Active microfluidic mixing using magnetic artificial cilia

Master student project assignment

Introduction

Microfluidics is the science and technology of systems that manipulate fluids at small scales (typically from $10^{-4}$ to $10^{-8}$ liters) for applications such as chemical synthesis and biological analysis [1]. In microfluidic systems, mixing flow is a paramount function. However, it is very challenging to create efficient mixing flows due to the difficulty to create turbulent flows, and the low efficiency of diffusion. Therefore, it is of high importance to develop feasible methods to create efficient mixing flows in microfluidic devices.

In recent years, researchers have proposed a number of micro-mixer concepts. A detailed overview of most of these concepts can be found in the review article made by Nguyen & Wu [2]. Besides these methods, den Toonder et al. [3] proposed the use of electrostatic artificial cilia to obtain active microfluidic mixing flows. This method was demonstrated to be efficient and versatile, outperforming most of the aforementioned concepts. However the need of electric field makes this method incompatible with most microfluidic related applications.

Project

Here we propose the use of magnetic artificial cilia (MAC) to create efficient mixing flows in microfluidic systems. Previously we successfully created MAC with good magnetic properties and actuation capability, which can generate substantial transportation flows in microfluidic devices (Fig. 1-3).

Based on this pioneering work, we aim to improve the properties of the MAC further by tuning the parameters such as the composition of precursor material, the inter-cilium distance, etc. Afterwards, the MAC’s capability of generating mixing flow will be studied by integrating them into a Y-shaped microfluidic device and actuating them in different ways, while performing particle tracking experiments.

The final aim is to obtain MAC which can be employed to create efficient micro-mixing in microfluidic systems.

References


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