Light responsive structures for on-demand mixing in microfluidics

Student project assignment

Introduction

Microfluidics allow the manipulation of fluids in channels with a dimension less than a millimeter. On this small scale, the Reynolds number often is in the order of 1. Therefore fluid streams are behaving laminar, resulting in unmixed liquids even after long distances and times inside the device. For many applications, this is desired as it allows complex manipulation of flows e.g. precise forming of micro droplets using two immiscible liquids. Nevertheless, in some situations e.g. reactions in microfluidics, mixing is highly desired.¹

Project

Passive mixers (Fig. 1 and 2)² will be used, as they do not require sophisticated external triggers. Passive mixers often are a surface structure that stretches and folds the two streams together. These structures will be made switchable using hydrogel based materials. Hydrogels are capable of switching from a swollen to a shrunken state upon increasing the temperature. However, to do so a heater is required, making the microfluidic device more complex. Our desire is to reduce the costs of mixers using light responsive materials.

In this project, a light-responsive hydrogel will be deposited in a microchannel, allowing activation and deactivation of the hydrogel using cheap LEDs. The microchannel will be composed of two PMMA substrates. The bottom channel contains the negative shape of the mixer and will be filled with the hydrogel material. The top will be a straight channel with the inlet and outlet.

The main goal of this project is the formation and measurements on microchannels created using an excimer laser. A method to form ratchet like structures and grooves in PMMA using an excimer laser needs to be developed (Figure 2A).

![Fig. 1 slanted groove micro mixer. A) schematic 3d depiction of the channel with the flow lines showing the motion of the flow. B) 2d depiction of the channel showing the various stages of mixing as depicted in C).²](image)

![Fig. 2 A) example of a structured surface containing ratchets, made by ablation with an excimer laser. B) The non-activated hydrogel filmed causing the non-mixing state. C) the swollen state of the hydrogel for improved mixing in microfluidics.](image)