1 Popular scientific summary

Microfluidics is a field that, as the name states, deals with fluids on the scale of micrometers. Lund university is performing cutting-edge research in the field and companies using the research are starting to emerge. A past example that the research has led to is the inkjet printer that deals with small volumes of ink that are disposed on a paper.

In this thesis I have experimented with two everyday types of fluids, water and oil, for the purpose of medical technology. The two fluids do not mix, which we can see in a salad dressing at the dinner table. The oil ends up on top of the water, in a layer or in smaller drops. Exciting videos showing and experimenting with this can easily be found on youtube for the one who likes the visual effects. The fact that they do not mix is in this project used to make controllable drops of water inside an oil, the size about half a millimetre (these small drops are also called droplets).

A setup to produce the droplets is a so-called micro channel that is constructed using similar techniques as integrated circuits. An example of a structure producing droplets can be seen below. The oil enters from the sides and pinches of small droplets off water.

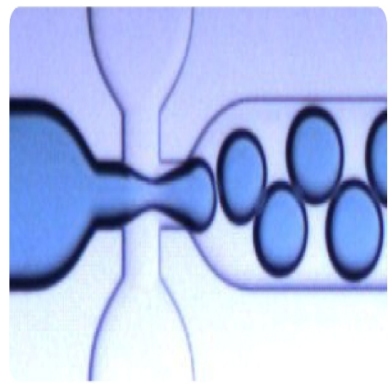

Figure 1.1: A construction used to generate small droplets of water. The oil coming from the sides pinches off the droplets. (Image taken from: http://www.dolomite-microfluidics.com/)

Just like we humans can feel when we feel like we are living inside a bubble, a drop of water can be its own protected environment. Making controlled experiments with cells inside droplets can be beneficial in medical research and diagnostics since these are not disturbed from outside influences. In this project I used test particles that substitutes the cells but were of the same size. These particles were trapped inside the water droplets.

Finally ultrasound is used to manipulate these particles, since small particles have been proven to be affected by sound. A frequency generator that supplies a voltage variation is attached to a piezomaterial. This piezomaterial vibrates mechanically when a voltage variation is applied. With a quickly switching voltage it gives high frequency vibrations. The pressure variations from these is the ultrasound. The frequency of this sound is set so that half a wavelength matches the channel width. This gives a standing wave phenomenon over the width of the channel that will continuously affect the particles.

The idea is to focus the particles tightly into the centre of a droplet and after doing so, to cut the droplet into smaller drops keeping the particles in only one of them. By cutting it into pieces the middle one of the smaller drops will increase its concentration of particles while the concentration in the others will decrease.

The final goal was never reached since there were other strong forces working on the particles inside a drop and a splitting of a droplet the size of a millimetre is not that easy. The results of the thesis show that in a droplet the size of a few millimetres it is possible to focus the particles but that the cutting of the droplet needs to be edged!