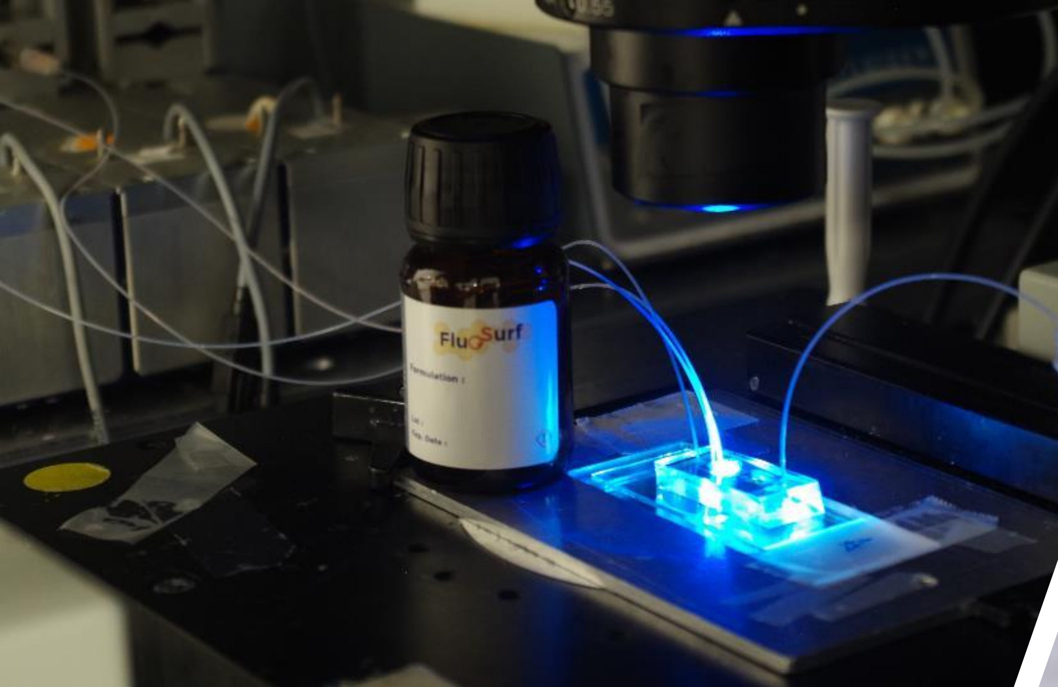
Formulations for
Droplet-based Microfluidics

Based in the south west of France, Emulseo has been founded in 2018 by Jean-Christophe Baret, Valérie Taly and Florine Maes.

Emulseo develops formulations for microfluidic technology such as the surfactant for droplet-based microfluidics named FluoSurf.

Emulseo comes from Jean-Christophe Baret Lab at the Centre de Recherche Paul Pascal in Pessac. Emulseo has thus a strong expertise in microfluidics and aims to help and collaborate with customers in improving and developping new products .


FluoSurf
Formulation :
Lot :
Exp. Date :

