

A microfluidic tool to investigate coalescence of protein stabilized emulsions

Food Process Engineering Department – Wageningen University

Presenter : Herditya Oktania Harsono

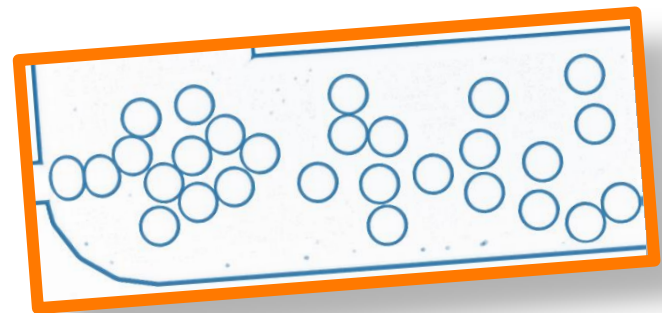
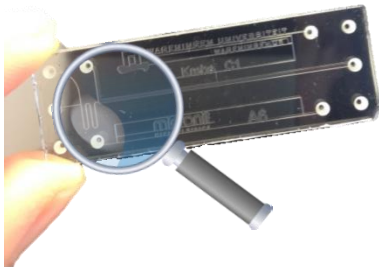
Contributor :

Kelly Muijlwijk

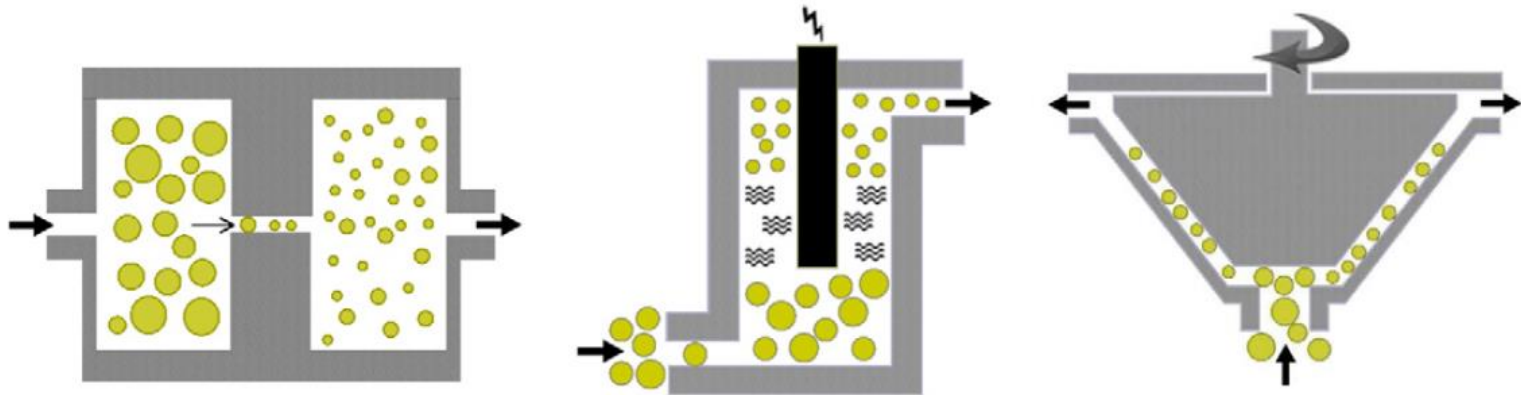
Thomas Krebs

Claire Berton-Carabin

Karin Schroën



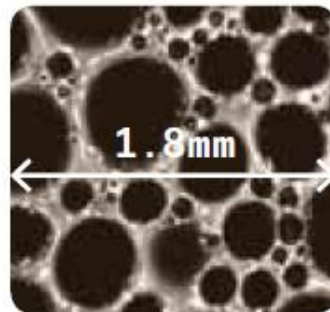
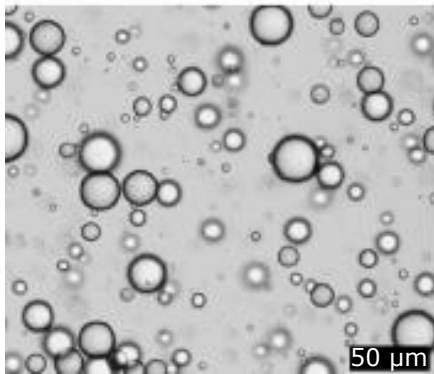
Industrial emulsification



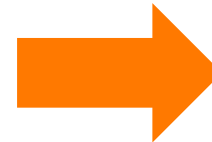
Formation and collision of droplets occurs in milliseconds

Why microfluidics?

