2015

Flow-Cytometry Machine for the Developing World

Paul Howell
Virginia Commonwealth University

Jewel Nkwocha
Virginia Commonwealth University

Jaynie Laverty
Virginia Commonwealth University

Team Members:
Paul Howell,
Jewel Nkwocha,
Jaynie Laverty

Faculty Advisor: Dr Lemmon

BIOMEDICAL

Flow-Cytometry Machine for the Developing World

CAPSTONE DESIGN EXPO 2015

Objective

To create a flow cytometry machine for the developing world with the ability to count and distinguish cell types as well as detect a fluorophore-marked cell surface epitope. The machine should be low-cost and have streamlined functionality.

Clinical Significance

Flow-cytometry provides critical diagnostic, measurement, and research applications across many health and biological disciplines. Its use in the detection of blood-cancers, HIV/AIDS, cell differentiation, and viral detection is unique and unparalleled.

Despite flow-cytometry's vast array of applications, its use is limited by expense. In addition, flow-cytometry's high costs create a barrier to its implementation in developing nations. Therefore in order for the dissemination of flow-cytometry's critical applications, especially to that of the developing world, a new, low-cost, model must be developed.

Results

The prototype flow cytometry machine allows for the counting of individual cells as well as detection of a fluorophore marked epitope. 3D printed casing with attachment of microscope objective, longpass filter, and LED circuitry create a portable and modular device. Figure 3 shows imaging of bead flow through μchannels; emulating detection of HIV/AIDS via CD4 positive lymphocytes.

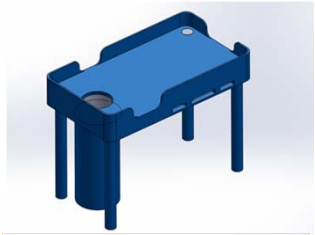

Figure 1. SolidWorks representation of 3D printed casing

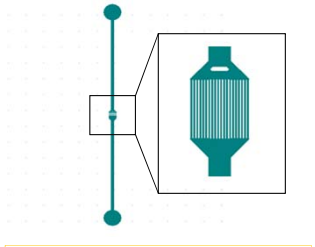

Figure 2. Diagram of flow cell negative for mask aligner.

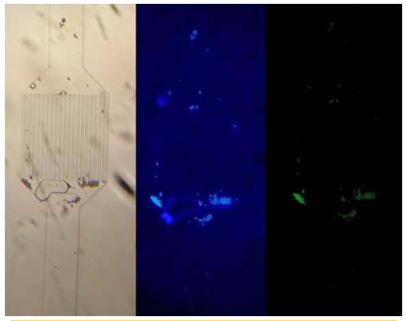

Figure 3. μchannel with μbead flow. Unfiltered white light (Left), 435nm LED (Center), Filtered 435nm LED (Right)

Methods

1. Microfabrication of silicon wafer with μchannel
   Spun with su-8 2010 and exposed for 3 minutes under mask aligner
2. PDMS μchannel plasma etched onto glass slide
   Plasma etched for 2 minutes at 100mV and .150 torr
3. Tubing attached via bore holes at ends
   Hand-drilled with 0.0292in drill bit
4. Syringe driven flow of PBS solution containing μbeads
   460/500nm beads as pos. control, 305/380nm beads as neg. control
5. Images captured via Galaxy s5 in custom 3D printed case
   495nm longpass filter, 25X objective, and 10X eyepiece attached

Future Considerations

1. Redesign of μchannel baffle to prevent aggregation of μbeads along flow cell perimeter.
2. Implementation of non-manual flow system
3. Creation of automated cell counting/detection programming

Acknowledgement

We would like to thank our advisor, Dr. Christopher A. Lemmon, graduate students Jiten Narang, Lauren Griggs, Tyler Ferro, as well as professors Dr. Hooman V. Tafreshi, Dr. Paul A. Wetzel, and Dr. Russell D. Jamison for all their help.