Protein-stabilised emulsions and foams studied with microfluidics

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MicroNanoConference ‘13

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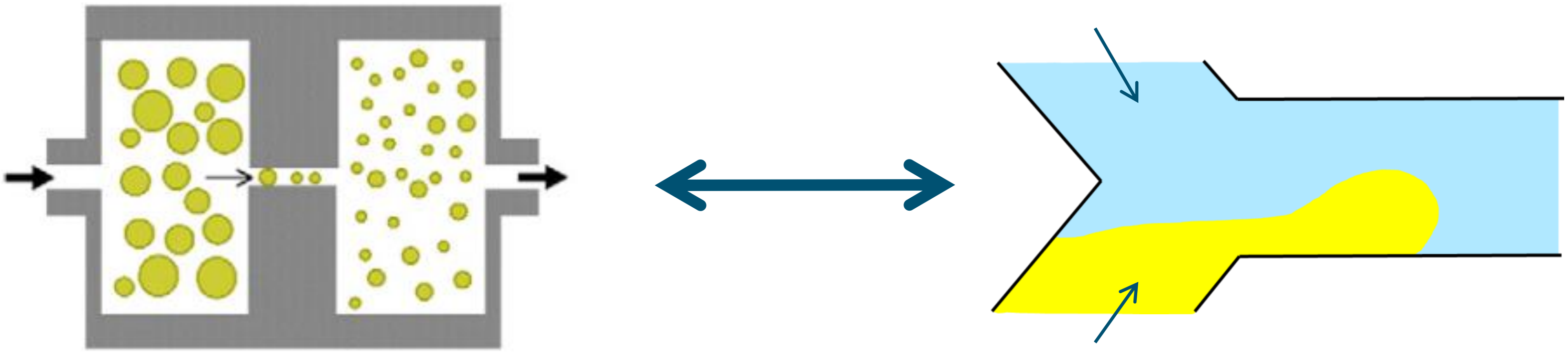
Microfluidics and industry

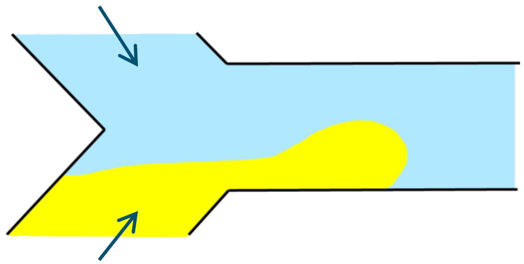


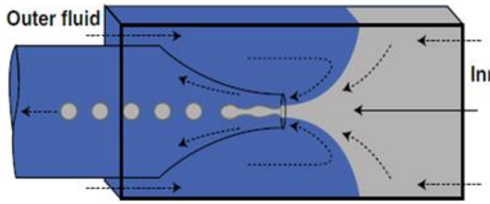
Microfluidics can be used to understand formation and stability of emulsions and foams in industrial processes

