Design and fabrication of a microfluidic circuit for the separation of micron sized particles

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AIM

To develop a microfluidic circuit to sort particles and to optimise the manufacturing of micron sized particles for this applications.

INTRODUCTION

The separation of micro particles based on size/density is important in many research fields[1]. Approaches include, the use of filters which are prone to complications such as limits in pore sizes and clogging. Other approaches have included using electrical, magnetic and optical methods to achieve separation[2]. Recently the use of centrifugal force and laminar flow to drive movement and achieve sorting have been investigated[3]. To test the micro-fluidic circuits we aimed to produce standardized particles of 1, 5, 10 and 20 µm in diameter and colour code according to size.

METHODS

Particle Manufacture

Particles used in this experiment are routinely manufactured in the lab with an average particle size of 6 µm. All particles were prepared using a two-emulsion system.

The 6µm particles were prepared by dissolving 50 µl of nonoxynol 4 in 5 ml mineral oil. The water phase, consisted of either, 200 µl of a 10% polyethyleneimine solution (adjusted to pH 9.0 with HCl) or 200 µl of 20% glutaraldehyde (grade II), added to the oil phase and emulsified using a vortex at maximum speed for 10 seconds. The two emulsions were combined and mixed for 1hour using the Intelli-mixer at a speed of 60 rpm.

The 13 µm sized particles were manufactured using as similar technique. The two emulsions were prepared by dissolving 75 µl of Span 20 in 5 ml mineral oil. The water phase remained the same as aforementioned. A magnetic stirrer at 500 rpm for 15 sec was used to emulsify the two phases. The emulsions were combined and mixed for 1 hour using an Intelli-mixer at a speed of 60 rpm.

The 20 µm sized particles were manufactured using the same procedure as the 13 µm particles except that 50 µl of Span was used.

All particles were recovered by centrifugation at 3000xg for 5 minutes and washed with 6x 50 ml volumes of MilliQ water. The particles were subsequently stained with dyes using a procedure adapted from Compton et al. (2002)[4].

Circuit Fabrication

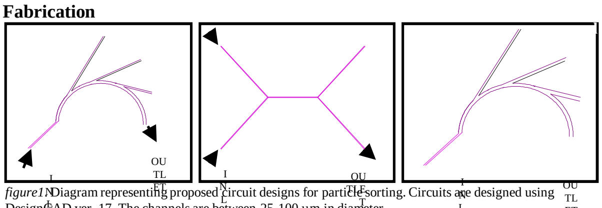

figure1. Diagram representing proposed circuit designs for particle sorting. Circuits are designed using DesignCAD ver. 17. The channels are between 25-100 µm in diameter.

A master is fabricated using mechanical or laser based micro machining. The polymer polydimethylsiloxane made up to a ratio of 10:1 elastomer and curing agent are poured onto the master and cured at 60 °C for 1 hour[5]. The resulting channel circuit is then irreversibly sealed with a piece of glass using a plasma cleaner.

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RESULTS AND DISCUSSION

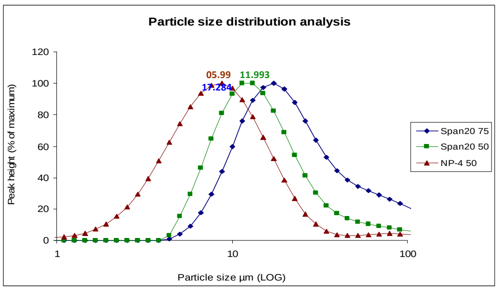

figure 2. Graph showing the different particle sizes manufactured using the modified methods. The particles peak at 5.99, 11.993, 17.284 for NP4 and Span respectively.

Particles that are different can be easily produced by varying certain parameters. Figure 2 shows distinct particle size difference when different manufacturing techniques were used in this case the detergent concentration was varied as well as detergent type.

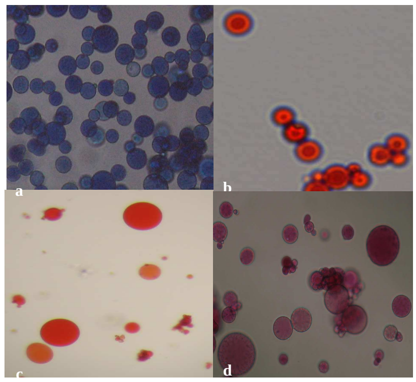

figure 3. Microscope images of stained particles using dyes (a) RBBR, (b) Congo red (c) Brilliant yellow (d) Acid violet.

The dyed particles will enable easy visualisation of the separated particles from the microfluidic circuits. Figure 3 a, b ,c and d are the dyed particles that were tested which included RBBR, Congo red, Brilliant yellow and Acid violet. UV-VIS absorption is being investigated to provide a more quantitative assessment of particle separation.

CONCLUSION

Three distinct particle sizes were manufactured 6, 13 and 20 µm diameter. The particles can be stained in order to differentiate between the different sizes. This will enable quantitative analysis of the performance of the microfluidic circuit without the use of laborious particle counting techniques.

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