300
200
130
110
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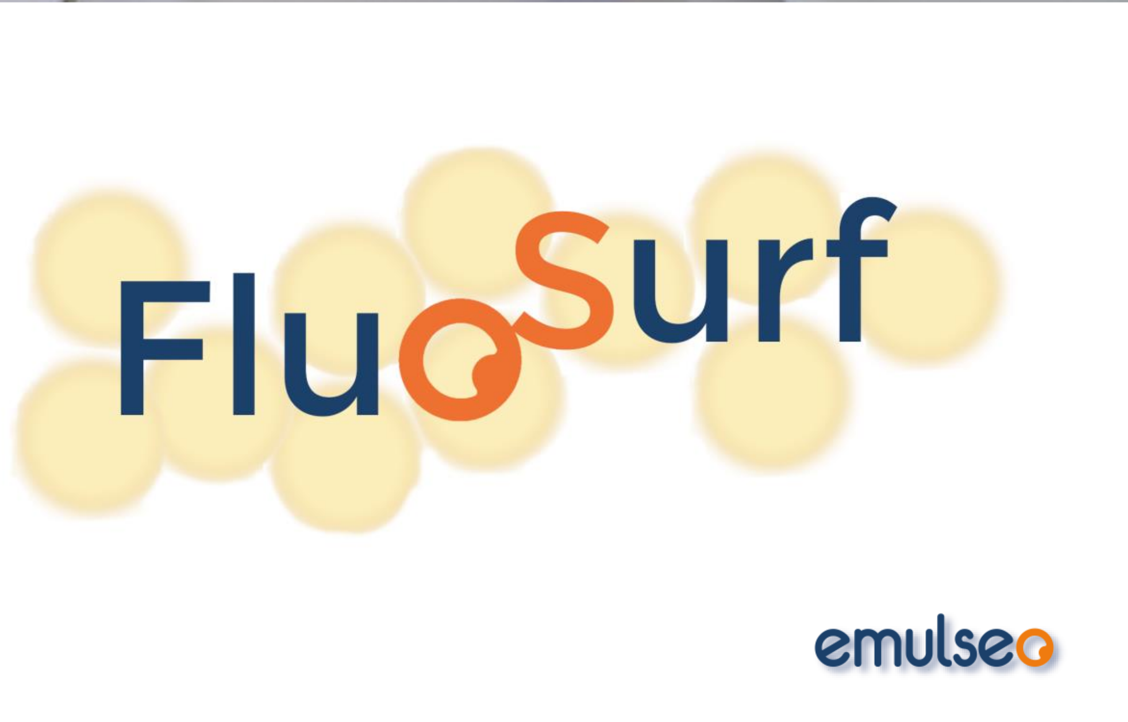
FluoSurf
Formulation :
Lot :
Exp. Date :


FluoSurf
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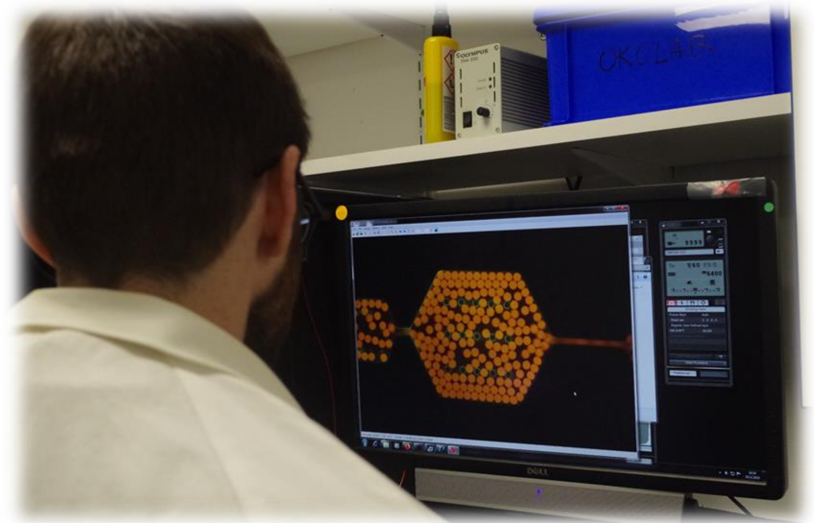
FluoSurf is a high performance fluorinated surfactant used to stabilize droplet-based microfluidic emulsions and aims to respect required criteria for many applications:

- Stability (T°C / pH)
- Biocompatibility
- High purity
- Leak proof
- Reproducible from batch to batch
- Production of large volumes

