ETH zürich

Licensing Opportunity

In-droplet separation of DNA, proteins and peptides for high throughput testing and screening

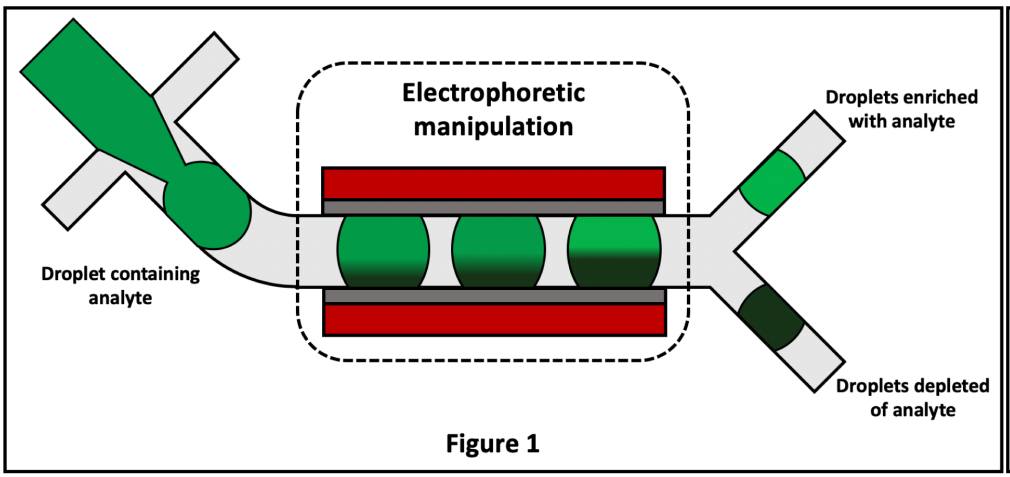

Figure 1

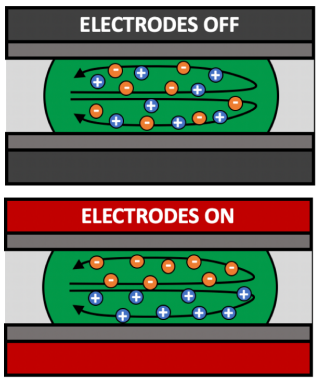

Figure 2

Fig. 1) Schematic concept of a microfluidic device, comprising a droplet generator, a flow channel for electrophoretic enrichment and a Y-junction for droplet splitting. Fig. 2) Migration of charged molecules within the moving droplet without and with an applied electric field.

Application

In bioanalytical applications, such as drug testing and screening, toxicity tests or single-cell sequencing, only small sample volumes are available. Droplet microreactors can be used for testing multiple conditions on the scarce sample at high throughput. This invention is an add-on that simplifies the manipulation, analysis, enrichment and purification of samples by in-droplet electrophoresis.

Features & Benefits

- Selective manipulation of biomolecules inside droplets without any additional intermediaries, such as beads
- Rapid and sensitive separation of biomolecules
- High throughput, low-cost fabrication and operation

Publications

- M.A. Saucedo-Espinosa, P.S. Dittrich, “In-droplet electrophoretic separation and enrichment of biomolecules”, Anal. Chem. 2020, 92, 8414−8421 https://dx.doi.org/10.1021/acs.analchem.0c01044
- Patent pending

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Technology Readiness Level

Background

Current methods for the manipulation of biomolecules inside droplets in microfluidic devices are slow. Instead of directly manipulating the molecules in the droplet, the efforts focus on extracting the droplets into a secondary channel or adding functionalized micrometer-sized beads to capture them. As these methods are slow, they do not exploit the available operating speed of established droplet generators and, thus, become the bottleneck for high throughput processing.

Invention

This invention introduces in-droplet electrophoresis for the direct manipulation of the sample. The droplets move at velocities over 10 mm/s perpendicular to an electric field - much like in free-flow electrophoresis. Charged biomolecules with different sizes and net charges separate into the upper and lower halves of the droplets. The flow characteristic within the moving droplets supports the separation and enrichment of charged analytes (see fig. 2). The separation can be fine-tuned by changes in the ionic strength, pH and/or viscosity of the surrounding buffer. Typical electric fields are on the order of 200 - 400 V/cm. The electrodes are coated with a PDMS-carbon composite material, which prevents bubble formation and other electrolytic by-products generation.

The invention includes a method for fast and low-cost fabrication and integration of such electrophoretic-based devices into microfluidic chips, which allows further processing of the enriched sample.