6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

LIFT FORCES CHANGE CELL TRAJECTORIES IN MICROFLUIDIC SEPARATION DEVICES

Rohan Vernekar[1]*, Kerwin Kwek Zeming[2], Vivek Shrestha[1], Jongyoon Han[2,3] and Timm Krüger[1]

[1] School of Engineering, University of Edinburgh, King's Buildings, Edinburgh, EH9 3JL,
*R.Vernekar@ed.ac.uk
[2] Singapore-MIT Alliance for Research and Technology, Singapore
[3] Massachusetts Institute of Technology, Cambridge, USA

Keywords: *microfluidics, particle separation, red blood cells, lattice Boltzmann, immersed boundary method*

Red blood cell (RBC) membrane deformability is an important bio-marker for the detection of diseases such as malaria. Malarial infection causes an increase in the rigidity of the infected RBCs and, deformability-sensitive cell separation devices can prove important for disease diagnosis.

Deterministic lateral displacement (DLD) is a microfluidic device popular for size-based bio-particle separation [1]. DLD consists of micro-obstacles in a microfluidic channel. DLD separation principle relies solely on particle-obstacle collisions, with larger particles 'bumped' by the obstacles on an inclined trajectory to the average fluid flow, eventually leading to size-based separation. The DLD principle works well for rigid particles, however behaviour of deformable, non-spherical particles such as RBCs is not well understood.

Previous deformability-based RBC separation attempts in DLD devices have relied on the fact that deformed RBCs appear smaller in cross section [2]. This necessitates limiting the microfluidic device depth to restrict RBC rotation. The pitfall of such shallow microfluidic devices is increased fluidic resistance, which significantly decreases the throughput.

We change DLD obstacle geometry and induce hydrodynamic lift forces without restricting the device depth. Using simulations and experiments, we test the dynamics of both 'soft' and 'rigid' RBCs in our DLD devices. Significant hydrodynamic lift is generated as the RBCs interact with the modified obstacles. This lift varies depending on RBC membrane deformability. Thus, in addition to particle-obstacle collisions, hydrodynamic lift is shown to alter the RBC trajectories based on their membrane stiffness.

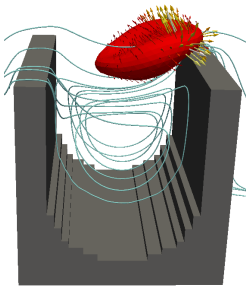

Figure 1: RBC forces in DLD

References

[1] J. McGrath, M. Jimenez, H. Bridle, *Lab on a Chip* **2014**, *14*, 4139–4158.
[2] T. Krüger, D. Holmes, P. V. Coveney, *Biomicrofluidics* **2014**, *8*, 054114.