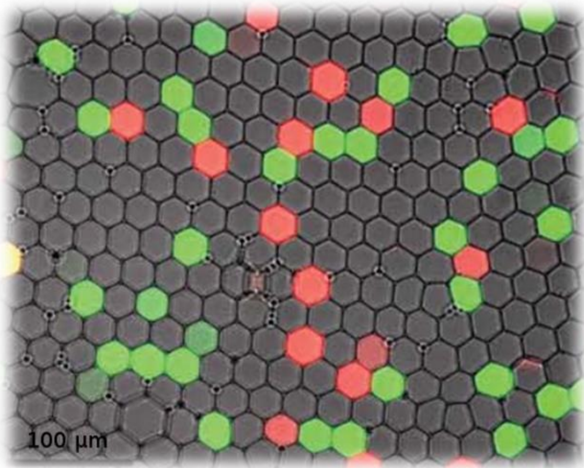


Quality controls have been specifically developped to check the performance and reliability of FluoSurf. Emulseo provides to customers the certificate of analysis for each batch.

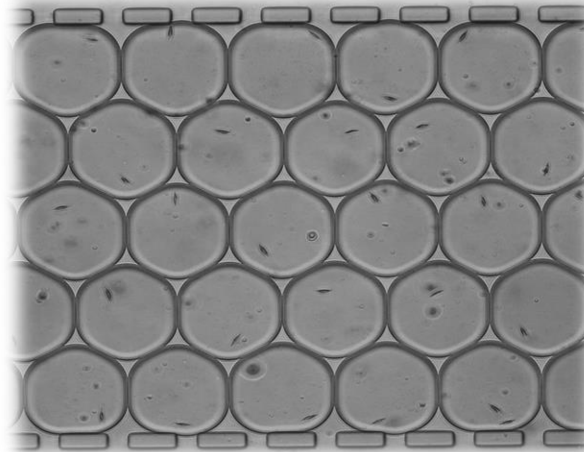
FluoSurf

FluoSurf is used for many applications in droplet-based microfluidics for example :

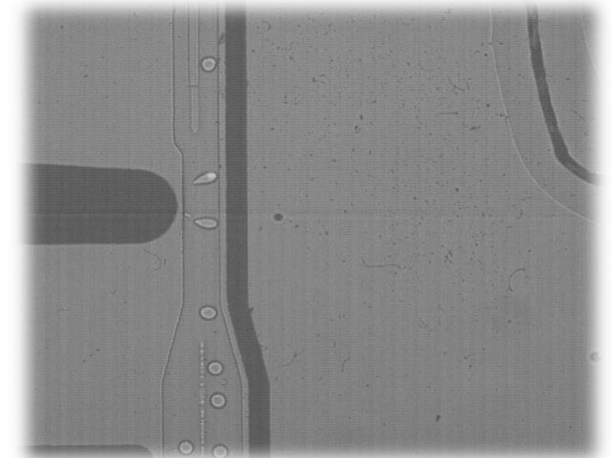
dPCR



Enzyme or protein Screening



Single cell analysis



More details : www.emulseo.com

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CHARACTERISTICS

- Mixture of diblock and triblock :
  PFPE-b-PPO-PEO-PPO-b-PFPE
- Molecular weight :
  7kD<Mw<13kD
- Charge :
  Neutral
- Surface Tension :
  4 mN/m
- Critical micelle concentration :
  0.03 w/w %

Available neat or diluted in HFE 7500 or FC 40

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Structural Characterization

Color	Linkage bond	Composition	Mn (in kD PMMA eq.)
Yellow	Amide	Mixture of diblock and triblock ($1<R_{T/D}<2$)	17 kD and 4.3 kD

Thanks to the mixture of diblock / triblock and the molecular size , FluoSurf allows a good balance between the leakage phenomena and the stability during the thermocycling

