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Numerical Study of a Novel Micromixer with Obstructions

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Abstract
Micromixer is a principal part in microfluidic systems which deal with more than one fluid. Because of the low Reynolds number nature of the fluid flow within the microchannels, it is important to improve the quality of mixing by utilizing novel methods. Passive structures have been widely used in micromixers, because of their high efficiency, uncomplicated design, and easy fabrication. In this paper, a novel obstruction unit was proposed and efficiency of the micromixer was studied by using FEM-based software COMSOL 5.1. The numerical results demonstrate a significant improvement in comparison to the efficiency of the straight micromixers. This novel obstruction unit can be used in bio-applications in order to improve the mixing efficiency.

Keywords: Microfluidics, Passive Micromixers, Biomechanics, COMSOL, CFD

Introduction

Microfluidics has been widely used in biomedical applications. Rapid and high quality mixing is a crucial step in many of the systems which deal with more than one fluid such as lab-on-a-chip (LOC). In microfluidic systems, due to the absence of turbulence, mixing procedure is restricted to molecular diffusion and as the result, mixing is slow and needs significant amount of length and time for a proper result. Micromixers are used to overcome these problems [1, 2].

Micromixers can be classified into two main categories: active and passive [3]. Active micromixers utilize external energy source or stimuli such as ultrasonic vibration. In the passive type of micromixer, mixing is achieved by various design of geometry including T flow design and flow obstructions within channels. Obstacles increase the interfacial area and reduce the diffusion path which improves the homogeneity of mixtures. Passive micromixers enjoy simple design, easiness of fabrication, and appropriate integration into bio-microsystems. As a results of these numerous advantages, passive micromixers are used in most of the bio-microfluidic systems, rather than active micromixers [3-5].

In this paper, a novel planar passive micromixer with obstruction was proposed and the efficiency of this micromixer was studied by using the Finite Element Method based software COMSOL Multiphysics 5.1.

Design of the obstruction unit

Figure 1 illustrates the schematic diagram of one mixing unit. Each mixing unit comprises two baffles as well as two grooves. At the first step, species flow into the main mixing channel. As the fluid course through the first baffle, the fluid is divided as two separate streams. Then, these two streams recombinant as they collide to each other. When the stream flows to the groove, they are concentrated due to the smaller cross sectional area.

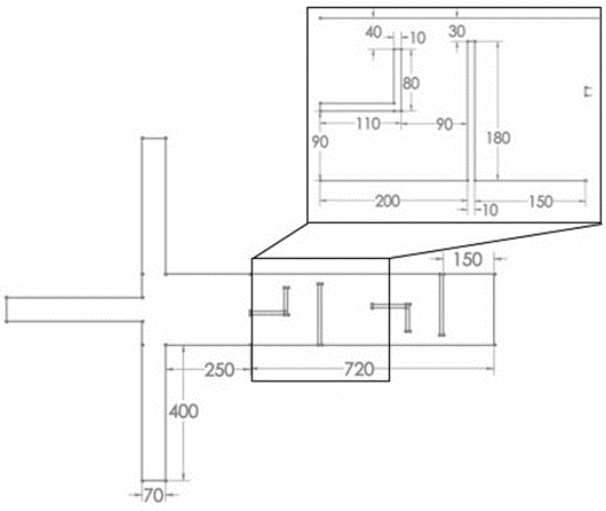

Figure. 1. Schematic diagram of a unit of the novel micromixer with obstructions.