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3D-printed microfluidic systems for cell culture and biotechnological applications

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Abstract

The development of microfluidics and “lab-on-a-chip” (LOC) systems offer a tremendous potential for a wide range of applications in biotechnology and bioprocess engineering. There is a constant interest in the use of microfluidic devices for biotechnological applications due to their capability to enable precise and rapid manipulation of cells and other biological samples. The advantages of miniaturized systems include small sample volumes, low reagent consumption, the possibility of systems parallelization and automation as well as a strictly controlled and reproducible environment.

Three-dimensional (3D) printing technologies represent an attractive alternative to conventional micro fabrication techniques due to their great potential for the production of complex structures in high resolution and in a short period of time. Therefore, 3D printing is particularly advancing the development of LOC prototypes. In addition, biocompatible 3D printing materials are emerging that can be used for biological applications (e.g. cell cultivation). Here we present some examples of 3D-printed microfluidic systems that can be directly integrated into bioprocesses. 3D-printed micromixers allow a fast and homogeneous mixing of cells, particles and detergents. Through the integration of 3D-printed spiral separators, a continuous separation of CHO cells is achieved at the end of cultivation. In addition, 3D-printed biosensor systems have been developed for the online detection and monitoring of analytes in cell culture processes. 3D printing and the availability of biocompatible printing materials is facilitating the development of individual LOC prototypes and microbioreactors, which can also further bioprocess development.

Biography

Ina Siller received her M. Sc. in Life Science from the Leibniz University of Hannover (LUH), Germany in 2017. She then joined the research group of Dr. Janina Bahnemann at the Institute of Technical Chemistry at the LUH and spent half a year as a visiting researcher at the California Institute of Technology (Caltech), USA to complete her doctorate. Her research focuses on bioprocess engineering, cell culture, microsystems technology, biosensors and 3D printing.

Publications

1. Publication I: 3D-Printed Flow Cells for Aptamer-Based Impedimetric Detection of E. coli Crooks Strain
2. Publication II: Characterization of a customized 3D-printed cell culture system using clear, translucent acrylate that enables optical online monitoring
3. Publication III: Real-Time Live-Cell Imaging Technology Enables High-Throughput Screening to Verify in Vitro Biocompatibility of 3D Printed Materials
4. Publication IV: 3D Printed Microfluidic Mixers—A Comparative Study on Mixing Unit Performances
5. Publication V: Adenosine receptors regulate gap junction coupling of the human cerebral microvascular endothelial cells hCMEC/D3 by Ca(2+) influx through CNG channels

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