Droplets generation and effect of thermocycling on size distribution

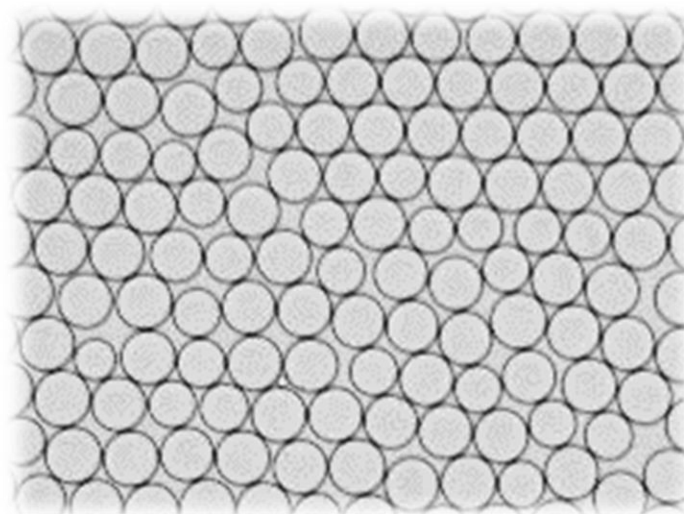
EXPERIMENTAL CONDITIONS

4 w/w % of surfactant in HFE-7500 oil

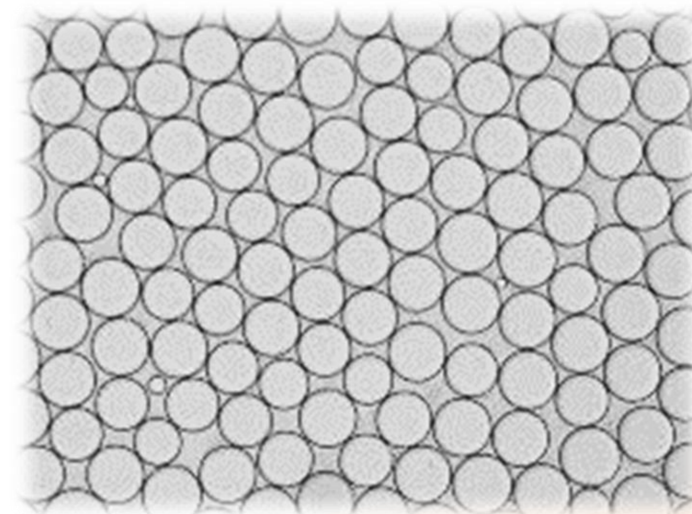
Microfluidic drop generation :
- Fluorinated phase at 300 µL/h
- Aqueous phase at 100 µL/h

Thermocycling conditions :
30 cycles :
- 95°C during 30s
- 55°C during 1 min
- 72°C during 5 min
- 40°C during 1 min

