ME Seminar

Modeling in Microfluidic Applications: Electrokinetics, Biofluid Dynamics, Droplet Spreading

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ABSTRACT

In this seminar, we will focus on the modeling of three major microfluidic applications.

Polyelectrolyte layer aided electroosmotic mixing: Polyelectrolyte layers (PELs) due to their various intrinsic parameters offer a wider flow-controllability and thus can improve mixing in microfluidic devices. We propose two ways of use of such PELs for efficient mixing: (i) continuous grafting in rotating channels, and (ii) patterned grafting in regular channels. The dumbbell shaped vortices and the Lamb vortices occurring respectively in these proposed applications play a pivotal role in the enhancement of mixing. The formation of these vortices, effect of different parameters on them and the outcome due to their occurrences in the respective problems will be discussed in the presentation.

Cellular gas transport through dynamic shapes of RBCs: Red blood cells during their motion through arterioles exhibit dynamic shapes such as slipper, croissant and tank-treading. In this work, we use the in-house developed boundary integral method (BIM) code to get the dynamic shapes of RBCs and finite-volume method (FVM) code to solve the species transport equation with reactions for gases. The theory of dynamic shapes, problems in numerical modeling and their solution, and the current outcomes of the research will be discussed in the presentation.

Droplet spreading on patterned SHPB and SHPL surfaces: In vapor chambers, for proper re-circulation of the coolant, the directional transport of condensed droplet is very essential. In the present study, we use the SHPB and SHPL patterned surface to obtain such directional transport. However, finding the optimal shape of the SHPL patches is a challenge. In the presentation, we will discuss for this problem the solution of using COMSOL's phase-field theory simulations and the simulations of surface mesh deformation using energy minimization techniques.

ABOUT THE SPEAKER

Harshad is an Alexander von Humboldt postdoctoral fellow at the University of Bayreuth, Germany. He earned his BTech degree in mechanical engineering from Savitribai Phule Pune University, MTech in mechanical engineering from Indian Institute of Technology (IIT) Guwahati, and PhD in fluids and thermal engineering from IIT Guwahati. His research is in microfluidics, electroosmotic flow aided micromixing, droplet spreading dynamics and computational biofluid dynamics. Currently in Bayreuth, he is working on 3D finite volume method on unstructured mesh for studying the transport of Oxygen and other cellular gases through dynamic shapes of RBC in arteriole sized channels. His previous postdoc was in University of Illinois at Chicago and Argonne National Laboratory where he worked on computational modeling of droplet spreading dynamics on patterned super-hydrophobic and super-hydrophilic surfaces. In his PhD, he focused on important microscale applications where the enhanced electroosmotic and streaming potential due to the polyelectrolyte layers grafted on the walls of the microchannel plays an important role.

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