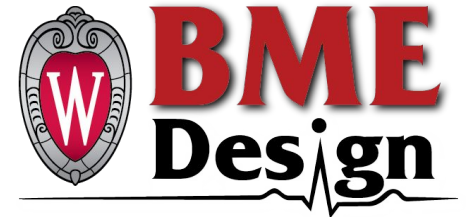


Microcosm for Plant Roots and Bacteria

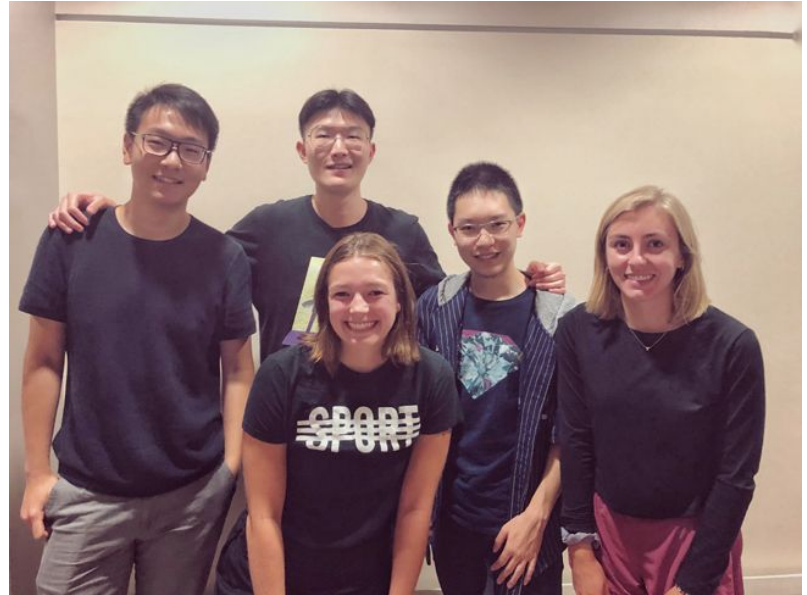


Overview

Team Members: Xavier Fan(Team Leader), Yanbo Feng(BSAC), TShawn Zhu(Communicator), Salina Loer(BWIG), Courtney Mohs(BPAG)

Client: Professor Jo Handelsman, Dr. Amanda Hurley from Handelman's Lab in WID

Advisor: Professor Melissa Kinney from Department of Biomedical Engineering



Problem Statement

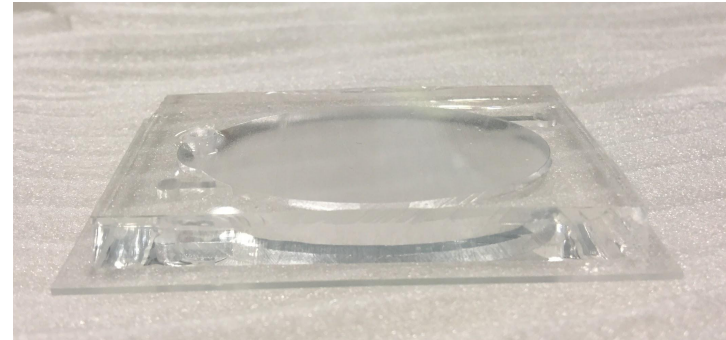
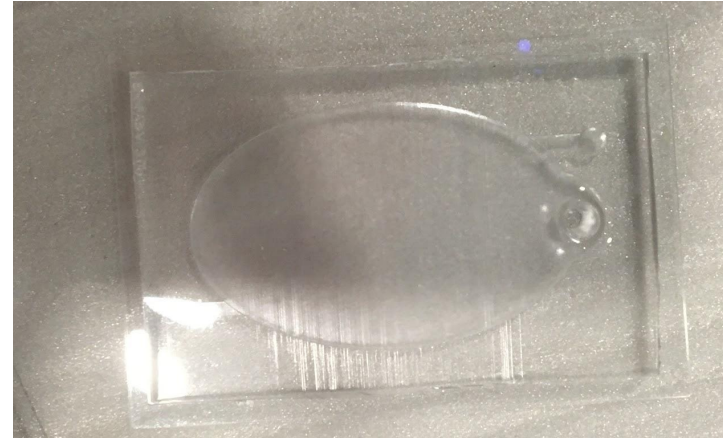
- Our client requires an apparatus that can culture and observe the bacteria in the sand/on the plant roots.
- Main issues on the current device:
 - Hard to load culturing media, sand and bacteria
 - Hard to extract the samples
- Device designed
 - Multiple Pores
 - Detachable Structure

Background Material

The client's lab needs a device that can investigate the interaction of multiple bacteria with sand and plant root. [5] They currently have a prototype as shown on these photos.