- Short time scale phenomena in flowing system
- food structure & formulation is in microscale
i.e., emulsions and foam



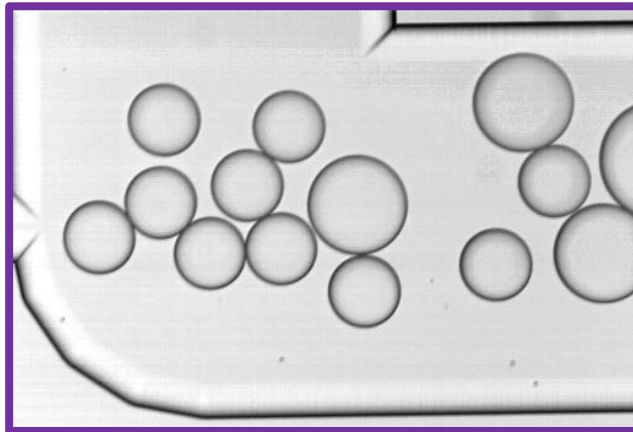
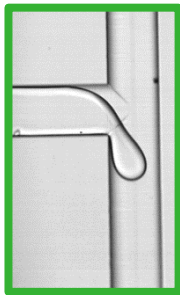
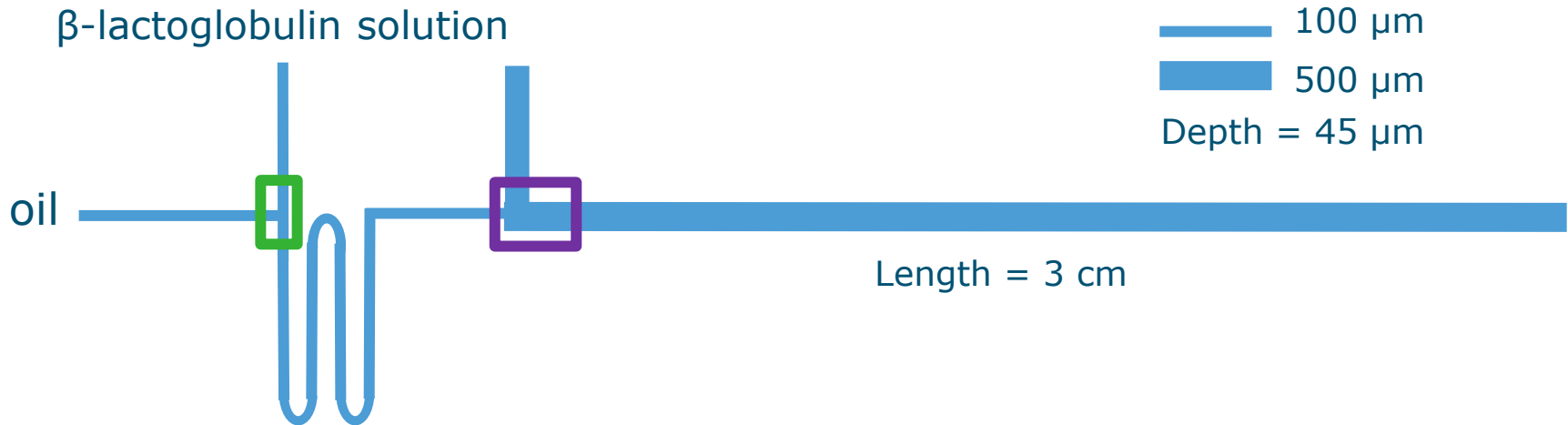
Cappuccino foam



