Multiplexed and multimodal analysis of single cells in nano- and picoliter volumes

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Microfluidic technology is nowadays an important tool for cell analysis. One of the huge potential lays in the possibility to create small liquid environments of defined and reproducible volumes so that analyses can be performed with unprecedented high sensitivity and reproducibility. We use two microfluidic methods to encapsulate cells, (i) droplet microfluidics and (ii) valve-based systems. In this presentation, the latest developments of these strategies will be presented.

(i) Droplet microfluidics is a particularly powerful method for high throughput screening. Monodisperse aqueous droplets of pico- or nanoliter volume immersed in a hydrophobic fluid are formed in a microfluidic device at kHz frequencies. In the field of single-cell analysis, droplet microfluidics is nowadays a well-approved method and alternative to cytometry. The tiny volumes of the droplets are particularly beneficial, when secreted compounds are analyzed. Most assays in nL droplets, however, are based on fluorescence spectroscopy, which limits the choice of assays and multiplexing capability. In this presentation, our advanced platform will be introduced that enables analysis of proteins secreted by few cells by the two complimentary analytical methods, time-lapse fluorescence spectroscopy and matrix-assisted laser desorption/ionization (MALDI)-MS.

(ii) In our alternative “valve-based” method, cells are captured and encapsulated by donut-shaped valves. Here, we achieve size- or marker-selective capture of individual cells and quantitative analysis of secreted factors by means of immunassays performed on barcoded beads at extremely low limit of detection as required for single-cell analysis. Examples include the analysis of tumor cells and circulating tumor cells, isolated on-chip from full blood sample.