CALIFORNIA STATE SCIENCE FAIR
2015 PROJECT SUMMARY

Name(s)

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Project Number

35589

Project Title

A Novel Spiral Microchannel Device for Urinalysis

Abstract

Objectives/Goals

The 1st objective is to establish a clear connection between the theory of dean vortices and effective particle separation in spiral microfluidic channels. My 2nd objective is to develop a spiral microchannel to separate urine sediment particles based on their inertial characteristics followed by urine morphology analysis. The particle separation efficiency will be determined and compared with the previous microfilter device I developed last year.

Methods/Materials

The spiral microchannel device (1 mm wide and 50 micron deep) was designed using AutoCAD software and fabricated in Polydimethylsiloxane using soft lithography. An equation explaining this particle separation principle was developed using Dean#s number. Real human urine samples were tested using the spiral channel. Urine was pumped through the spiral microchannel at 125 microliter/sec using a syringe pump. The device was imaged under a microscope. On-chip morphology analysis and particle counting were performed to determine particle separation efficiency.

Results

The spiral microchannels were successfully fabricated and tested. The results showed the devices sorted and separated urine particles by size and mass difference. Large particles such as epithelial cells flowed in equilibrium positions near the outside wall while small particle such as blood cells and crystal fragments took paths toward the inner walls. The spiral design created distinguishing flow patterns among similar-sized particles. These sized-grouped particles are eventually separated at downstream junctions and placed into corresponding tangent branch microchannel outlets. A separation efficiency of 92% was achieved. Following on-chip separation, the urine particles including blood cells, cast, crystal, Epithelial Cells, yeast, etc, were identified.

Conclusions/Discussion

I have successfully developed a spiral microchannel to separate different sizes of urine particles utilizing dean vortices and inertial separation principle. This device addresses the channel clogging issues that the microfilter device I developed last year encountered and significantly improves the separation efficiency. It combines both functions of a traditional centrifuge and microscopic examination into one single lab-on-a-chip device for urinalysis and could potentially revolutionize the field of urinalysis.

Summary Statement

My project is about the development of a novel spiral microchannel device for effective urine particle separation followed by particle morphology analysis.

Help Received

Used Prof. Abe Lee's lab equipment at University of California, Irvine. Dr. Robin Liu mentored me and gave me advice on the project.