Microchip

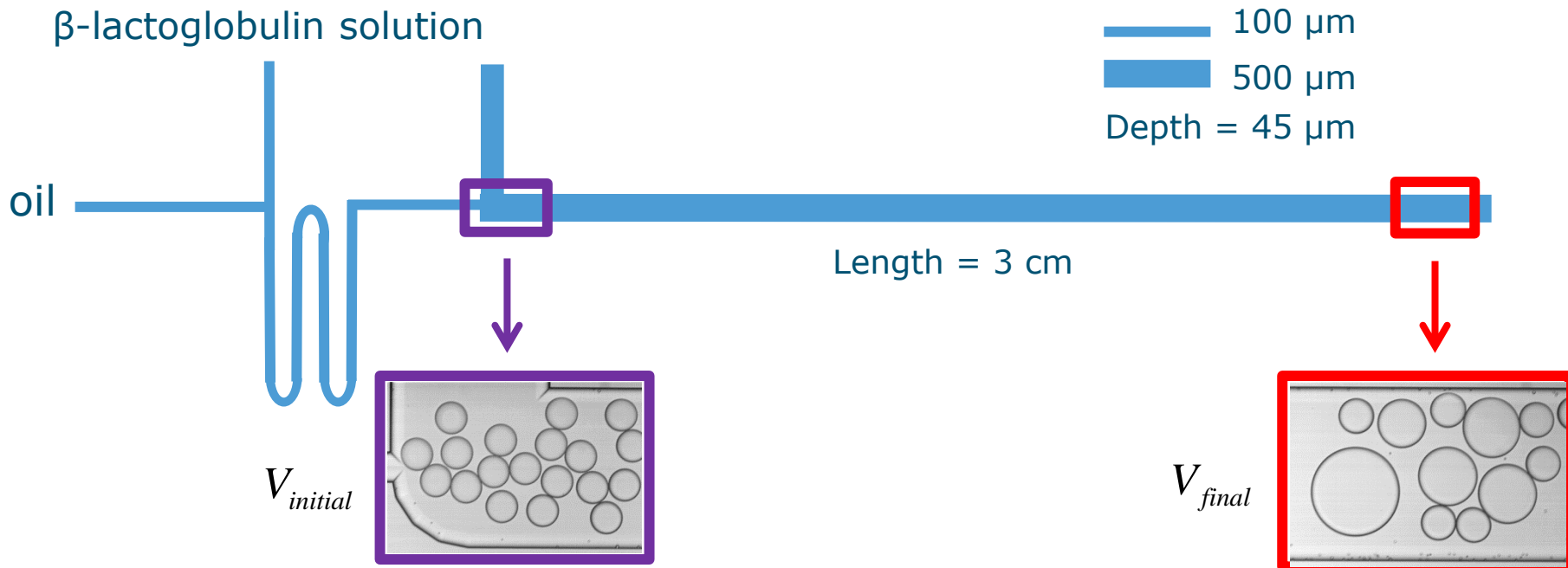
Approach

microchip layout



Approach

microchip layout



$$\text{Number of coalescence events} = \frac{V_{final}}{V_{initial}} - 1$$

Coalescence study



Attractive forces



Electrostatic repulsion



Thin film rupture

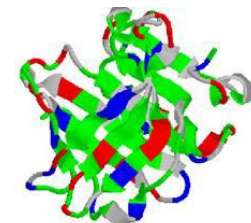


Steric & rheology



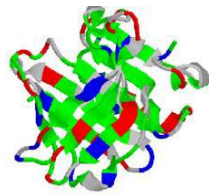
