

B5: Hydrogel-based microfluidic logic circuits

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Motivation:

Microfluidic systems are used as a platform for novel analytic, diagnostic or synthetic methods with high throughput or are used for the realization of very complex, multi-level protocols. However, these microfluidic circuits are often passive and are controlled externally by pumps and valves which do not scale with the chip. Therefore, at the chair of microsystem are integrable, hydrogel-based switching elements developed for the control of complex microfluidic systems. These switching elements have a transistor like behavior which scale with the chip and are able to perform chemical information processing. The goal is to develop an intrinsically controllable and scalable platform for microfluidic circuits.

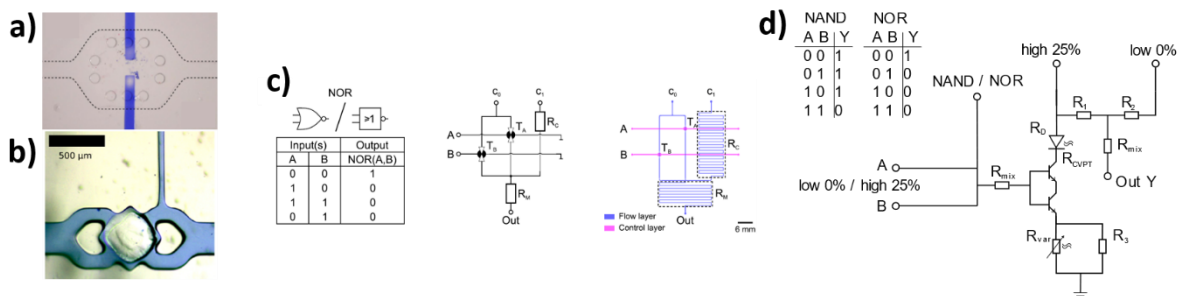


Figure: Chemofluidic circuit. a): membrane-isolated chemofluidic volume phase-transition transistor (MIS-CVPT), b): chemofluidic volume phase-transition transistor (CVPT), c): NOR circuit with MIS-CVPT d): NAND or NOR circuit with CVPT

Current state of the art and own work:

The fabrication processes are developed based on the current lithography and are expanded through a laser-ablation system and a multi-channel 3D polymer printer. In addition with cooperation B6, a multi-layer film technology is available. Two chemofluidic transistor concepts (CVPT and MIS-CVPT) are developed which are characterized through lumped model descriptions (Mehner et al. 2017). Also automated measuring setups for parameter characterization and controls are available. Fundamental complex IC programs (Greiner et al. 2012) as well as first circuits of planar (Paschew, Pini, Häfner et al. 2016, 2018) and membrane-isolated logic (Frank et al. 2017) are demonstrated.

Scientific questions and project goals:

The goal of the project is to design logic circuits based on the previously developed logic concepts. Thereby, known circuits like half-adder, full-adder up to a logic microprocessor are targeted to be realized and be verified on first applications. The microfluidic circuits can be designed and characterized with a microfluidic toolbox implemented in Matlab. The by the realization gained findings are targeted to contribute to the microfluidic toolbox. Furthermore, the current developed characterization and control setups for the complex logic circuits are to be extended. Additionally, a microfluidic control concept for the multi-reactor chip in cooperation with B6 is to be demonstrated.