Integrated Microfluidic Devices for the Digitization of Microfluidics

Fig. 1. Digitization of microfluidics.

Graduation/internship project | in collaboration with Holst

Introduction | Digitization of Microfluidics

People are getting older and older, resulting in higher prevalence of age-related diseases. Cell-culturing, automated immunoassay and Organ-on-Chip modalities drive our understanding of underlying microbiological processes, the development of new medical diagnostics in lab-on-a-chip environments, as well as new drugs and cures for these (chronic) medical diseases. Microfluidic devices are increasingly employed in this domain, where automated manipulation of microfluidic flow, either continuous or droplet-based, as well as additional sensor integration for continuous monitoring are of high interest and envisioned to drive the digitization of microfluidics [1]. Integrated technology will need to be developed to realize functional devices combining knowledge and know-how from the microfluidics as well as the electronics application domains [2]. TU/e and TNO / Holst Centre together want to develop a thin-film technology toolbox for the realization of integrated microfluids for abovementioned applications.

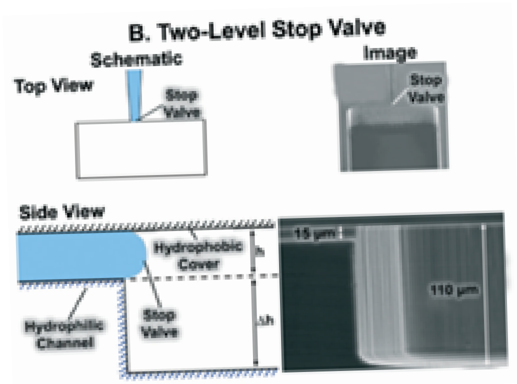

Fig. 2. Microscopy images demonstrating initial electrostatic capillary valve realization with large-area thin film technology.

Project | Electrostatic Capillary Valves

One of the building blocks for such toolbox is active valving of fluids. In the current specific case, we aim to valve capillary fluid flow using so-called electrostatic capillary valves. These valves operate but stopping capillary fluid flow and using a burst voltage signal to enable fluid flow again. Low voltage operation is needed to render expensive driving electronics obsolete and drive down cost and power consumption of these types of valves.

To realize low-voltage operation, various tasks are foreseen. Model simulations (COMSOL or other software package) of fluid flow and valve geometries are foreseen to understand the influence of geometry on the burst voltage needed, while considering the manufacturability of the geometries. Next, specific proof-of-concept valve geometries will need to be realized (using thin film technology at TNO / Holst Centre) which will be characterized to validate model predictions.

Fig. 3. Capillary stop valve geometry.

Goal | milestones and achievements

- Simulation of valve geometries and burst voltages
- Realization of specific valve geometries
- Valve characterization and model validation

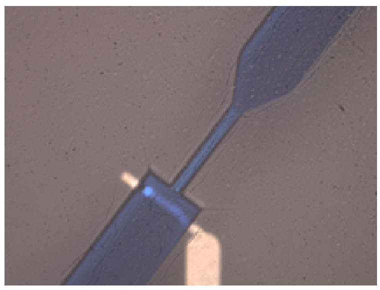

Fig. 4. Microscope image of initial electrostatic capillary valves.

References

[1] J. Li, C-.J. Kim. Current commercialization status of electrowetting-on-dielectric (EWOD) digital microfluidics. Lab Chip 2020, 20, 1705-1712.
[2] D. Dopsa, A.J. Kronemeijer, G.G. Gelinck. Integrating Electronics in Organ on Chip: can Adoption be Accelerated? Holst Centre Whitepaper, available from: https://www.holstcentre.com/news---press/2020/integrating-electronics-in-organ-on-chip/

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