Project 3.8. Printing of self-assembling droplet arrays: from physical mechanisms of self-assembly to applications in cell encapsulation and high-throughput screening

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ICP PAS Group: Soft granular matter and tissue engineering

Background:

Testing of drugs in industrial setting typically involves screening of thousands or even millions of samples per day. Operations on liquid aliquots—such as pipetting—are normally performed at high-throughput (HT) by fully automated robots. However, there is an increasing demand on HT drug screening outside industry. In particular, in cancer treatment, personalized testing of drugs could help in administration of custom-tailored drug combinations which would improve efficiency of treatment, reduce cost and minimize harmful side-effects. One of the promising routes towards such personalized HT screening is the use of miniaturized platforms automatically generating thousands of nanoliter sub-samples. In droplet microfluidics the initial sample containing dissociated cells is injected onto a microfluidic chip, mixed with drugs and dispersed into thousands of nanoliter droplets. The behaviour of cells is subsequently observed to judge about efficiency of a given drug combination. One of the bottlenecks of the technology is identification of each of thousands of monodisperse droplets.

In recent experiments in our research group we observed that microdroplets, upon deposition at a substrate, tend to self-organize into regular, yet unique, patterns, such that each droplet may be labelled via an associated local pattern. This strategy opens way towards simple, rapid and cost-effective labelling of thousands of droplets.

Aim:

The goal of the project is to develop a microfluidic droplet labelling technique via printing of droplets into ordered arrays at a substrate. The research tasks will include (i) investigation of physical mechanisms of droplet self-assembly, (ii) development of the droplet-printing setup and automated image-processing tools, (iii) proof-of-concept application of the platform in drug screening.

Requirements:

- very good track record from undergraduate studies,
- preferred background: physics/chemistry/engineering,
- fluency in written and spoken English