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Integration of Different Materials on a Spiral Channel Design to Optimize Microfluidic Sperm Sorting

Jesse Griffin (Dr. Bruce Gale)
Department of Bioengineering

Introduction:

A microfluidic spiral channel pumped with any liquid can be used to separate particles by size. As the liquid moves through the device, at higher flow rates, it is observed that particles in the channel are clearly separated and easier to identify. This separation is produced by Dean flow caused by the curvature of the device. At high flow rates, the Dean flow can separate different sized particles between the outer and inner walls of the mechanism. Better separation requires higher flow rates, which requires higher pressure. The required pressures can become very high and the polymers currently used in these devices do not handle these pressures well. Thus, a new device design with higher strength materials is required. In addition, the device needs to be cost effective.

The importance of this research is to develop a device that can separate sperm cells from red blood cells, white blood cells, and other contamination so it can speed up the process it takes to examine samples through a microscope. Fabrication of a better device would help obtain sperm cells later used for in vitro fertilization or intrauterine injection.

Methods:

In testing the PDMS device, I would first have to develop and fabricate the PDMS mold to put on the slide. Once the device was made, a syringe pump was used to measure the maximum flow rate until failure. By increasing by increments of 0.01 mL/m every 10 seconds, I continued until the device would leak or break. Since two ports of entry are on each device, the flow rate was reported as double.

For testing the polycarbonate serpentine device, I would use a microscope to inspect impurities or mistakes made in the fabrication process. Then proceed to do 0.25 mL/m increments until failure.

Results:

In reviewing the data, the polycarbonate serpentine device was proven to withstand higher flow rates. Although the design is less desirable due to rough channel edges, certain aspects of the design were sturdier and more difficult to break. The PDMS device lacked in the fact that the ports were easily pushed out from the higher pressures.

Slight improvements in manufacturing the devices were found to be affective. By increasing sterility and processes within both devices, higher percentages of successful devices and flow rate containment were achieved.

Conclusion:

In conclusion, the devices made from polycarbonate sheets and serpentine design tolerated higher flow rates than the devices made out of PDMS. Furthermore, the ports of the polycarbonate devices are stronger thus allowing for faster flow rates to enter the device.

To improve the PDMS design, the tubing ports should be glued or made stronger to withstand the immense flow rates demanded for separation.

A hybrid device with polycarbonate material and a spiral channel design would be advantageous for further research.

References:

1. Carlo, Dino Di, Jon F. Edd, Katherine J. Humphry, Howard A. Stone, and Mehmet Toner. "Particle Segregation and Dynamics in Confined Flows." Physical Review Letters. American Physical Society, 03 Mar. 2009. Web. 27 June 2017.

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