Bigger droplet

β -lactoglobulin



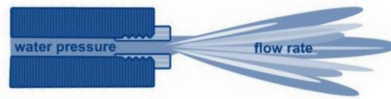
Coalescence dynamics

β -lg concentration



0.0002% - 0.02%

Flow rate



33-77 $\mu\text{L}/\text{min}$

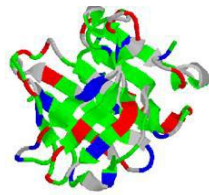
pH



3 - 8

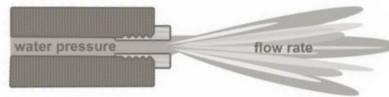
Coalescence dynamics

β -lg concentration



0.0002% - 0.02%

Flow rate



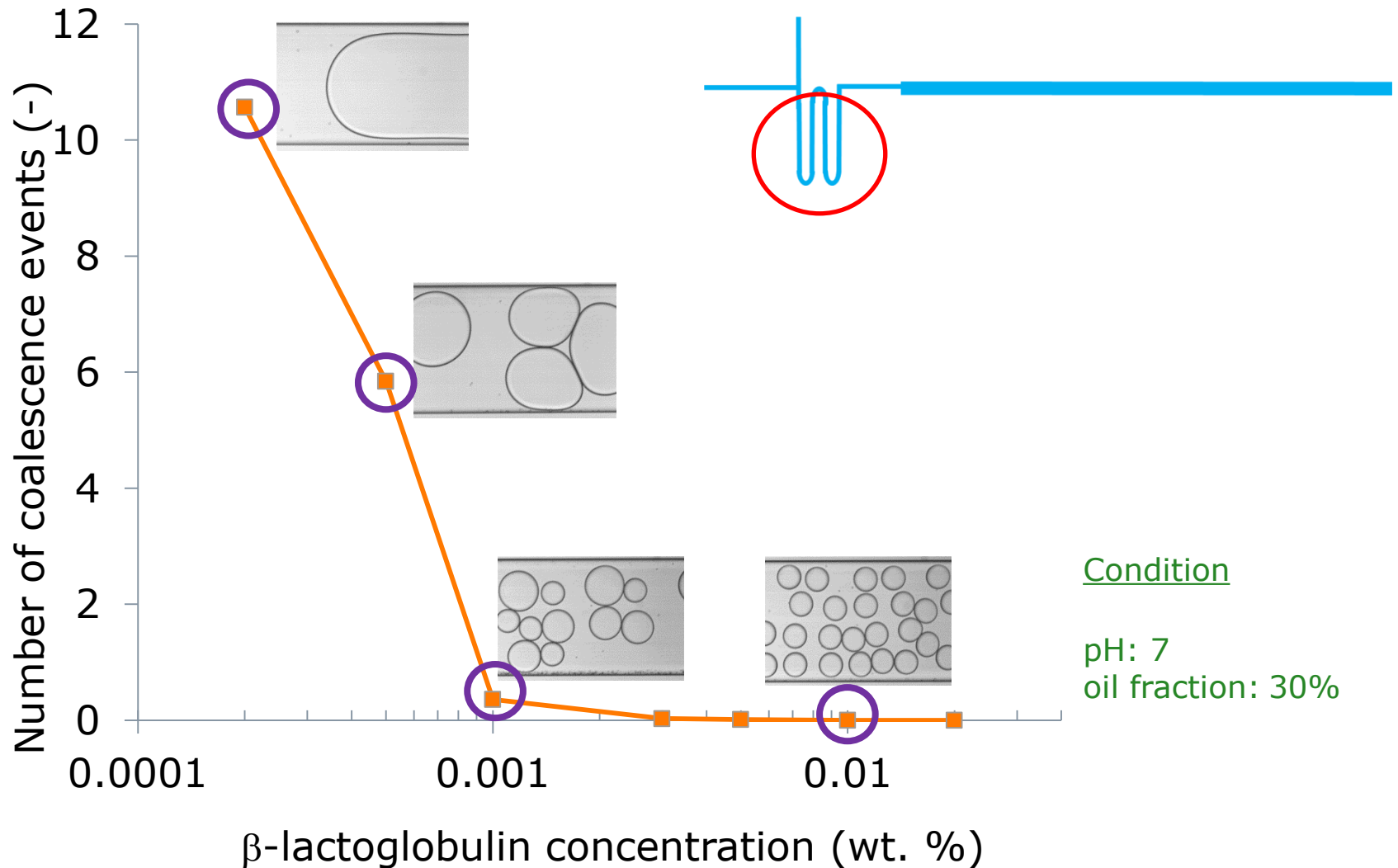
