Microfluidic Sample Extraction Device with an Integrated Pressure Measurement

J. Varfolomeeva *, C. Müller *, L. Riegger * *, H. Reinecke*

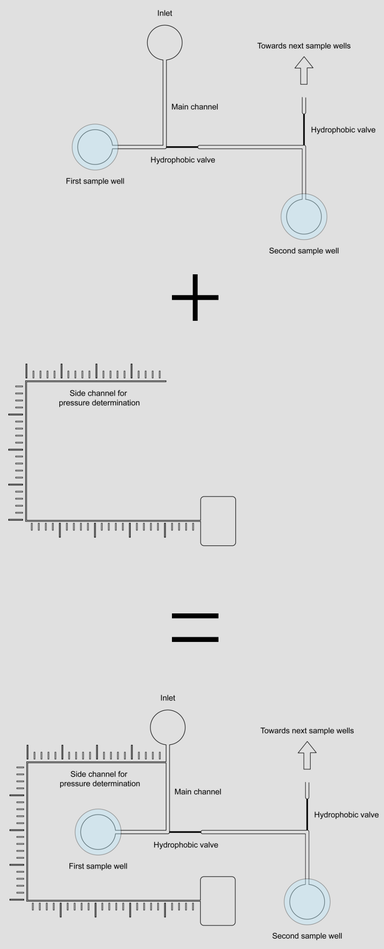
*Laboratory for Process Technology, Department of Microsystems Engineering - IMTEK, University of Freiburg, Germany
** Laboratory for MEMS Applications, Department of Microsystems Engineering - IMTEK, University of Freiburg, Germany

Introduction

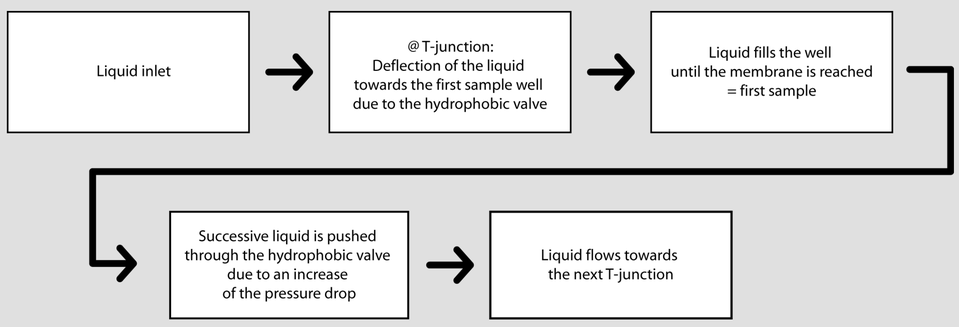
Bioanalytical applications, like the monitoring of metabolic processes, often require a continuous sample extraction. In this work we describe a microfluidic device which is able to subsequently extract samples in microliter range out of a continuous sample stream and provides an optional integrated channel for the measurement of the fluid pressure.

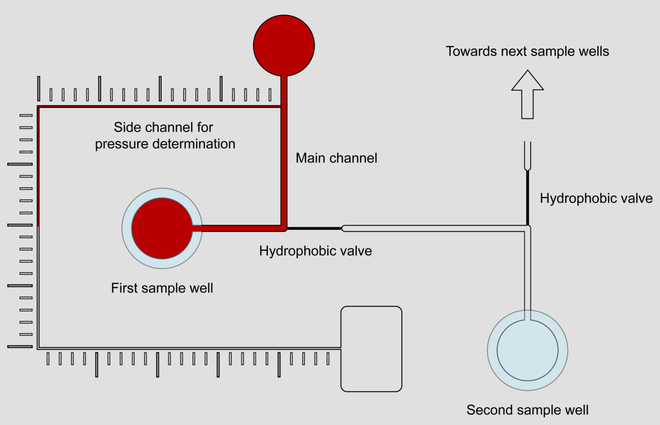
Design

- Modular structure
- T-junctions
- Sample wells, coated with a semipermeable membrane:
  - Venting function
  - Fluid reservation
- Restriction, coated with Teflon CB:
  - Contact angle on PMMA: >120°
  - Enhancement of the capillary valve effect (“hydrophobic valve”)
- Optional side channel:
  - Determination of e.g. valve burst pressure through the method of air compression



Functional Principle



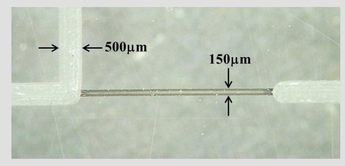


In the case of the integrated pressure measurement, a certain amount of liquid is also pushed into the side channel due to the compressibility of air and can be converted in a pressure value.

Fabrication

The main steps in the fabrication chain include:

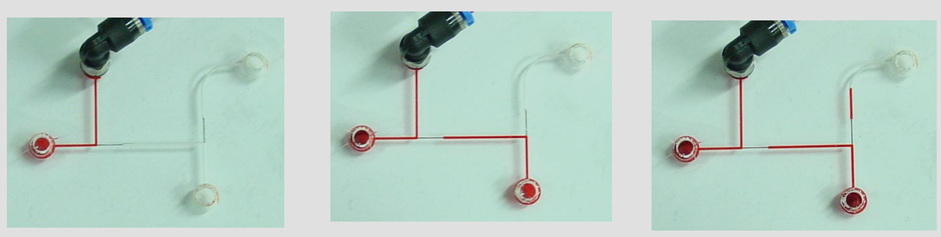
- Milling of the sampling structures
- Coating the restrictions with Teflon CB
- Covering the sample wells with a PTFE-membrane
- Ultrasonic bonding of PMMA



Experimental Results

Characterization of the sampling process:

- Sampling device with three sample wells
- Dyed water as working fluid
- Pressure driven flow
- Flow velocities: 0.1µl/s to 0.5µl/s
- Sample volume: 16µl
- Successful sequential extraction of all samples



For the determination of the valve burst pressure, we integrated the side channel (150µm x 150µm) in the milling step. From the amount of liquid, that was pushed inside the channel before and after the valve burst, the bust pressure could be determined. The mean pressure value was 700Pa, which is in the range of the expected theoretical value.

Conclusions

We have designed and fabricated a sample extraction device, which is able to sequentially extract liquid samples out of a continuous sample stream and in which an optional side channel for pressure measurement can be integrated.

References

[1] Riegger, L.et al. (2009): Teflon-carbon black as new material for the hydrophobic patterning of polymer labs-on-a-chip. In: *Solid-State Sensors, Actuators and Microsystems Conference, 2009. TRANSDUCERS 2009. International*

[2] Grover, William H.; Muhlen, Marcio G. von; Manalis, Scott R. (2008): Teflon films for chemically-inert microfluidic valves and pumps. In: *Lab Chip* 8 (6)

[3] Srivastava, Nimisha; Burns, Mark A. (2007): Microfluidic pressure sensing using trapped air compression. In: *Lab Chip* 7 (5)