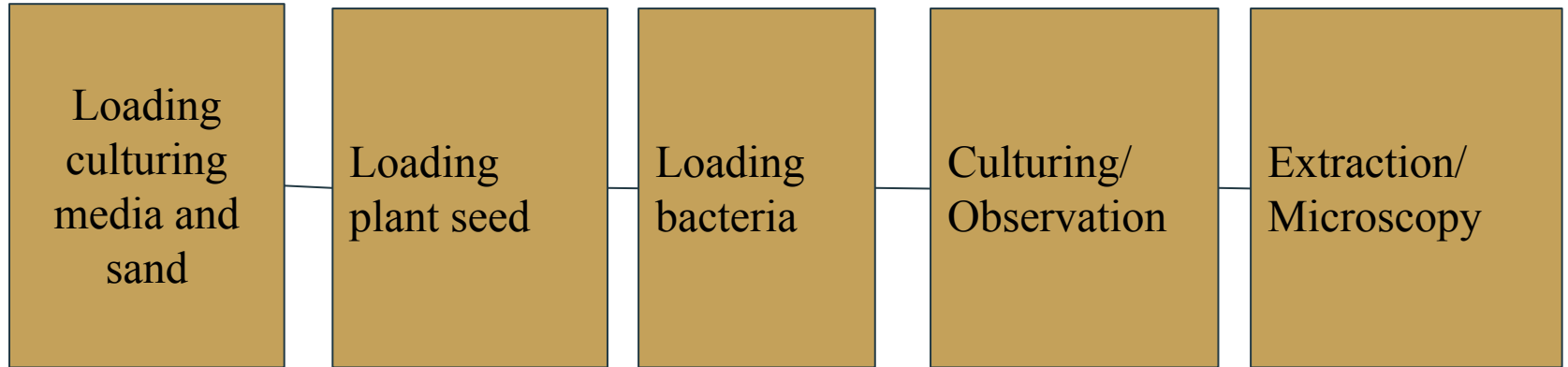
Structures:

- Glass Base
- PDMS layer
- Culturing liquid/bacteria/plant inlet



Dimensions: 68mm*44mm*6mm PDMS layer
3mm depth PDMS chamber

Background Material



Competing Design

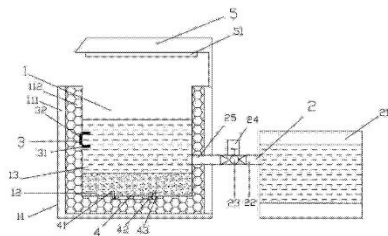


图1

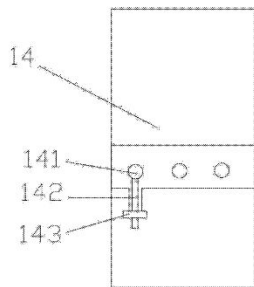
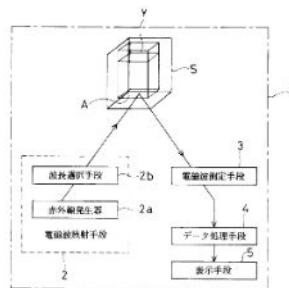
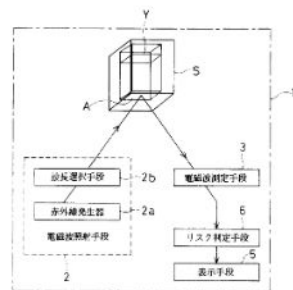


图2



JP 3891518 B2



CN 107167564 A

Product Design Specifications

Client Requirements:

- Apparatus size within 5-7cm x 6-9cm x 1-2cm
- Material oxygen permeable and chamber depth within 3mm
- Inner chamber for root growth and interaction between roots or sand and bacteria
- Include two inlet for bacteria 1 mm diameter and one plant seed hole 2mm diameter
- Detachable structure to simplify the loading and extraction process
- Reusability is favorable to lower experiment costs

