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BOOK OF ABSTRACTS

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Microfluidic traps - a new tool for precise manipulation on small droplets

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Droplet microfluidics provides a set of techniques allowing a control over small compartments of liquids[1]. The great advantages of this approach are miniaturization of the volume of reactions and ability to run a large numbers of reactions in parallel. These aims can be reached by the use of active parts like electromagnetic valves that close and open flows of liquid. This solution provides flexibility of the system where the protocol can be changed by the user or adjusted on-line by the device. Droplet on demand systems allow to generate a droplet, move it, merge with another droplet or split.[2] This set of operations is complete for full control over the content of single droplet and each droplet in a sequence.

Despite of an excellent ability of this approach for laboratory use in high throughput screening[3], the applications in point of care devices are limited because of high requirements like: number of high quality of mechanical elements, precise control on parameters like: rates of flows, pressures and temperature. Besides the applications in complex devices for very special and highly demanding use, there is a lot of potential applications for droplet microfluidics where the simplicity and low cost are required.

These expectations can be met in passive systems where flexibility of the protocol is sacrificed for the simplicity of the use offering the same level of precision or even the higher one.

Here we present a concept of microfluidic modules (traps) that allow to trap, dose and merge droplets precisely[4]. The precision of the operations is encrypted in the geometry of the device and large mismatch of shear stresses and capillary forces. This guaranties reproducibility over a wide range of rates of flow that do not need to be controlled precisely. We also demonstrate that these modules can be integrated into systems that perform complicated protocols with high level of accuracy while do not need to be precisely controlled.

The ability to trap a portion of liquid can be used for bioanalytical applications, where trapped droplet can serve as immobilized isolated incubator consisting of population of living cells. Content of this incubator may be changed with by the flow of another droplets through it. This opens a new perspective for an accurate control of conditions in biological applications.

Moreover, the combinations of active valves and passive modules in one device spread the dynamical range of available dilutions of reagents and offers "digital precision" which could be used in a variety of laboratory applications in chemistry and biology.

References

[1] Theberge, A. B. et al. Microdroplets in Microfluidics: An Evolving Platform for Discoveries in Chemistry and Biology. Angew. Chem. Int. Ed. 49,5846–5868 (2010).

[2] Jakiela, S., Kaminski, T. S., Cybulski, O., Weibel, D. B. & Garstecki, P. Bacterial Growth and Adaptation in Microdroplet Chemostats. Angew. Chem. Int. Ed. 52,8908–8911 (2013).

[3] Churski, K. et al.Rapid screening of antibiotic toxicity in an automated microdroplet system. Lab. Chip 12,1629– 1637 (2012).

[4] Korczyk, P. M., Derzsi, L., Jakieła, S. & Garstecki, P. Microfluidic traps for hard-wired operations on droplets. Lab. Chip 13,4096–4102 (2013).