Microfluidic devices

- Shear based systems

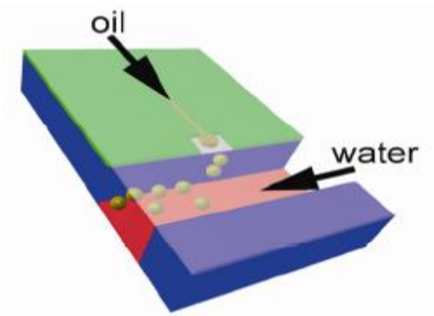
Cross-flow



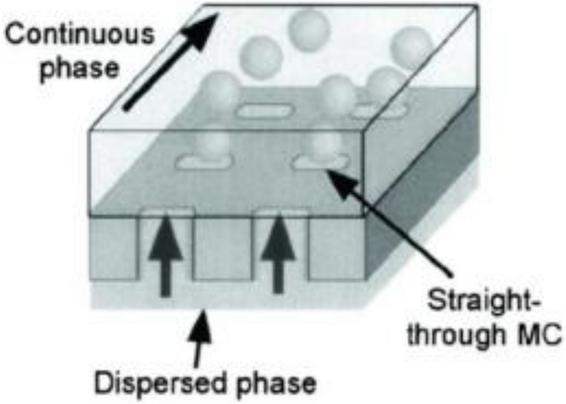


Flow-focusing

- Spontaneous emulsification systems



Grooved microchannel



Straight-through microchannel

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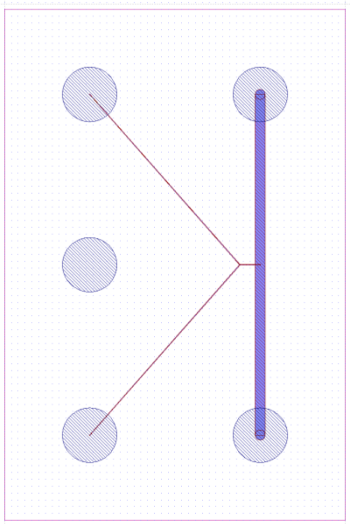
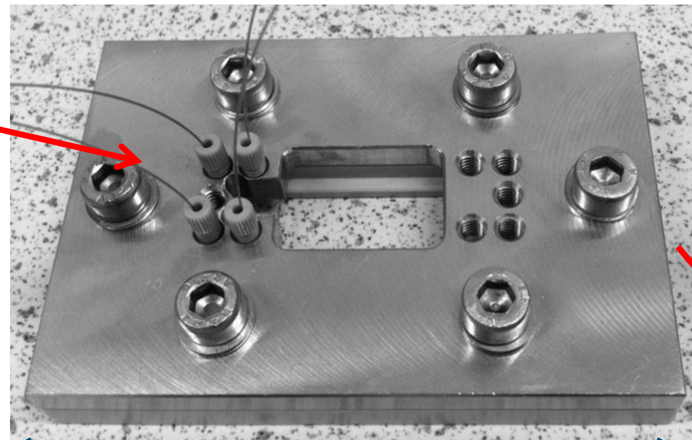
Maan et al. Journal of Food Engineering 107 (2011) 334-346

Microfluidic set-up



1 cm



8.5 cm

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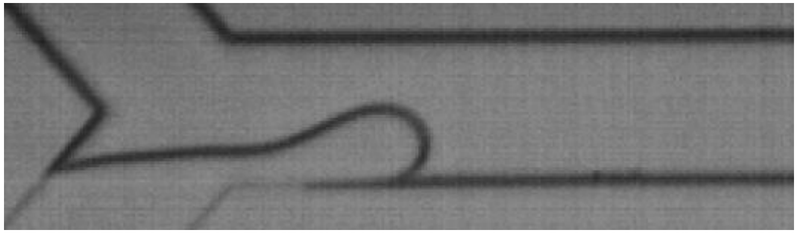
Overview

