Fabrication and Design of 3D Printed Transparent Tissue Chips

Ali Weekley

Advisor: Russell K. Pirlo, Ph.D.

Department of Chemical and Materials Engineering, University of Dayton

Rationale

- Fused Filament Fabrication (FFF) is effective for iterative design of custom parts and allows for insertion of non-FFF during a pause.
- Cyclic Olefin Copolymer (COC) is a biocompatible material with good transmittance from 300-700nm.
- Here we demonstrate the use of COC and a Prusa FFF printer to fabricate in vitro tissue chip components (windows and channels), while optimizing the smallest replicable channel size and highest transparent first layer window.

Methodology

$$Transmittance\ \% = 10^{(2-Absorbance)}$$

Equation 1: Absorbance to transmittance

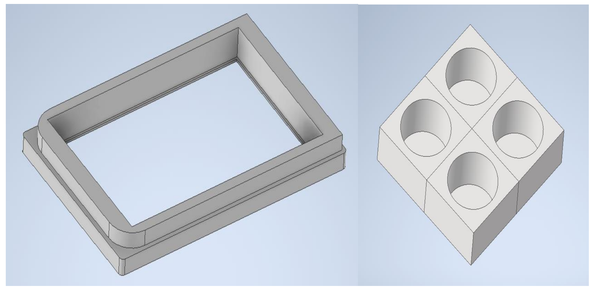

Figure 1: 24 well plate device designed to hold 6 units of 4 wells each for cell culturing and transmission testing.

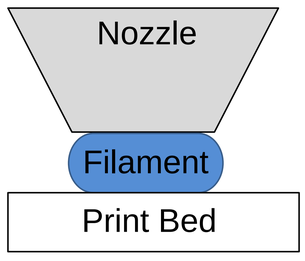

Figure 2: Extrusion of filament for FFF printers

Results

Channels

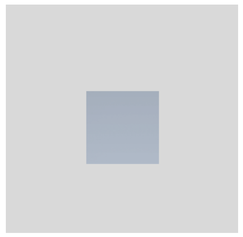

Figure 3: Autodesk Inventor® image of 200-micron channel.

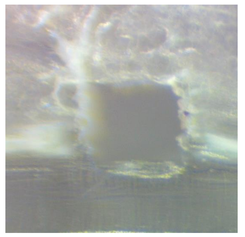

Figure 4: Microscope image of 200-micron channel.

Transmission

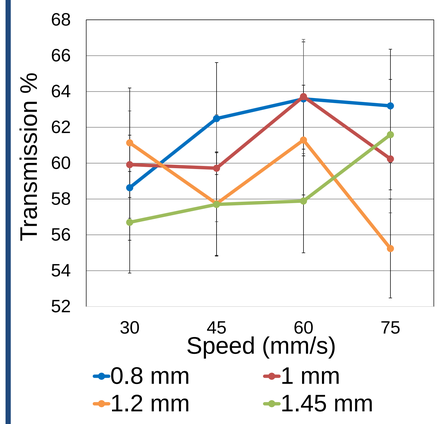

Figure 5: Maximization of extrusion width and speed.

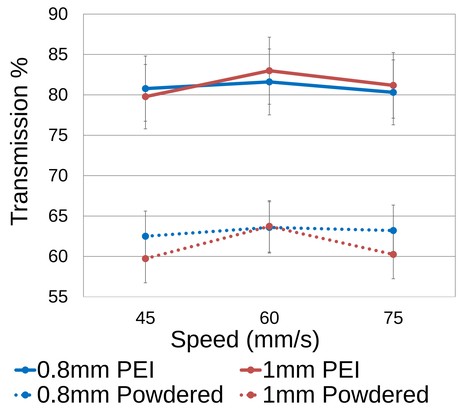

Figure 6: Control samples 0.8mm and 1mm printed on PEI and Powdered coated beds

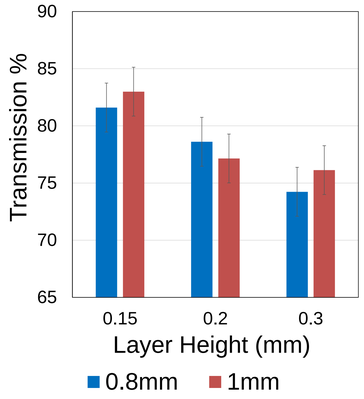

Figure 7: Varying layer heights of controlled samples 0.8mm and 1mm.

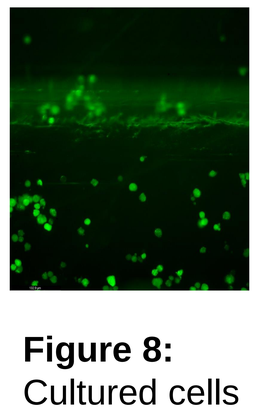

Figure 8: Cultured cells the size of 10-microns on transparent window.

Conclusions

- Utilizing COC filament, a PEI coated print bed, and optimizing the print settings at an extrusion width of 1mm, speed 60 mm/s, and layer height 0.15mm, Prusa FFF printer is capable of printing windows at 83% transmission that visibly detects cells and 200-micron square channels.
- Next step, further develop microfluidic channels to withstand pressure and flow testing. Perform additional transparency testing to replicate results.

Acknowledgements and References

Portions of this work were funded by the University of Dayton Summer Undergraduate Research Expereince (S.U.R.E)