33-77 $\mu\text{L}/\text{min}$

pH



3 - 8

β -Lactoglobulin concentration



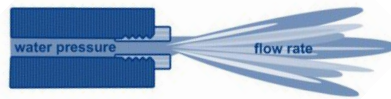
Coalescence dynamics

β -lg concentration



0.0002% - 0.02%

Flow rate



33-77 $\mu\text{L}/\text{min}$

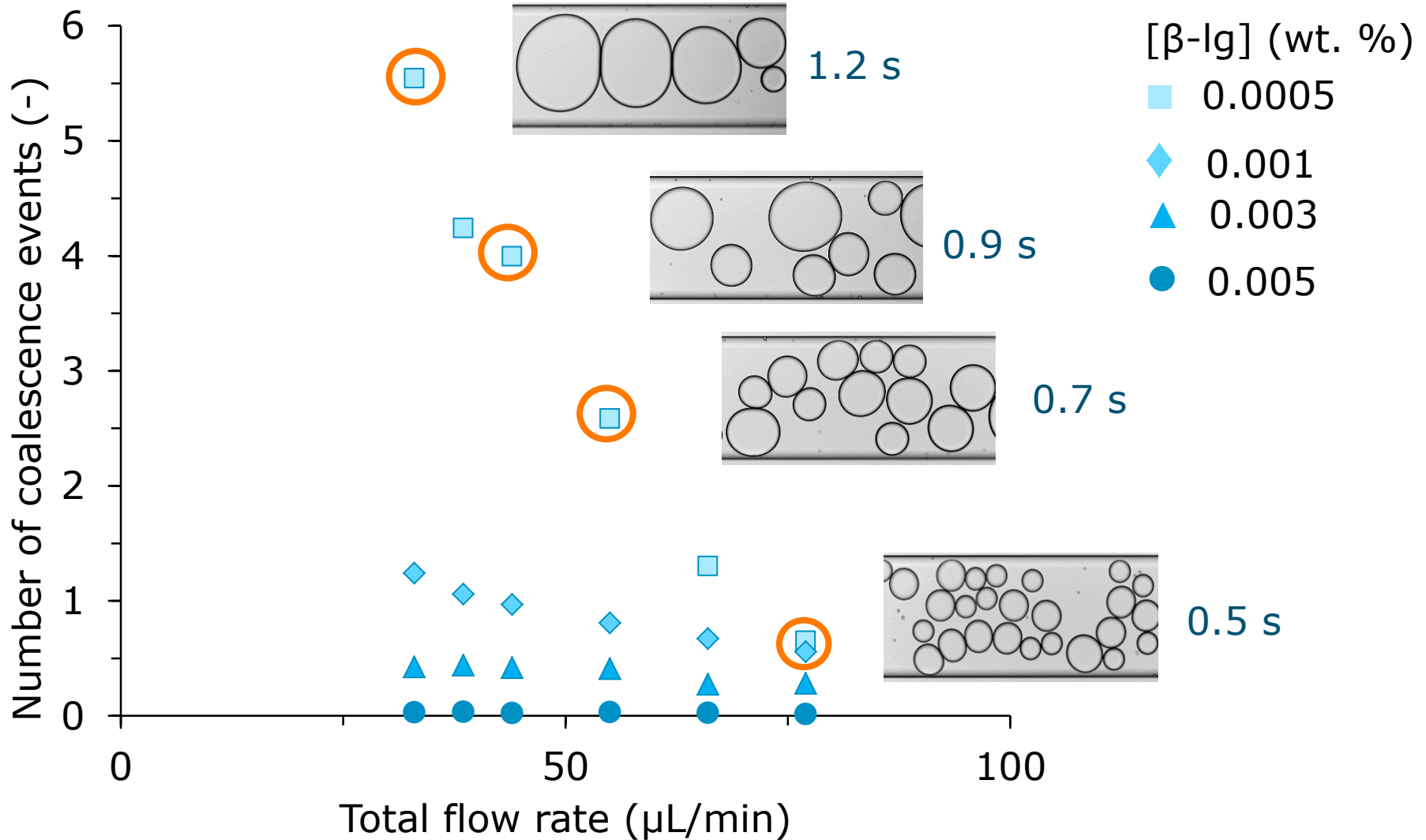
pH



3 - 8

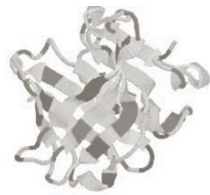
Flow rate

pH : 7
oil fraction : 30%