Microfluidics

Dynamic interfacial tension

Coalescence channel

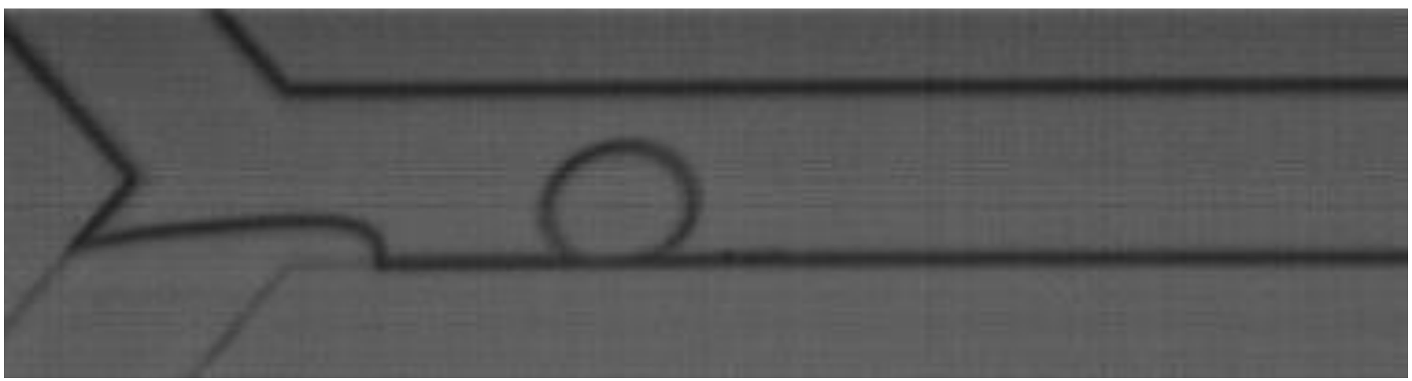


Y-junction

Drop size determined by
- Continuous phase shear rate
- Interfacial tension

$$Ca_c = \frac{\eta_c v_c}{\gamma}$$

No influence of dispersed phase flow rate or viscosity



18 µm

Depth = 5 µm

18 µm

Up to 50.000 frames/sec
Droplet formation in 0.001 - 2 millisecond

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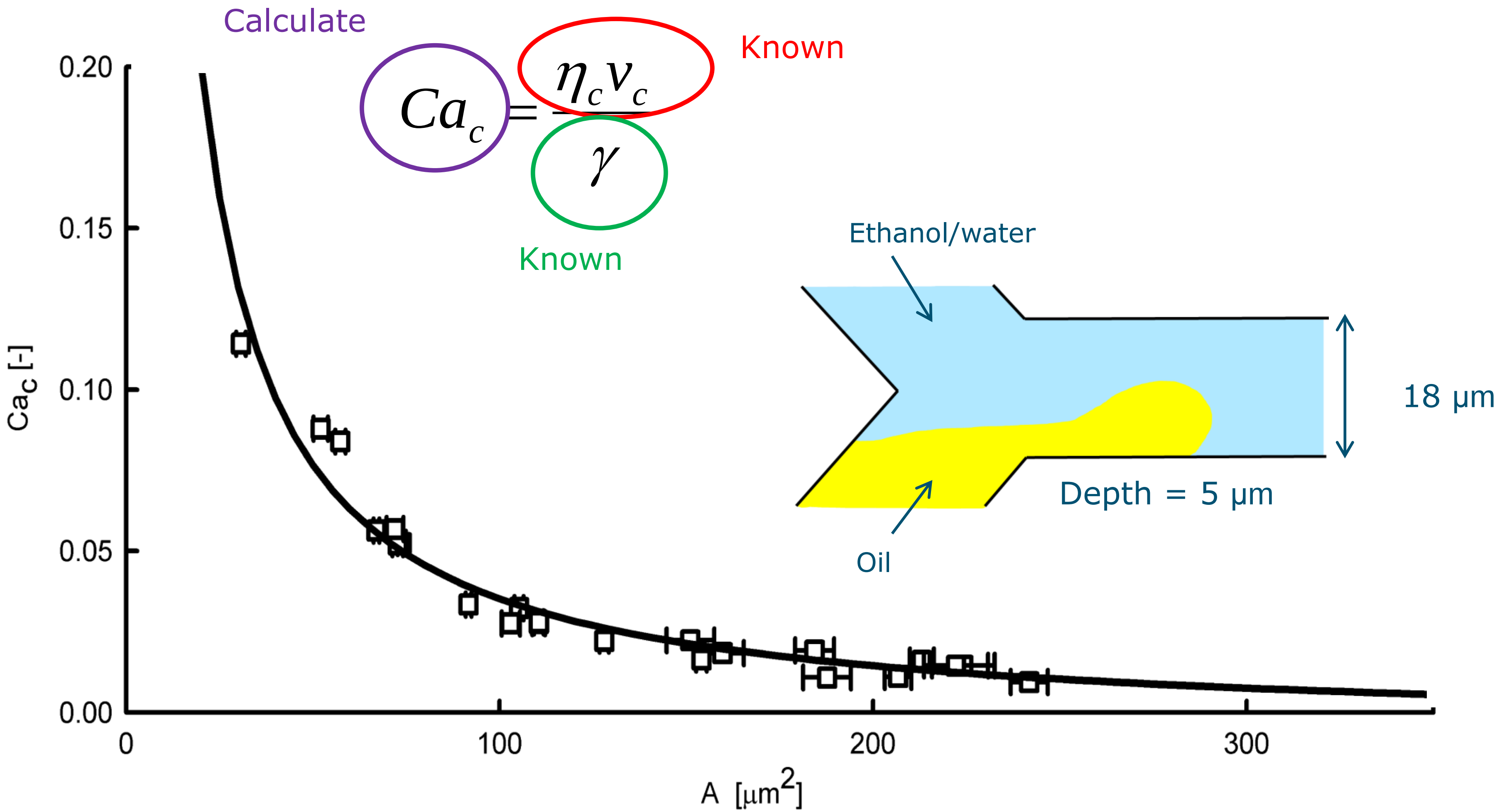
Steegmans et al. Langmuir (2009) 25 (17) 9751-9758