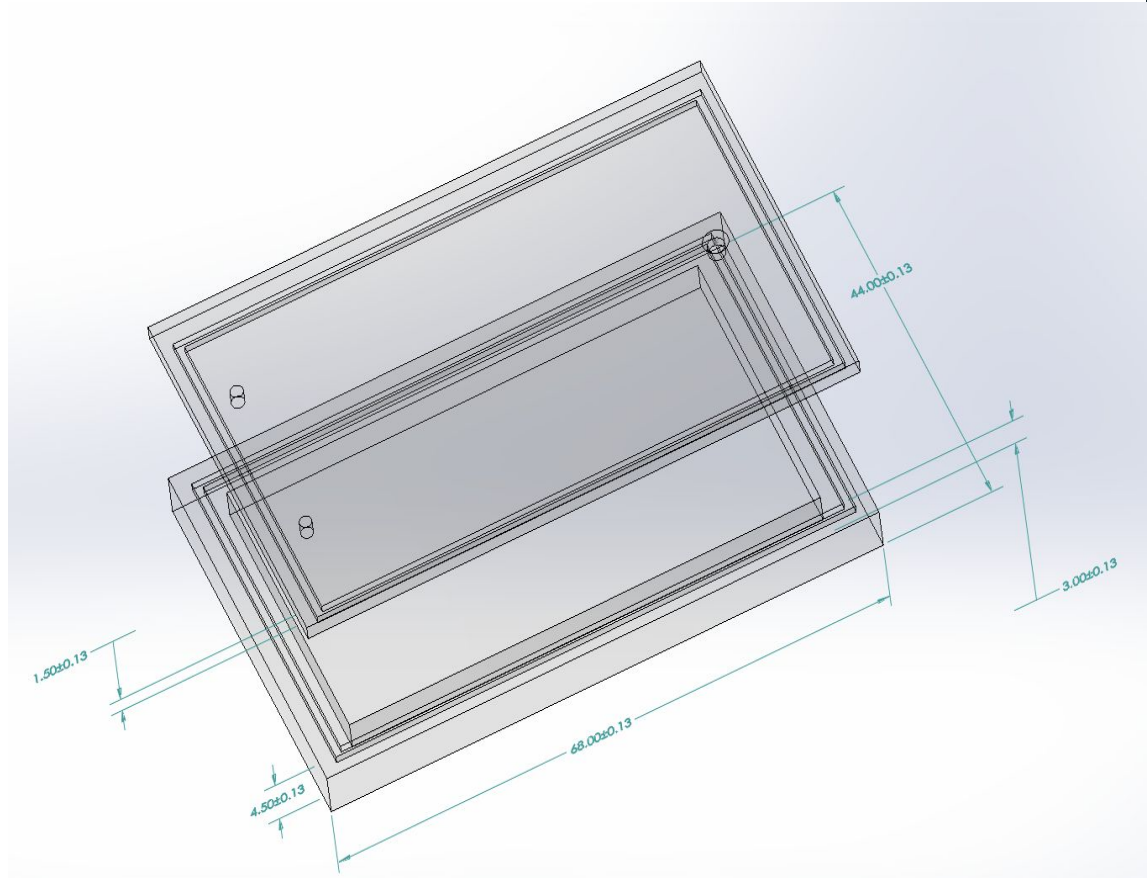
Product Design Specifications

Design Requirements:

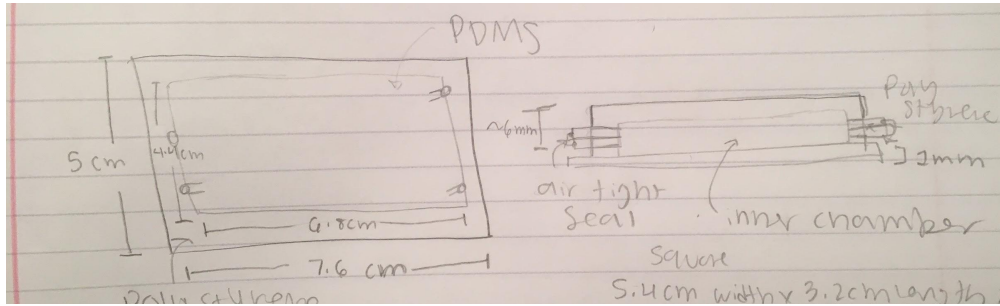
- Bottom layer clear to allow microscopy, above 90% transmittance[4].
- Must be able to hold liquid media, or a mix of liquid media and sand.
- Should use biological inert material such as PDMS[1], polystyrene[2][3]
- Inlet and outlet holes on the top of the chamber to allow loading of bacteria.
- Needs a set of holes along the chamber to enable extraction of bacteria samples.