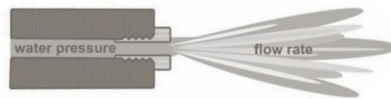
Coalescence dynamics

β -lg concentration



0.0002% - 0.02%

Flow rate



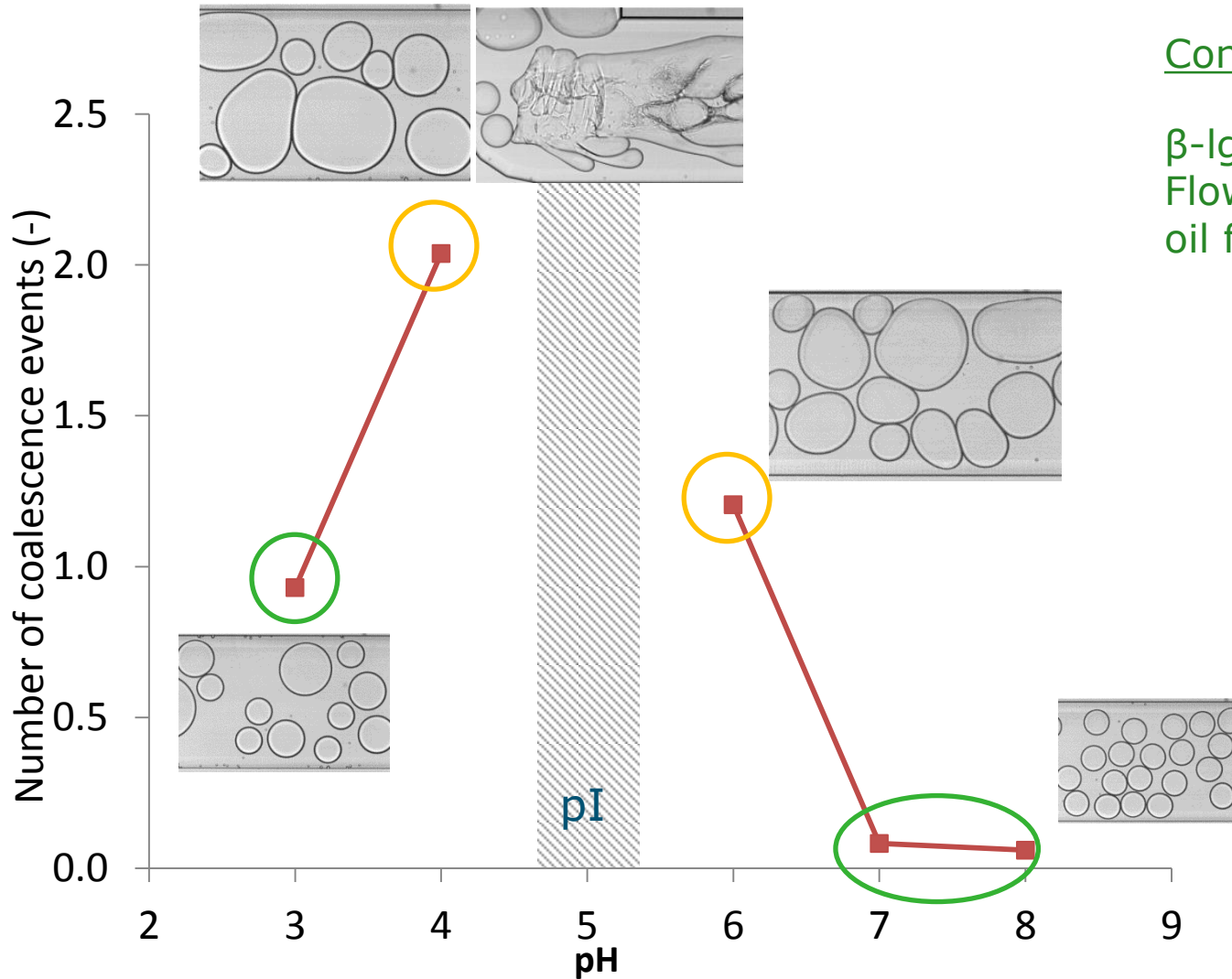
33-77 $\mu\text{L}/\text{min}$

pH



3 - 8

pH



Condition

β -Ig conc. : 0.005 wt.%
Flow rate : 45 μ L/min
oil fraction : 30%

Conclusions

Microfluidics can be used to measure coalescences in dense (30-60%), flowing (2 - 6 mm/s) food emulsions.