Calibration curve

$$Ca_c = \frac{\eta_c v_c}{\gamma}$$



Steegmans et al. Langmuir (2009) 25 (17) 9751-9758

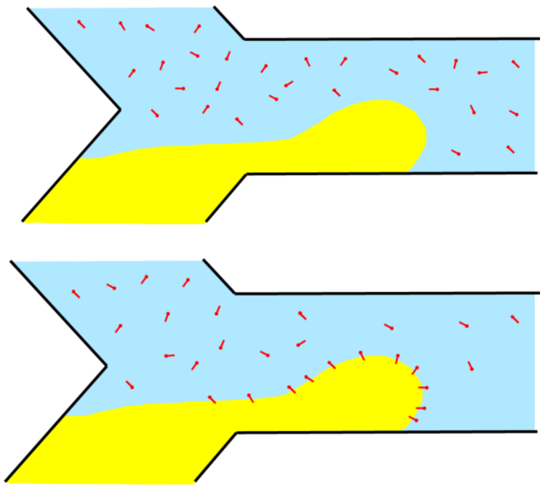
Dynamic interfacial tension

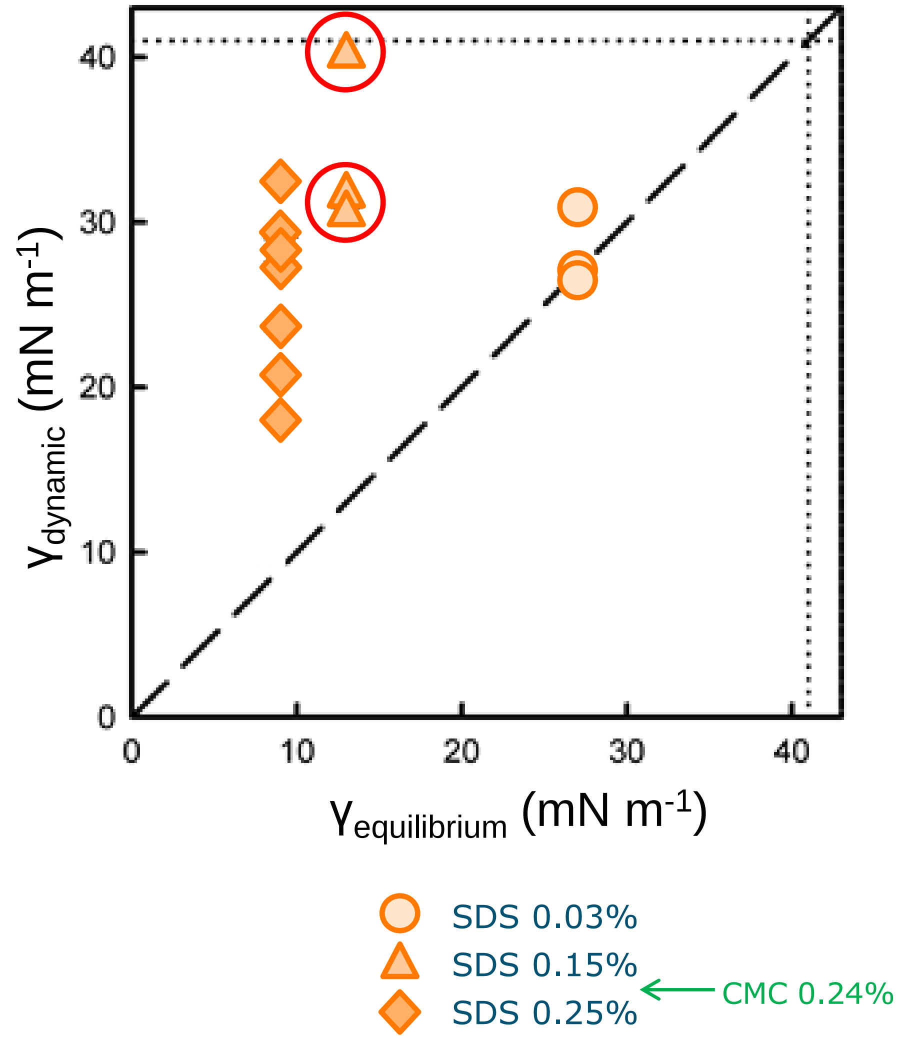
Calculate from Area

Known

$$Ca_c = \frac{\eta_c v_c}{\gamma}$$

Calculate





- Next step = proteins

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Microfluidics

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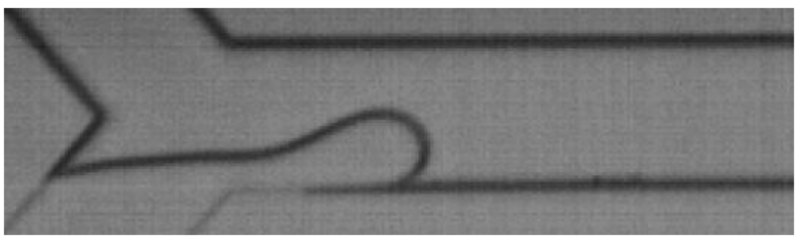
Coalescence channel