Design #1 Lego

- One hole for seed and two for bacteria
- All made of PDMS
- Connected parts can seal perfectly

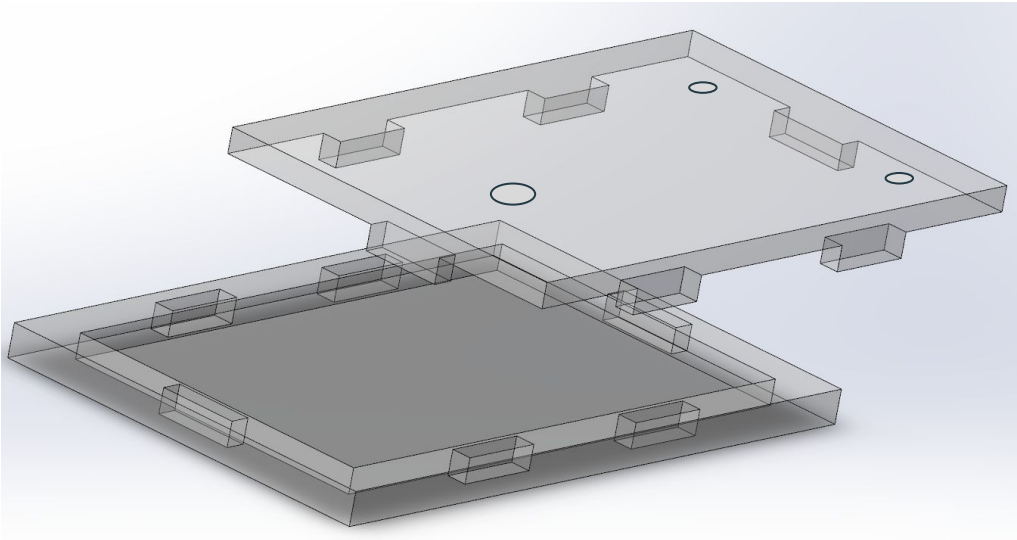


Design #3 Sealed Jar



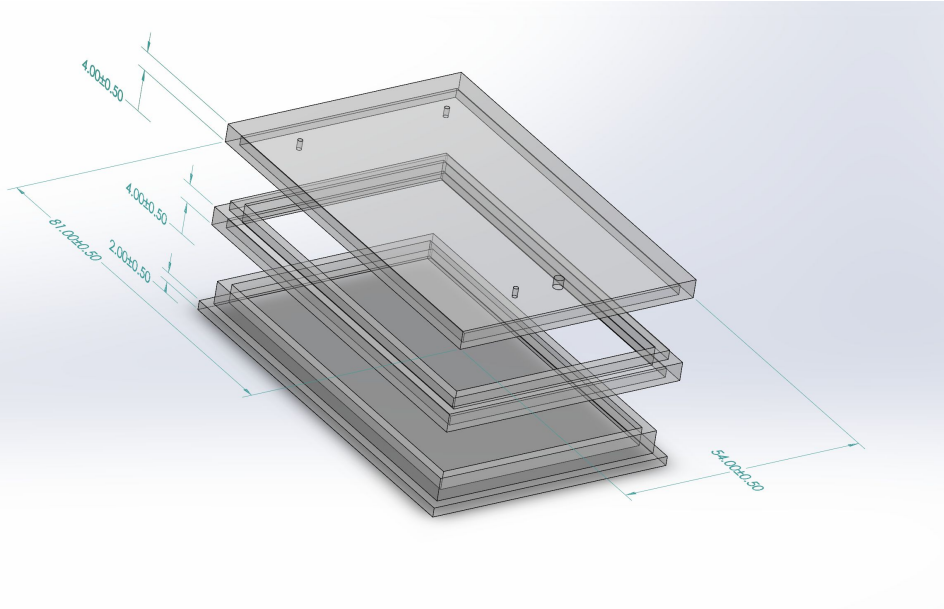
- Bottom glass slide
- PDMS chamber
- There are two glass slide cut outs that match the chamber dimensions and extend out and clipped together with lid clips
- Holes for bacteria and seed

Design #4 Puzzle Piece



- Bottom section of device made of glass
- Top section made of PDMS
- Has hole for seed and two holes for bacteria addition
- Teeth on lid will slide into cutouts on bottom part to seal device

