15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-190

EFFECT OF BIOFLUID RHEOLOGY AND WETTABILITY ON DROPLET DYNAMICS IN LAB-ON-CHIP SYSTEMS FOR CANCER DIAGNOSTICS

Frederico Jacinto, Ana Moita, Antonio Moreira

IN+ Instituto Superior Tecnico, Universidade de Lisboa, Portugal
fredjacinto@hotmail.com, anamoita@dem.ist.utl.pt, aluismoreira@tecnico.ulisboa.pt

Keywords: Lab-on-chip, biofluids, droplet dynamics, rheology, cell stiffness, wettability, image post-processing

Summary: Innovative diagnostic tools are vital for early and prompt identification of many diseases. In this context, the fast development of microfluidics opened a wide range of possibilities to explore as diagnostic tools, the so-called lab-on-chips. Change in cell stiffness is a new characteristic of cancer cells and different types of cancer cells depict similar stiffness e.g. [1]. Detailed research on cell deformation is therefore proposed in more recent literature to play a vital role in the identification of label free biomarkers towards the early diagnostics of malignancy in lab-on-chip systems.
This paper addresses the test and design of a lab-on-a-chip system, for cancer diagnostics, based on the analysis of droplet dynamics of sample biofluids, which is affected by the deformability ratio of the cells. This in turn is expected to be correlated to different stages of malignancy.
The design of the lab-on-chip promoting an efficient transport of the biofluid droplet is strongly dependent on the wetting and rheological properties of the biosamples, which affect droplet flow and dynamics. An experimental approach is followed to infer on the basic chip configuration, allowing its best performance, to handle the biosamples, using electrostatic actuation. This performance is evaluated based on high-speed visualization and image post-processing to characterize droplet dynamics, quantifying the spreading/receding diameters, the dynamic contact angles and the contact line velocities. Droplet dynamics is then modelled and simulated in COMSOL Multiphysics 4.3b. The numerical results are confronted with the experimental data. Once the model is validated, preliminary results are then presented and discussed, as the rheological properties of the biofluid droplets are changed, following the rheological models as e.g. [2], to relate at a primary level, the biofluid rheology with different ratios of cell deformability and cell stiffness.

References

[1] Cross, S.E., Jin, Y.-S, Rao, J., Gimzewski, J.K. (2005) Nanomechanical analysis of cells from cancer patients. Nature Nanotechnology Letters, 2, pp. 780-783.
[2] Gosset, G.R., Tse, H.T.K., Lee, S.A., Ying, Y., Lidgren, A.G., Yang, O.O., Rao, J., Clark, A.T., Di Carlo, D. (2010) Hydrodynamic stretching of single cells for large population mechanical phenotyping, PNAS, 109(20), pp. 7630-7635.