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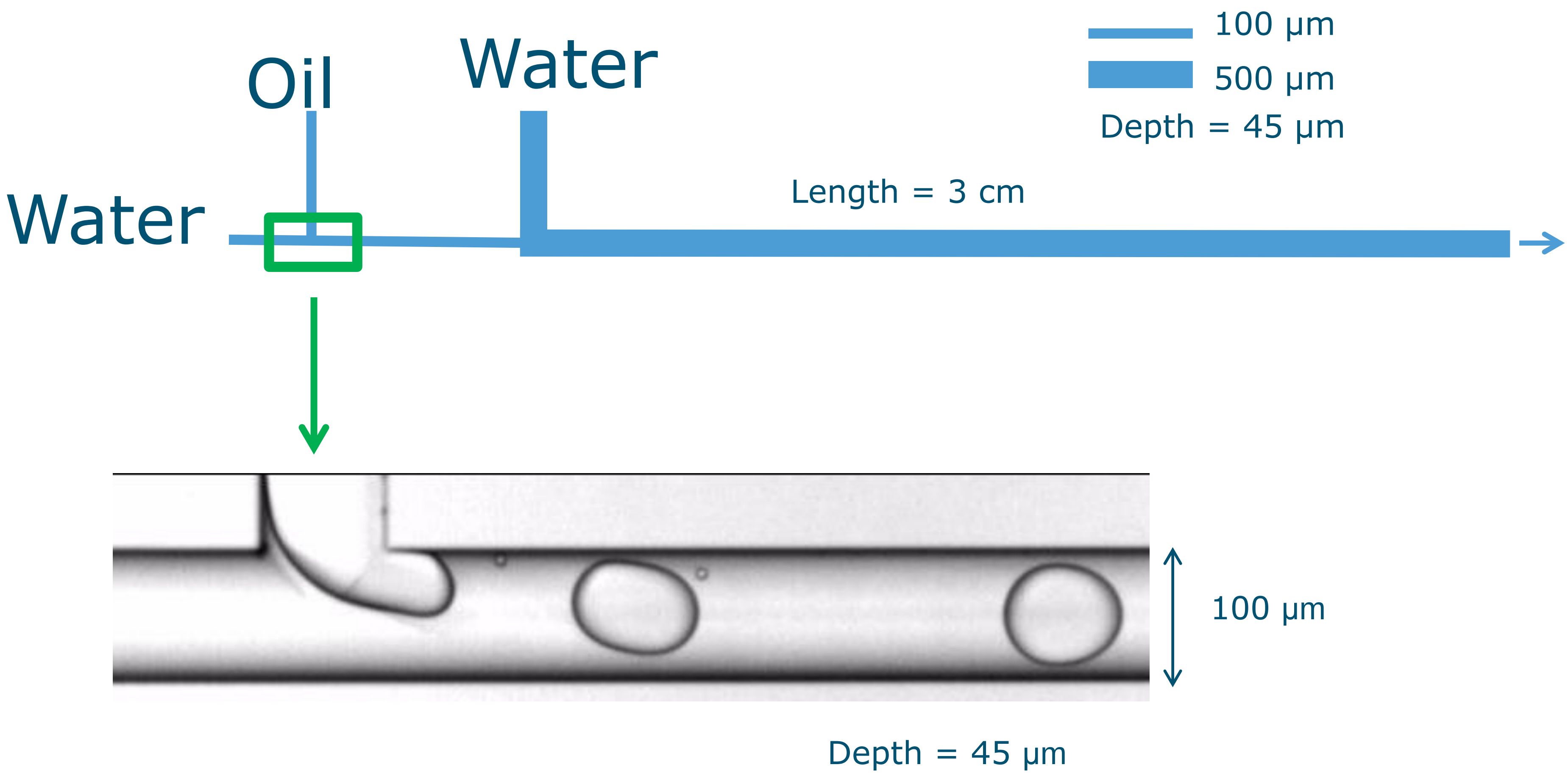
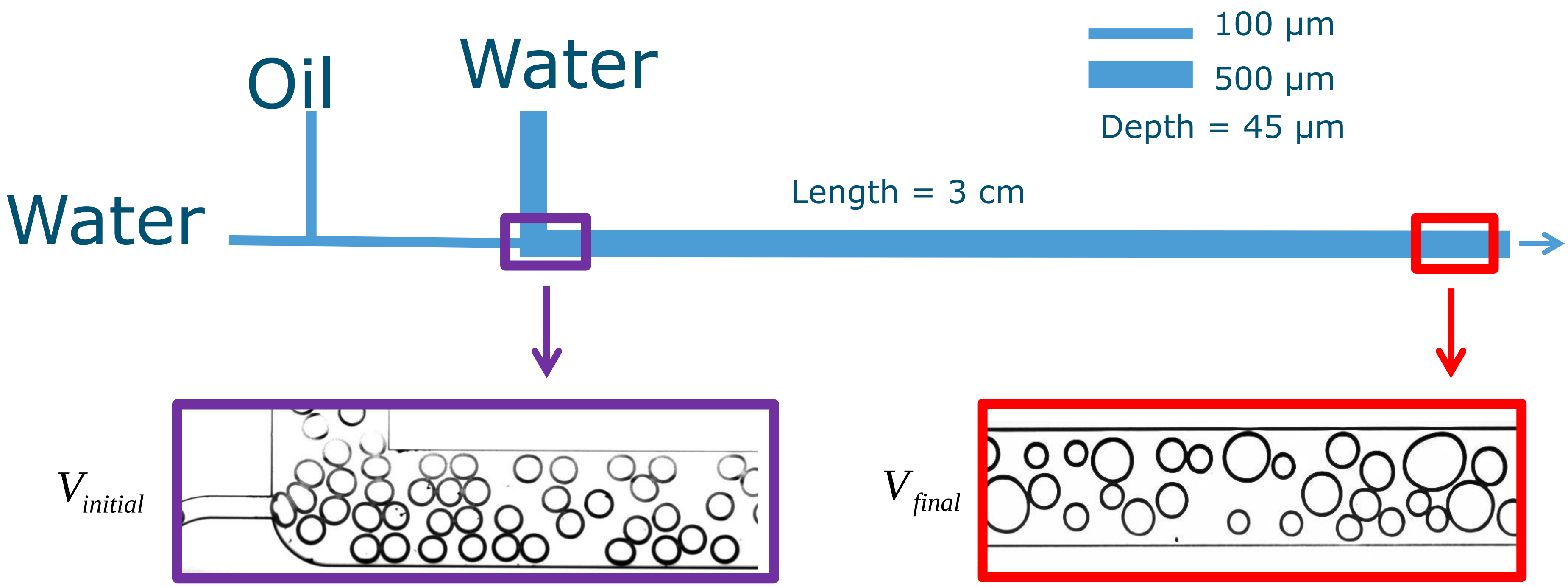
Coalescence channel