Before thermocycling

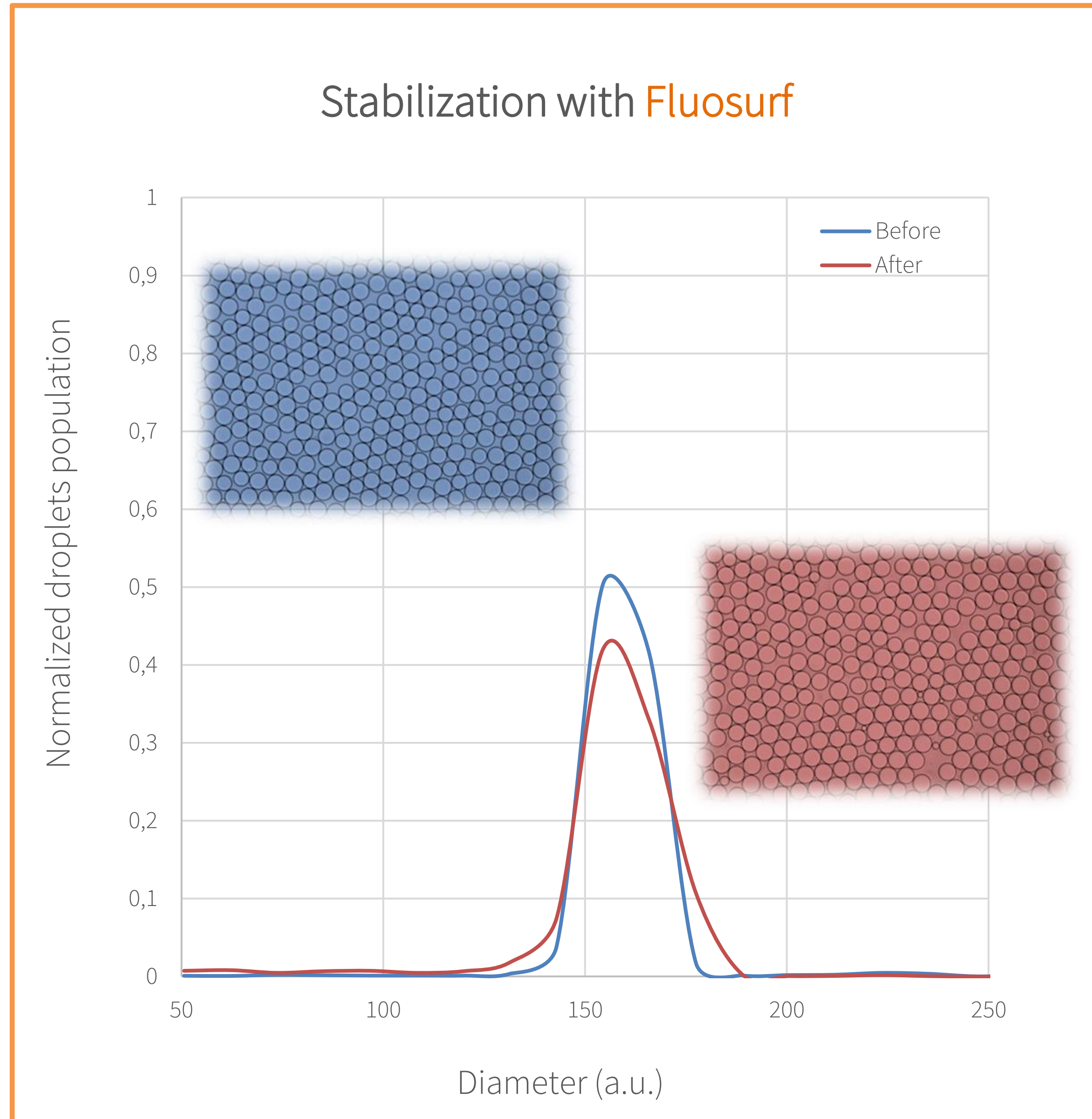


After thermocycling



FluoSurf allows a good stability of the droplet during thermocycling

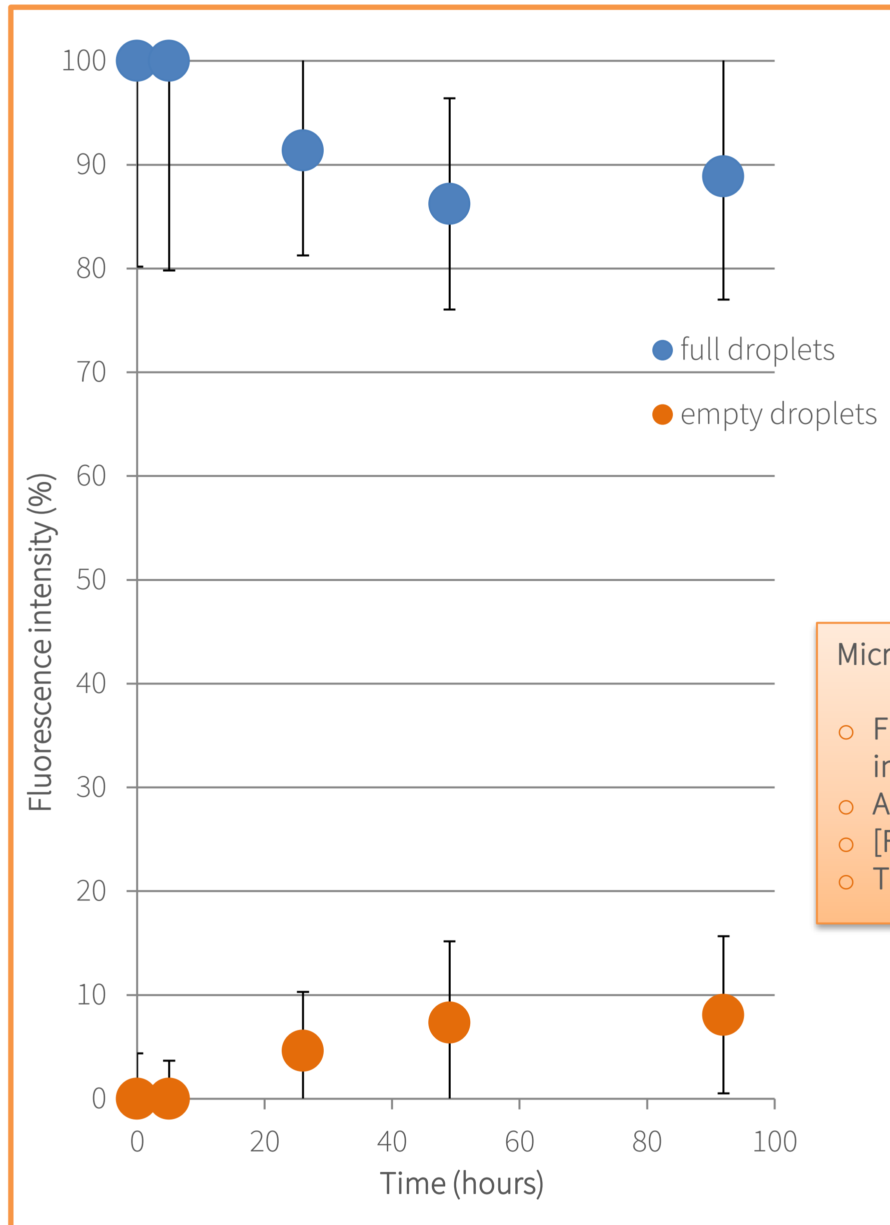
Droplets generation and effect of thermocycling on size distribution



With FluoSurf, the thermocycling has a limited effect on the droplet size distribution

Retention Performance

Evolution of mean intensity in full / empty droplets with fluorescein 100 µM



Microfluidic drop generation :

- Fluorinated phase : Surfactant 2 w/w % in HFE -7500 at 600 µL/h
- Aqueous phase at 100 µL/h
- [Fluophore] = 100 µM
- T°C = 37

FluoSurf limits exchanges between droplets
(less than 10% of fluorescein exchanges after 4 days)

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FluoSurf

SCIENTIFIC ARTICLES

High-Throughput Triggered Merging of Surfactant-Stabilized Droplet Pairs Using Traveling Surface Acoustic Waves

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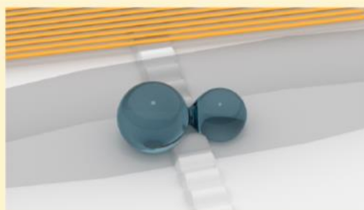
Supporting Information

ABSTRACT: We present an acoustofluidic device for fluorescently triggered merging of surfactant-stabilized pico-liter droplet pairs at high throughput. Droplets that exceed a preset fluorescence threshold level are selectively merged by a traveling surface acoustic wave (T-SAW) pulse. We characterize the operation of our device by analyzing the merging efficiency as a function of acoustic pulse position, duration, and acoustic pressure amplitude. We probe droplet merging at different droplet rates and find that efficient merging occurs above a critical acoustic power level. Our results indicate that the efficiency of acoustically induced merging of surfactant stabilized droplets is correlated with acoustic streaming velocity. Finally, we discuss how both time-averaged and instantaneous acoustic pressure fields can affect the integrity of surfactant layers. Our technique, by allowing the merging of up to 10^5 droplets per hour, shows great potential for integration into microfluidic systems for high-throughput and high-content screening applications.



