Project Title: Design and develop hybrid passive- and active microfluidic control, mixing and testing setup to be used in Lab-on-a-chip devices.

Supervisor's Name:

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Co-Supervisor(s): *(if already known)*

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2. **Dr. Nabeel Al-Rawahi**

Sources of Fund: *(if any)*

Presently no funding for this project, Department lab facility will be used. A proposal on this topic is in the process for funding.

Research Field(s): Thermofluids (computational fluid modeling)

Summary and Problem Statement:

The advancement of micro- and nano-fabrication processes has provided great impetus to the development of MEMS (Microelectromechanical systems), LoC (lab on a chip), and μ-TAS (Micro Total Analysis System) based devices. The microfluidic control and mixing phenomena have contributed significantly to designing these devices for various applications including drug delivery, medical diagnosis, medicine development, and chemical reaction (Lee et al., 2011; Lee et al., 2016). The flow in microfluidic devices can be effectively controlled and mixing can be enhanced by introducing external interference in the flow (Hessel et al., 2005). The induction of flow disturbance through externally introduced electric field (Dutta et al. 2002; Cho et al. 2012; Yu et al. 2012), ultrasonic (Yang et al. 2000; Doinikov et al. 2018), random (DUPLAT and VILLERMAUX, 2008) or periodic (Truesdell et al. 2005; Li and Kim 2017) vibrations can greatly enhance flow control and chaotic advection.

This research proposal is targeted the development of microfluidic control and mixing models and conducting supporting fabrication and experimental analysis to validate proposed models. The proposal is aimed to develop hybrid designs of microfluidic control and mixing that consist of both passive and active control methods to synergize the performance of the system (Husain et al., 2018). A three-dimensional numerical model used to predict fluid flow behaviour in microfluidic devices will be used to model active control of fluid flow and mixing with the help of electrokinetic equations and wall zeta potential and user-defined functions. The advective chaos can be generated and controlled through proper patterning of wall zeta potential under the controlled electric potential applied across the channel, which can be utilized to model the microfluidic control process.

Keywords: Microfluidics, micromixing, active and passive flow control, electroosmotic flow, Numerical modeling,

Objectives:

The main aim of the proposed research is the development of numerical and experimental models for microfluidic control and performance enhancement through a hybrid technique of passive and active flow control strategies. Further, the realization of the proposed models by fabricating and conducting experimental analysis, validation and optimization of the proposed model are the main objectives of this project.

Tentative Methods of Approach:

Numerical Modeling, fabrication and experimental analysis.

Required backgrounds and skills

Backgrounds:

Fluid mechanics, Numerical methods, Dynamics and control

Computing Skills:

Pre-knowledge of ANSYS can greatly help

Other requirements:

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