Design #5 Modular



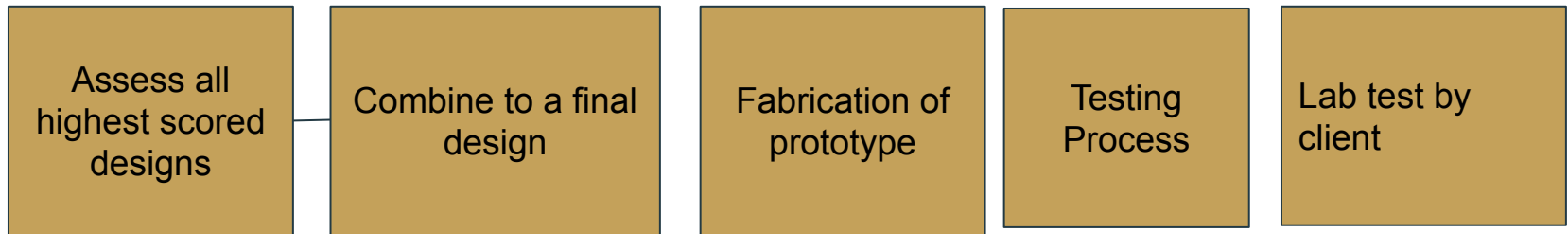
- Top cover and middle optional layer made of polystyrene
- Bottom chamber made of PDMS
- Middle optional layer used to increase chamber capacity if required
- One hole for seed, one hole for assisting airflow, and two holes for bacteria
- Easy to manufacture and operate
- Leakproof

Design Matrix

Criteria	Weight	Design 1: TShawn Lego		Design 2: Yanbo Match Box		Design 3: Courtney Sealed Jar		Design 4: Salina Puzzle Piece		Design 5: Xavier Modular	
Transparency	25	5/5	25	2/5	10	5/5	25	5/5	25	5/5	25
Ease of manufacturing	25	3/5	15	2/5	10	2/5	10	5/5	25	3/5	15
Ease of Loading	15	5/5	15	5/5	15	5/5	15	5/5	15	5/5	15
Leakproof	15	5/5	15	5/5	15	4/5	12	5/5	15	4/5	12
Adjustability	10	0/5	0	0/5	0	3/5	6	0/5	0	5/5	10
Safety/Contamination	5	5/5	5	5/5	5	5/5	5	5/5	5	5/5	5
Cost	5	5/5	5	5/5	5	5/5	5	5/5	5	5/5	5
Total	100		80		60		78		90		87

Conclusions/Future Work

- Design 4 scored the highest overall, however we need to modify it to make the height adjustable.
- Our next steps are:



References

- [1] Elveflow. (2019). *PDMS: A review - Elveflow*. [online] Available at: <https://www.elveflow.com/microfluidic-tutorials/microfluidic-reviews-and-tutorials/the-poly-di-methyl-siloxane-pdms-and-microfluidics/> [Accessed 20 Sep. 2019].
- [2] ChemicalSafetyFacts.org, “What is Polystyrene?: Uses, Benefits, and Safety Facts,” *ChemicalSafetyFacts.org*, 17-Jun-2019. [Online]. Available: <https://www.chemicalsafetyfacts.org/polystyrene/>. [Accessed: 20-Sep-2019].
- [3] T. Rogers, “Everything You Need To Know About Polystyrene (PS),” *Everything You Need To Know About Polystyrene (PS)*. [Online]. Available: <https://www.creativemechanisms.com/blog/polystyrene-ps-plastic>. [Accessed: 20-Sep-2019].
- [4] “Transparency Meter - Haze Gard-i | Qualitest”, *Worldoftest.com*, 2019. [Online]. Available: <https://www.worldoftest.com/transparency-meter-haze-gard-i>. [Accessed: 25- Sep- 2019].
- [5] G. L. Lozano, J. I. Bravo, M. F. G. Diago, H. B. Park, A. Hurley, S. B. Peterson, E. V. Stabb, J. M. Crawford, N. A. Broderick, and J. Handelsman, “Introducing THOR, a Model Microbiome for Genetic Dissection of Community Behavior,” *mBio*, 30-Apr-2019. [Online]. Available: <https://mbio.asm.org/content/10/2/e02846-18>. [Accessed: 03-Oct-2019].