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Microdroplet Arrays: The Next Generation of Multi-Well Plates for High Throughput Analysis

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Summary

Droplet microfluidics has emerged as a powerful method for high throughput applications, e.g. for screening reaction conditions, synthesizing particles, or single-cell analysis and other bioanalytical applications. We employ droplet-based methods on an open platform, which is conceptionally similar to a multi-well plate, however, has a massively increased density of wells and hence, throughput. Thousands of aqueous nL-droplets deposited on a custom-made glass slide that have a defined hydrophilic-hydrophobic surface pattern. The droplets are covered by fluorinated oil and remain stable for several days. Compounds and fluids can be added by further spotting runs at any time. Moreover, our automated deposition system allows for the creation of chemical gradients along the surface and therefore, fine-tuned concentration-depending screening applications. In addition, we can employ optical microscopy for droplet assessment as well as MALDI-MS imaging for analysis of droplet composition. In this presentation, the use and versatility of the method for various applications will be discussed. After validation of the platform, we first confirmed the use of the platform for protein analysis and determination of posttranslational modifications. Next, we adapted the platform for cell analysis. For example, the biosynthesis of an enzyme could be monitored by both fluorogenic assay as well as label-free by mass spectrometry. Further recent advancements of the platform include the analysis of supernatant by droplet splitting, the production of chemical gradients and the use of hydrogels for embedding cells. In addition, a conceptionally similar approach for analysis of cell-secreted compounds will be presented.