Bussiere *et. al.*, Analytical Chemistry, 2019, 91(21), 13978-85

Streamlined digital bioassays with a 3D printed sample changer†

Roberta Menezes,[a] Adèle Dramé-Maigné,[b] Valérie Taly, [a] Yannick Rondelez [b] and Guillaume Gines [*b]

Droplet-based microfluidics has permeated many areas of life sciences including biochemistry, biology and medicine. Water-in-oil droplets act as independent femto- to nano-liter reservoirs, enabling the parallelization of (bio)chemical reactions with a minimum sample input. Among the range of applications spanned by droplet microfluidics, digital detection of biomolecules, using Poissonian isolation of single molecules in compartments, has gained considerable attention due to the high accuracy, sensitivity and robustness of these methods. However, while the droplet throughput can be very high, the sample throughput of these methods is poor in comparison to well plate-based assays. This limitation comes from the necessity to convert independently each sample into a monodisperse emulsion. In this paper, we report a versatile device that performs the quick sequential partitioning of up to 15 samples using a single microfluidic chip. A 3D printed sample rotor is loaded with all samples and connected to a pressure source. Simple magnetic actuation is then used to inject the samples in the microfluidic chip without pressure disruption. This procedure generates monodisperse droplets with high sample-to-sample consistency. We also describe a fluorescent barcoding strategy that allows all samples to be collected, incubated, imaged and analyzed simultaneously, thus decreasing significantly the time of the assay. As an example of application, we perform a droplet digital PCR assay for the quantification of a DNA amplicon from 8 samples in less than 2 hours. We further validate our approach demonstrating the parallel quantification of 11 microRNAs from a human sample using an isothermal nucleic acid amplification chemistry. As an off-chip device, the sample changer can be connected to a variety of microfluidic geometries and therefore, used for a wide range of applications.

Menezes *et. al.*, *Analyst*, 2020,145, 572-581

Bacterial expression systems for enzymatic activity in droplet-based microfluidics

Christos S. Karamitros, Mickaël Morvan, Aurélie Vigne, Jiseok Lim, Philipp J. Gruner, Thomas Beneyton, Jeremy Vrignon, Manfred Konrad and Jean-Christophe Baret

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Analytical Chemistry

Abstract

Functional screenings in droplet-based microfluidics require the analysis of various types of activities of individual cells. When screening for enzymatic activities, the link between the enzyme of interest and the information-baring molecule – the DNA – must be maintained to relate phenotypes to genotypes. This linkage is crucial in directed evolution experiments or for the screening of natural diversity. Micro-organisms are classically used to express enzymes from nucleic acid sequences. However, little information is available regarding the most suitable expression system for the sensitive detection of enzymatic activity at the single-cell level in droplet-based microfluidics. Here, we compare three different expression systems for L-Asparaginase (L-asparagine amidohydrolase, EC 3.5.1.1), an enzyme of therapeutic interest that catalyzes the conversion of L-asparagine to L-aspartic acid and ammonia. We developed three expression vectors to produce and localize L-Asparaginase in E. coli either in the cytoplasm, on the surface of the inner membrane (display) or in the periplasm. We show that the periplasmic expression is the most optimal strategy combining both a good yield and a good accessibility for the substrate without the need for lysing the cells. We suggest that periplasmic expression may provide a very efficient platform for screening applications at the single-cell level in microfluidics.

Karamitros *et. al.*, Analytical Chemistry, 2020, *Published ASAP*

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