Coalescence channel



Mean number of coalescence events

$$N = \frac{V_{final}}{V_{initial}} - 1$$

Coalescence time

$$t_{coalesce} = \frac{length}{N \times velocity}$$

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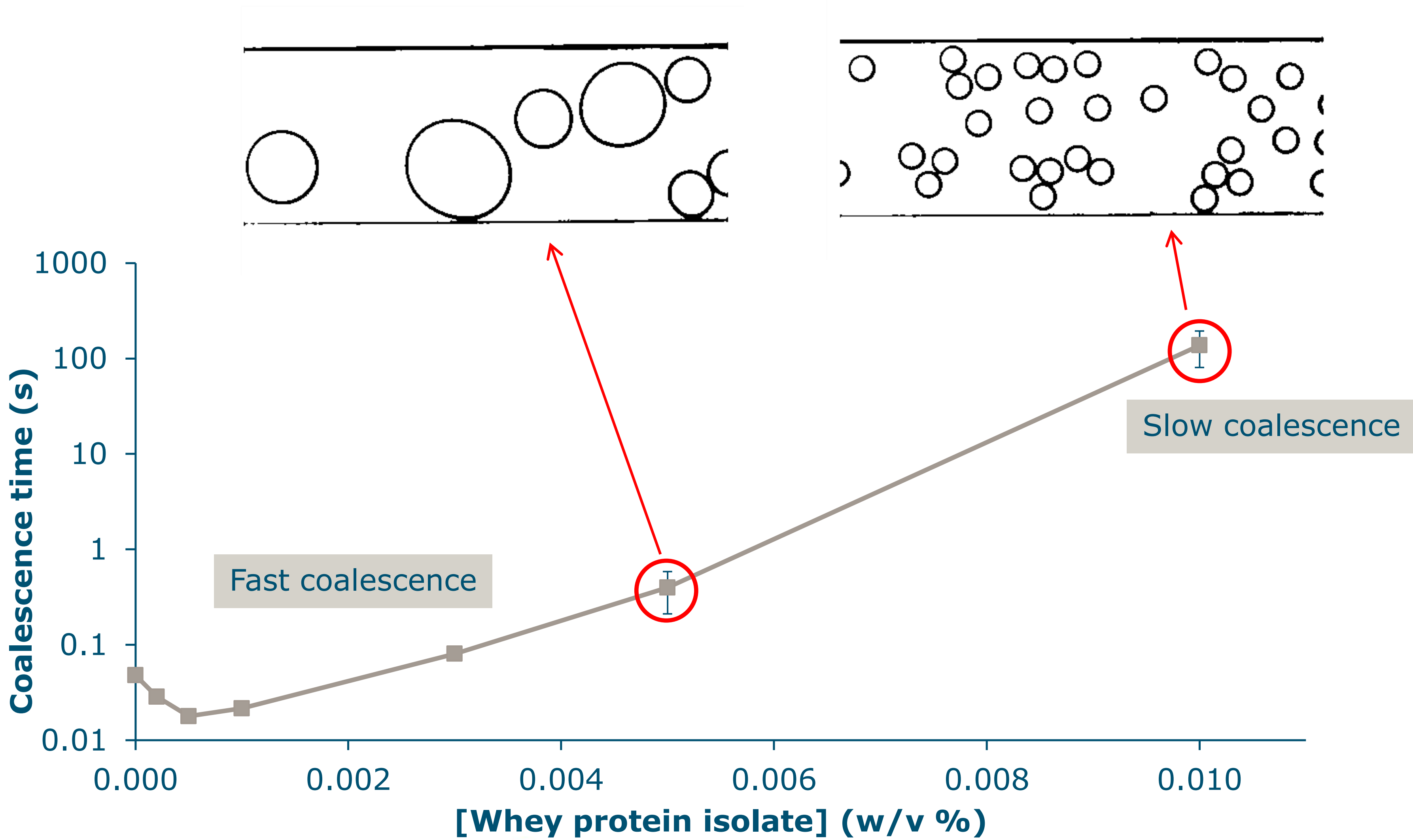
Coalescence channel - Emulsion