Characterize parameters for creating stable emulsions:

- Concentration
- Adsorption time of emulsifiers
- Flow rate
- pH

More sustainable in emulsification process

Thank you for your attention

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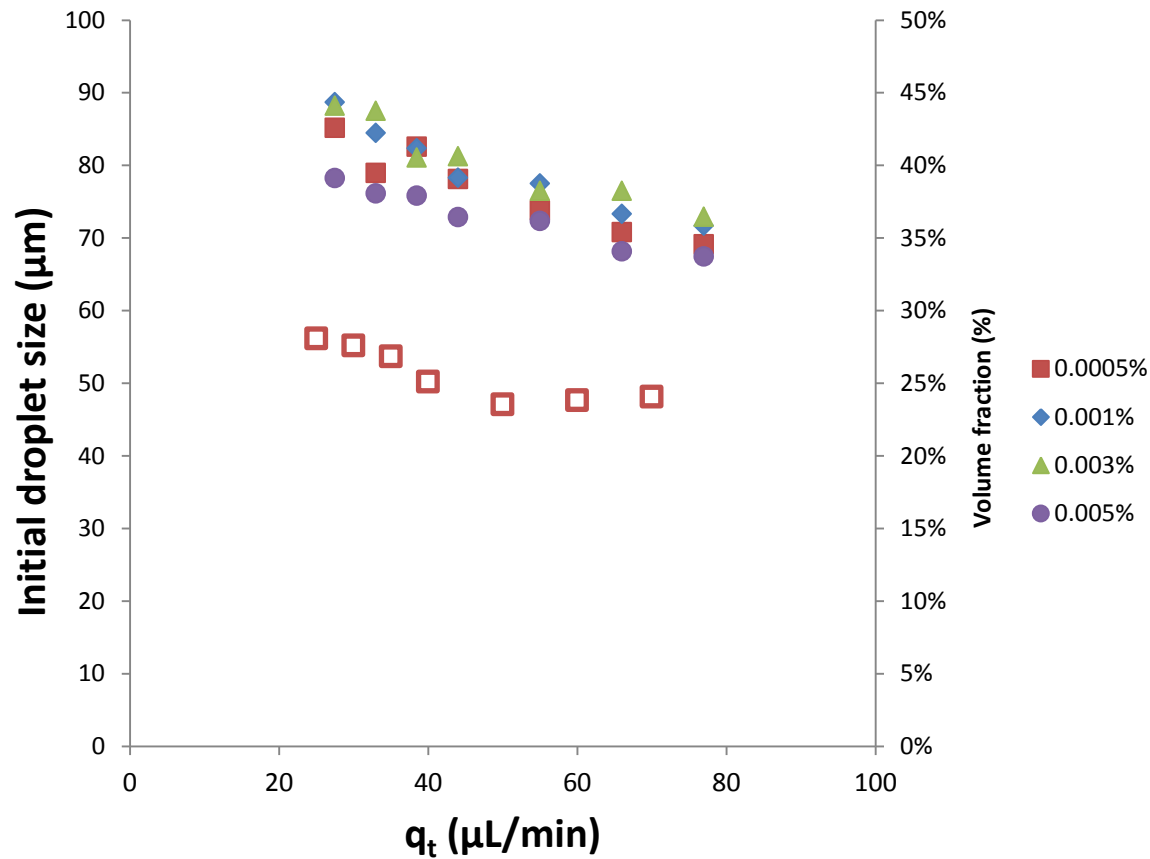


