B6: 3D highintegration of hydrogel-based microfluidic circuits

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Motivation:

Common microfluidic circuits consist of passive components, for which their control with pumps and valves are ensured externally. With these external controls a scalability of microfluidic circuits is not guaranteed and demands complex lab equipment. Therefore at the chair of microsystems are intrinsically active switching elements researched, which are integrable into microfluidic circuits. These switching elements have a transistor like behavior and allow active control concepts for chemical information processing, which among other things can be used for the control of enzyme cascade reactions in microfluidic reactors (A6) for chemical process engineering.

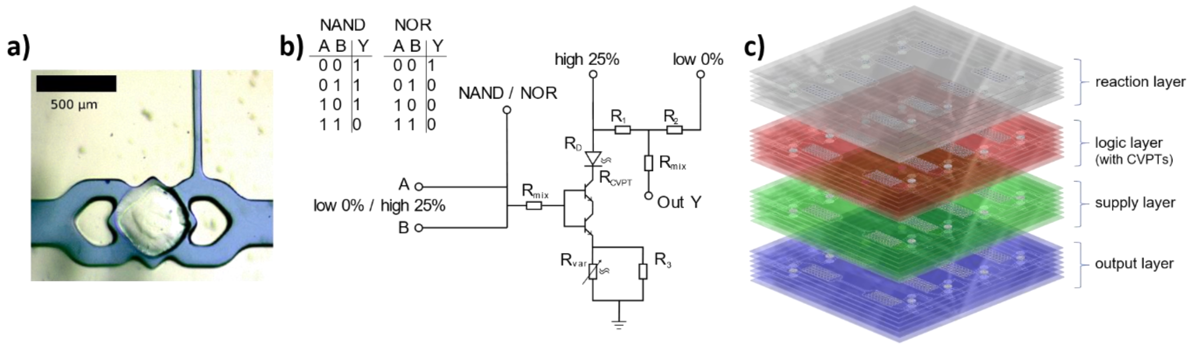

Figure: Chemofluidic circuit. A): Chemofluidic volume phase-transition transistor (CVPT), b): Circuit of the NAND or NOR gates based on a planar CVPTs, c): Microfluidic multi-layer concept for a multi-layer reactor chip.

Current state of the art and own work:

The design, the model description (Mehner et al. 2017) and the characterization of CVPTs are completed. In addition, first circuits are developed for planar logic (Paschew, Pini, Häfner et al. 2016, 2018) and membrane-isolated logic (Frank et al. 2017). Initial applications in the field of microfluidic, enzyme cascade reactors (Simon et al. 2018) are demonstrated. A lithography fabrication process for the circuit is established and expanded to film-based fabrication. With the extension of the laser-ablation system and a multi-channel 3D polymer printer for a sub 50 µm node, a fabrication of complex, active microfluidic circuits is guaranteed.

Scientific questions and project goals:

The aim of the project is the development of a multi-layer, active microfluidic circuits with hydrogel-based chemofluidic transistors. Thereby, the concept is to be integrated for the fabrication with a multi-channel 3D polymer printer and a laser-ablation system as well as establish an efficient control concept. It is targeted to formulate design rules for a robust circuit development and the functionality of the circuit is to be demonstrated. For this, existing setups for characterization and control can be used. The determined parameters for the circuit are to be implemented in the existing lumped models and if necessary expanded. The realization of the logic control circuit takes place in cooperation with project B5.