Single-cell dispensing – a solution for a broad range of applications

Dispensing single cells, encapsulated in minimal fluid volume, opens new avenues for single-cell analysis, assembly of well-defined spheroids and organoids and bioprinting of more complex tissues. Pharmacological effectivity studies and toxicological investigations of drug candidates will benefit from minimal dilution effects. Additionally, single-cell dispensing enables progress in innovative technologies from metabolism-studies of single cells to the direct assembly of microstructures in future, 3D-printed organs.

Fraunhofer IMM is highly interested in academic and industrial cooperations with experts in the field of cell dispensing.

We offer our partners:

- a new, high-potential cell isolation and dispensing method
- S2 bio lab, clean rooms for silicon-based MEMS development
- a permanent staff of >100 world-class scientists & engineers

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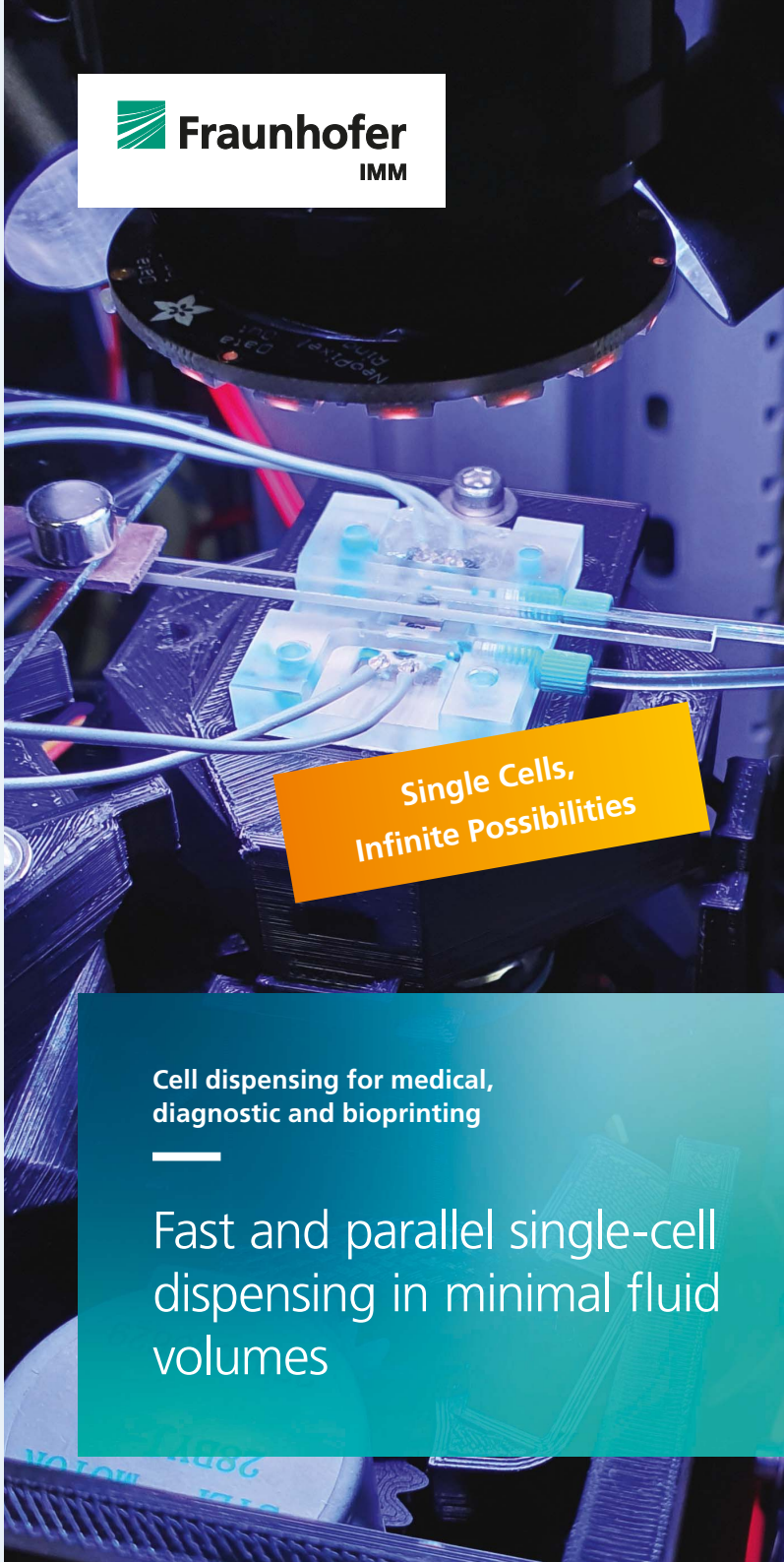
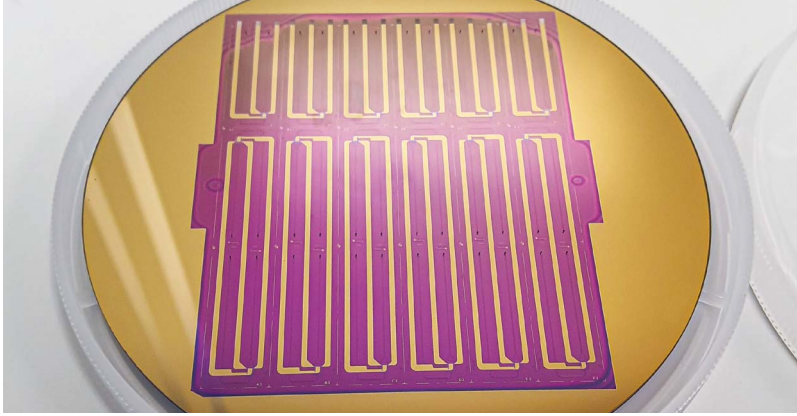


