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Abstract

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The main goal of this work was to develop different disposable Lab-on-Chip (LoC) systems for the application of biotechnological screening e.g. for bioprocess development through microorganisms or drug testing with human cell lines. Nowadays, microfluidics represents a highly promising field for the fabrication of microtools, as the increasing demand for screening data are difficult to meet with current platforms. This is mainly due to time and cost aspects as well as a limited amount of newly developed drugs. The ideal microfluidic platform for biotechnological screening should include three different groups of elements: (i) microbioreactors (MBR) in which cultivation takes place; (ii) auxiliary microfluidic systems (for transportation, filtration or mixing), and (iii) enzymatic biosensors for on-chip analysis of substrate concentrations which are difficult to measure offline due to small available sample volumes. Within the scope of this work, various horizontally and vertically positioned MBR designs (resembling plug flow reactors, micro stir tanks or bubble columns) were developed, fabricated and successfully applied to the screening of different biological expression systems, such as yeast cells (*S. cerevisiae*), fungal spores (*A. ochraceus*) and primary human endothelial cells. Different integrated functional structures based on geometrical, optical or electrical elements allowed for online monitoring of various physical, chemical and biological process parameters during cultivation. In terms of the second group, passive and active microvalves, PZT- and pneumatically actuated micropumps, passive filtration and mixing elements were produced. The third group comprised different types of enzymatic biosensors based on a hybrid detection principle (electrochemical-optical) and on different types of enzymatic responses. In general, the unique LoC setup (patterned element made of poly(dimethylsiloxane) and bonded to a glass substrate) allows an easy integration of systems into one monolithic LoC platform which are usually better suited for technically mature systems. Modular systems are advantageous for prototyping of new microfluidic applications. Therfore, an LoC construction kit was developed that offers a user friendly, standardized modular platform.