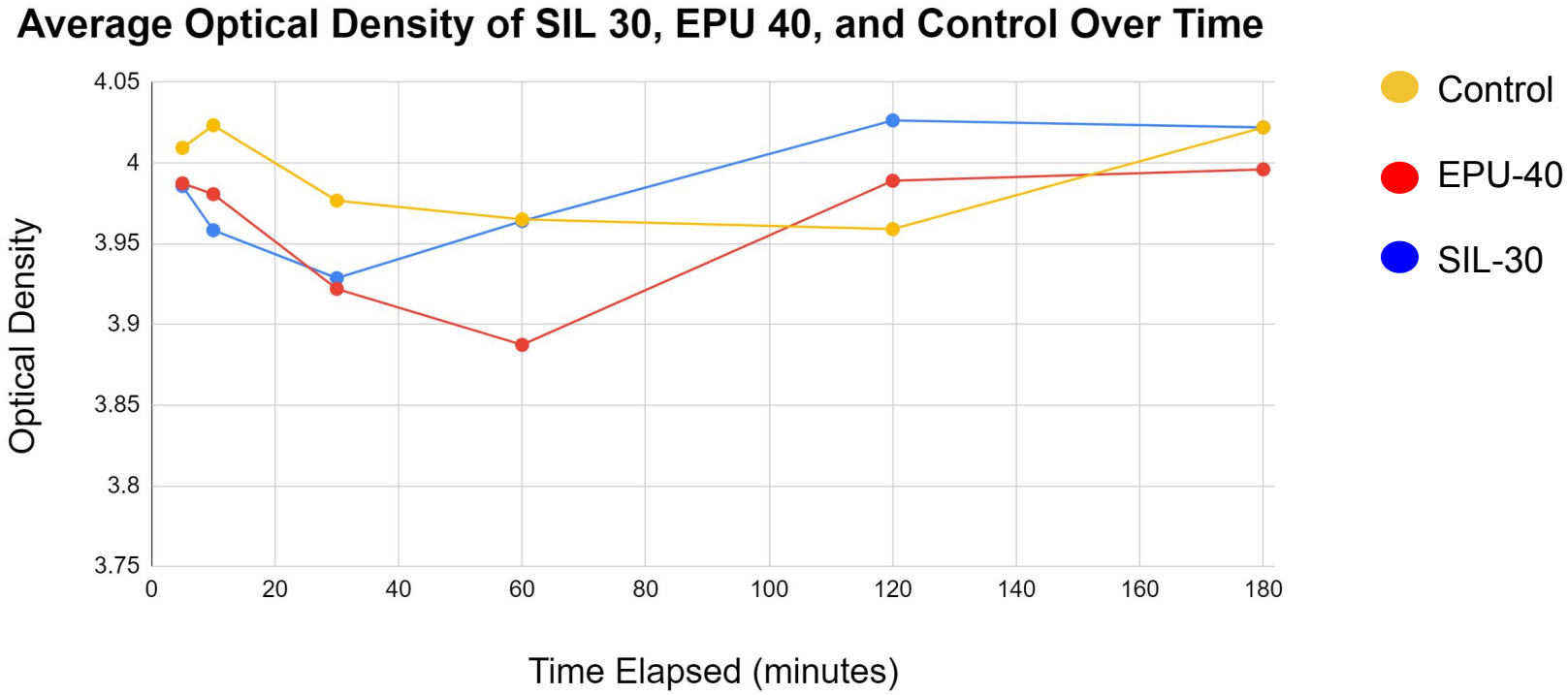
Fluorescent liquids

Spectrophotometer

96 well plate used in spectrophotometer

Fluorescent microscope

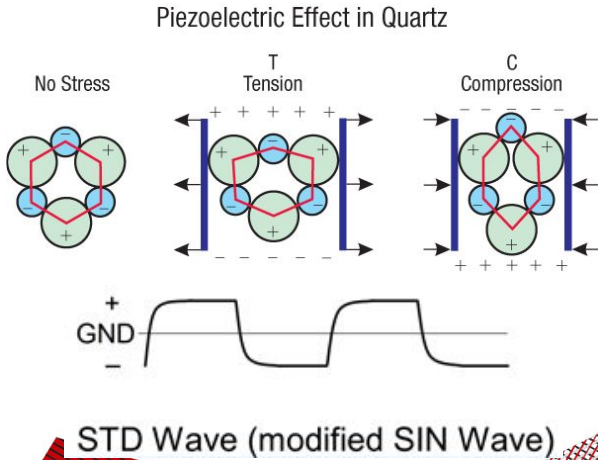
Protein Adsorption Results



Future Work

- Buy a controller to control piezoelectric pump
  - Need modified sine wave function
  - 120-250V peak to peak to power
  - Frequency range 10-60 Hz
  - Tailor controller/pump to output ideal flow rate
  - Current option is $1090 [3], considering others
- 3D print new microfluidic device
- Fabricate clamp
  - Using available Makerspace equipment
- Include filtration system
  - Likely post hoc
- Integrate system with Labview software

Pump bought by team



Acknowledgements

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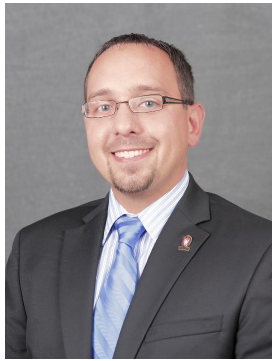

Dr. Paul Campagnola, Client

Samuel Alkmin, Campagnola Lab Contact

References

(1) V. Ajeti, C. Lien, S. Chen, P. Su, J. Squirrell, K. Molinarolo, G. Lyons, K. Eliceiri, B. Ogle, and P. Campagnola, "Image-inspired 3D multiphoton excited fabrication of extracellular matrix structures by modulated raster scanning", *Optics Express*, vol. 21, issue 21, pp. 25346-25355, 2013.

(2) "CLIP Materials," CLIP Materials @ Midwest Prototyping Additive Manufacturing. [Online]. Available: https://www.midwestproto.com/technologies/CLIP-Materials. [Accessed: 20-Feb-2020].

(3) Dolomite, "Piezoelectric Pump Controller," *Dolomite Microfluidics*. [Online]. Available: https://www.dolomite-microfluidics.com/product/piezoelectric-pump-controller/. [Accessed: 19-Feb-2020].