Cell dispensing for medical, diagnostic and bioprinting

Fast and parallel single-cell dispensing in minimal fluid volumes

On-demand single-cell dispensing



The driving requirement for single-cell printing

In Europe alone, around 140,000 people are on the organ transplant waiting list. The need for donor organs is high and the supply cannot meet the demand.

3D-printing of artificial organs is the ambition of a broad community of interdisciplinary experts. Predictions of when the first functional unit of a human organ will be successfully printed and implanted are measured in decades, but big steps are being made. In fact, postage-stamp sized printed skin grafts are undergoing clinical trials.

Currently, the self-assembly of cells into functional units within the printed construct is believed to be a necessary process for more complex artificial organs. This process is hard to control and requires time. A rapid method for the direct assembly of the functional units, cell-by-cell, layer-by-layer could become a key enabler for the time-constrained process of tissue and organ printing.

The Fraunhofer IMM „ORCA“ solution

For the printing of organs, a variety of challenges must be investigated, overcome and systematically optimized. The “ORCA” parameters for single-cell dispensing must be fulfilled.

» High-precision cell dispensing is a key enabler for future cell analysis and cell printing methods.«

ORCA:

- **O**n-demand single cell printing
- **R**eproducibility of the printing process
- **C**ell viability and sterility
- **A**dvanced speed and high resolution

Fraunhofer IMM is tackling all of the ORCA requirements with its novel trap-based cell-on-demand technology and is able to precisely print individual living cells in direct proximity encapsulated in microdrops of minimal volume.

The Fraunhofer IMM technology and research goals

At the heart of the new technology is a microfluidic silicon chip containing a microarray of dispensing units that each capture and hold individual cells in cell traps before they are printed through individual ejection nozzles. This approach allows single cells to be printed on demand, quickly, precisely and at the highest resolution. A print head similar to that of a modern inkjet printer, with several hundred nozzles per cell type, is in early development. The goal is to print cells at typical inkjet printer speeds, namely at a rate of 100,000 cells per second.

Current research is centered around are the improvement of the silicon-based, microfluidic MEMS chip, particularly trap efficiency and dispensing fidelity and the use of cell inks which can be cross-linked by UV light.