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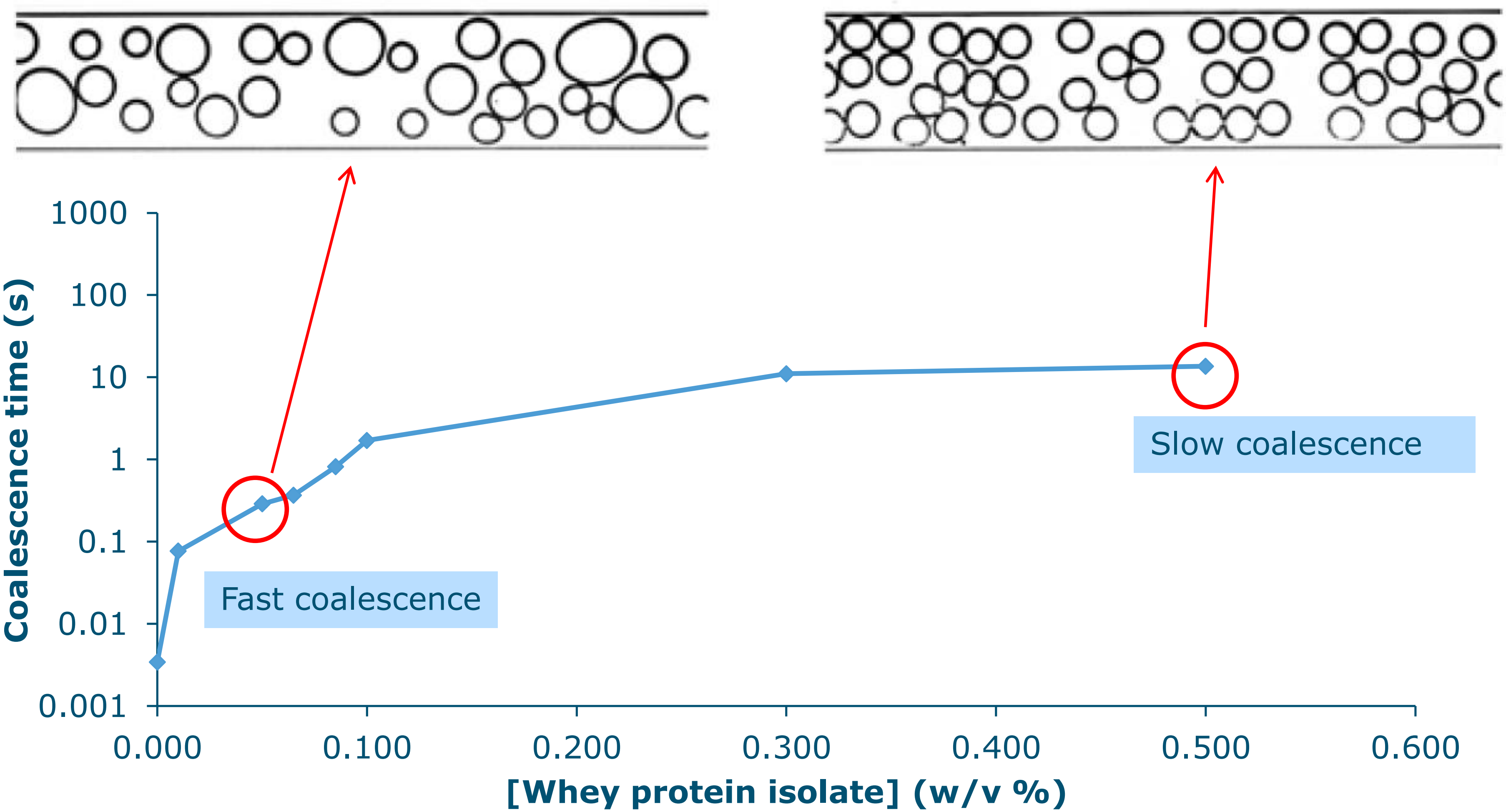
Coalescence channel - Foam



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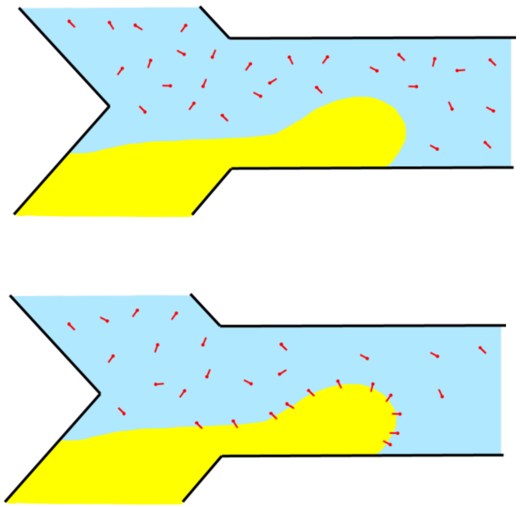
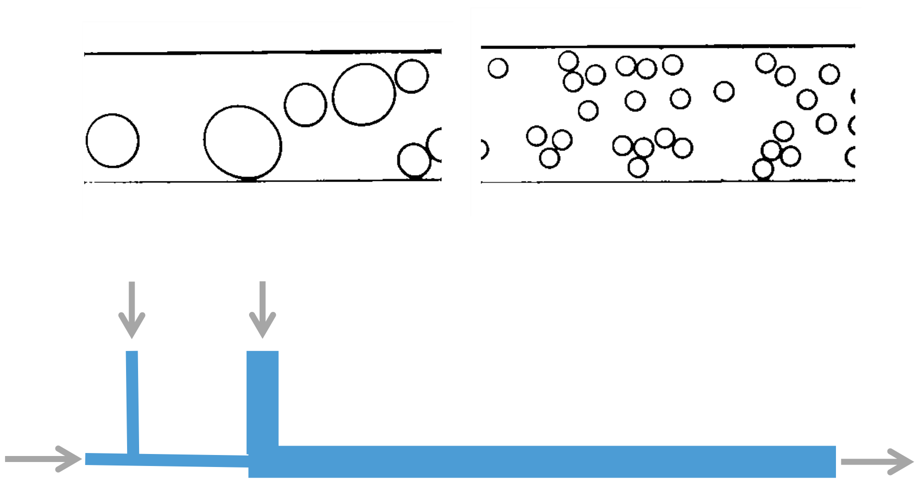
Conclusion