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For quality of life

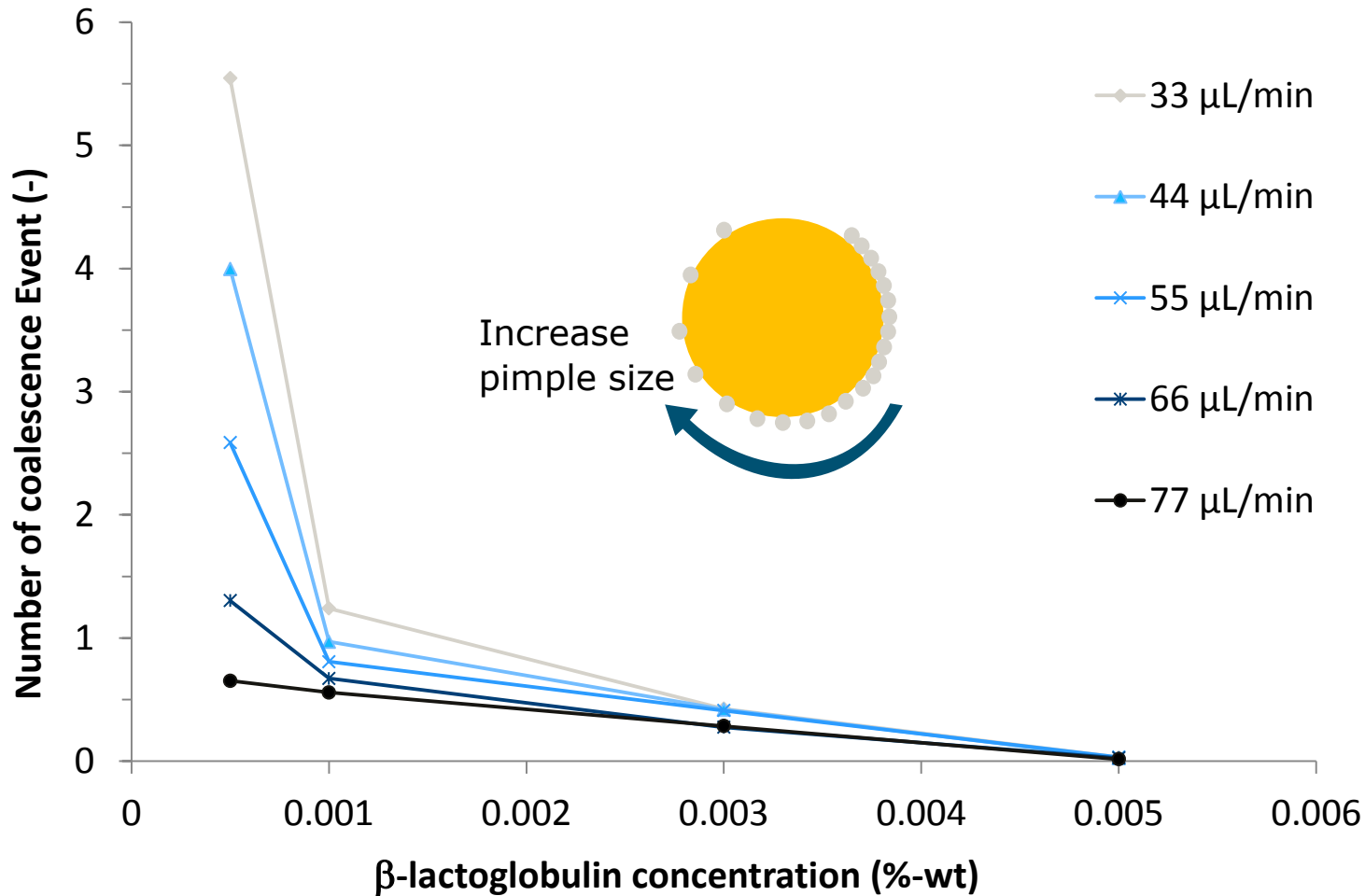
References

- Krebs, T., Schroën, K., & Boom, R. (2012). Coalescence dynamics of surfactant-stabilized emulsions studied with microfluidics. *Soft Matter*, 8(41), 10650–10657.
- Pattel, A. et al. 2013. Fabrication and characterization of emulsions with pH responsive switchable behavior. *Soft Matter*, 9, 6747.
- Nestle. 2007. Innovating the future. Nestec Ltd.

Initial droplet size



Coalescence event



pH = 7

β -lactoglobulin solubility