Microfluidics

Dynamic interfacial tension	Coalescence channel





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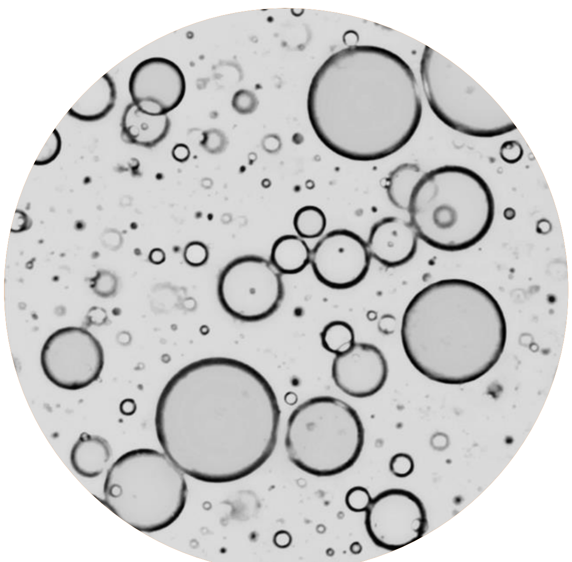

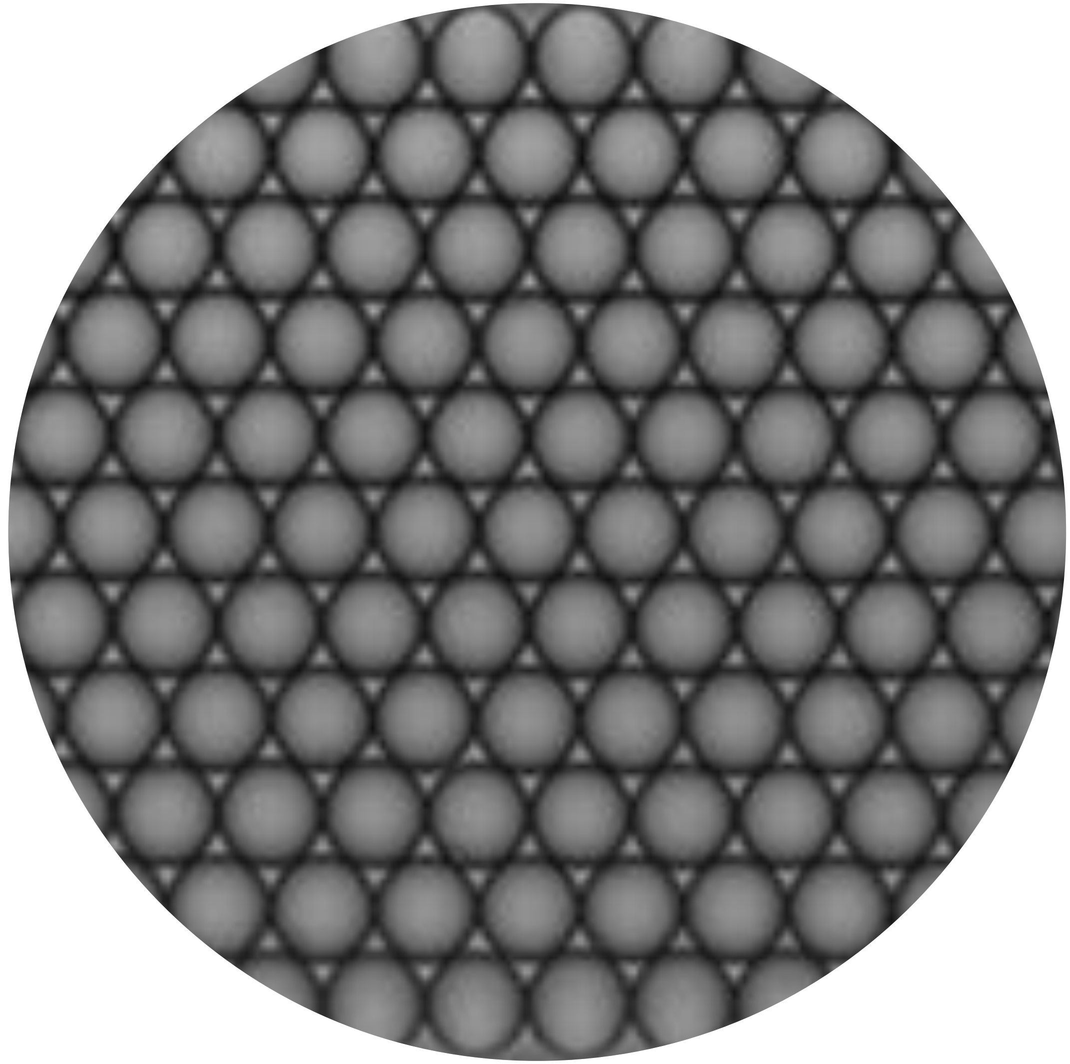

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