Electronic Supplementary Material (ESI) for Lab on a Chip

Electronic Supplemental Information for

An "Off-the-shelf" Capillary Microfluidic Device that Enables Tuning of the Droplet Breakup Regime at Constant Flow Rates

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Formation of double emulsions

Microfluidic double emulsions were produced in glass capillary microfluidic devices using the following conditions. The middle phase contained pure water with 1.35% (w/w) 250 nm latex nanoparticles (Surfactant-free poly methyl methacrylate, Arkema Inc.) which were fluorescently labeled using a solvent evaporation method described elsewhere[1] and 1.35% (w/w) Pluronic F68 (BASF). The inner and outer phases consisted of a mixture of 64% (v/v) Chlorinated Oil, (ParOil 10N, Dover Chemical Corp.) 34% (v/v) mineral oil, and 2% (v/v) ABIL EM 90 surfactant (Evonik Industries). The solutions were flowed together through orifices of 100 microns (Figure S1(a)) or 250 microns (Figure S1(b)).

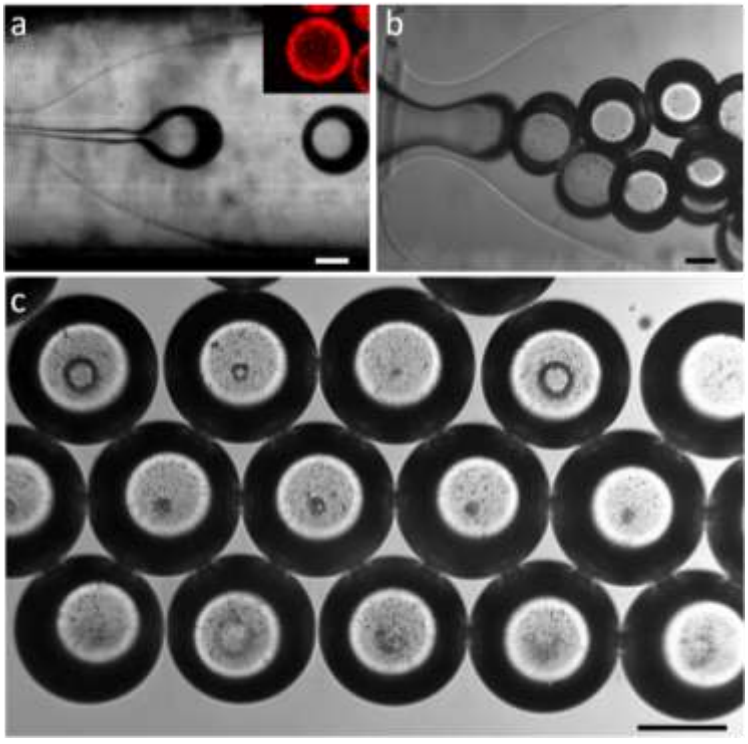

Figure S1. Microfluidic production of double emulsions with different devices. a) Production of a microfluidic double emulsion by jetting using a glass capillary device with a 100 µm orifice. Inner and middle phase flow rates were 0.5 µL/min, while the outer phase flow rate was 10 µL/min. Insert shows fluorescent nanoparticles in the middle phase. (i.e. aqueous outer phase of the double emulsion droplet) **b)** Screen shot of Supplemental Video 1 showing generation of a double emulsion by a device with a 250 µm orifice. Inner and middle phase flow rates are 5 µL/min and the outer phase flow rate is 25 µL/min. **c)** Monodisperse droplets generated by device in Supplemental Video 1. Scale bars are 100 µm.

Image of tip wetting

Two different microfluidic devices were built using a tapered injection tips without chemical functionalization. Wetting of the tip is present in both cases and affecting the droplet break-up.

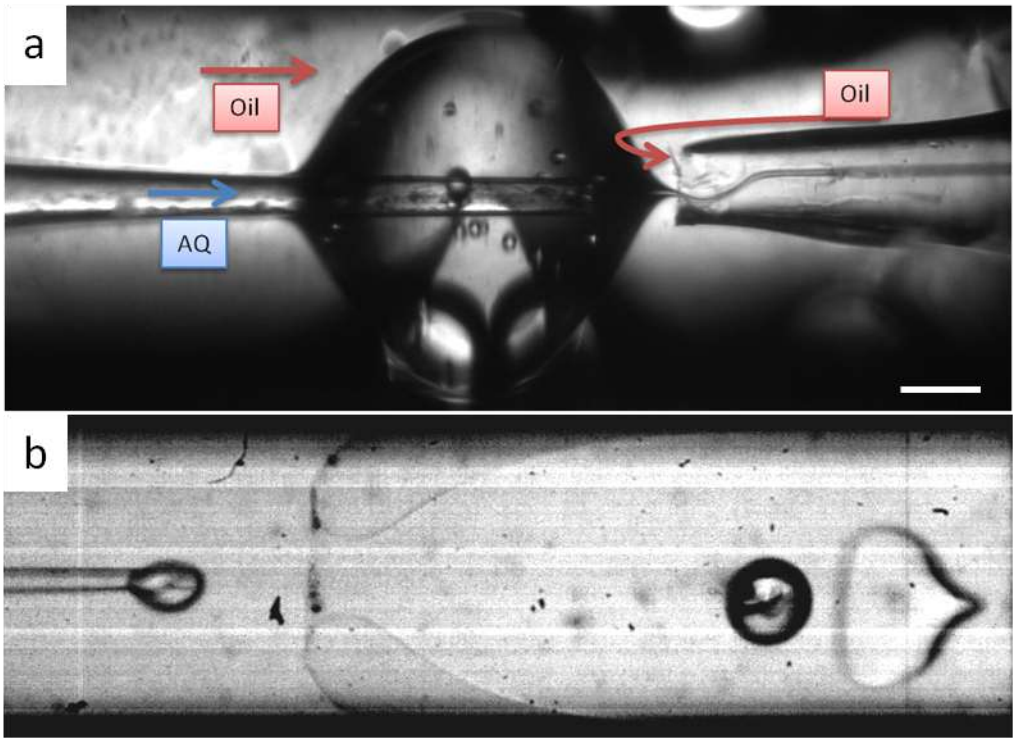

Figure S2. Wetting of the injection tip in two different microfluidics devices without chemical modification. a) Tapered collection orifice. **b)** Flamed collection orifice. Scale bar is 100 µm.

Images used to build graph in Figure 4

Capillary microfluidic droplet generation was performed using a pure water in mineral oil with 2% (v/v) Span 80 system. Images were used to construct Figure 4 and are presented in the supplemental information to show the phenomenon occurring using a different surfactant.

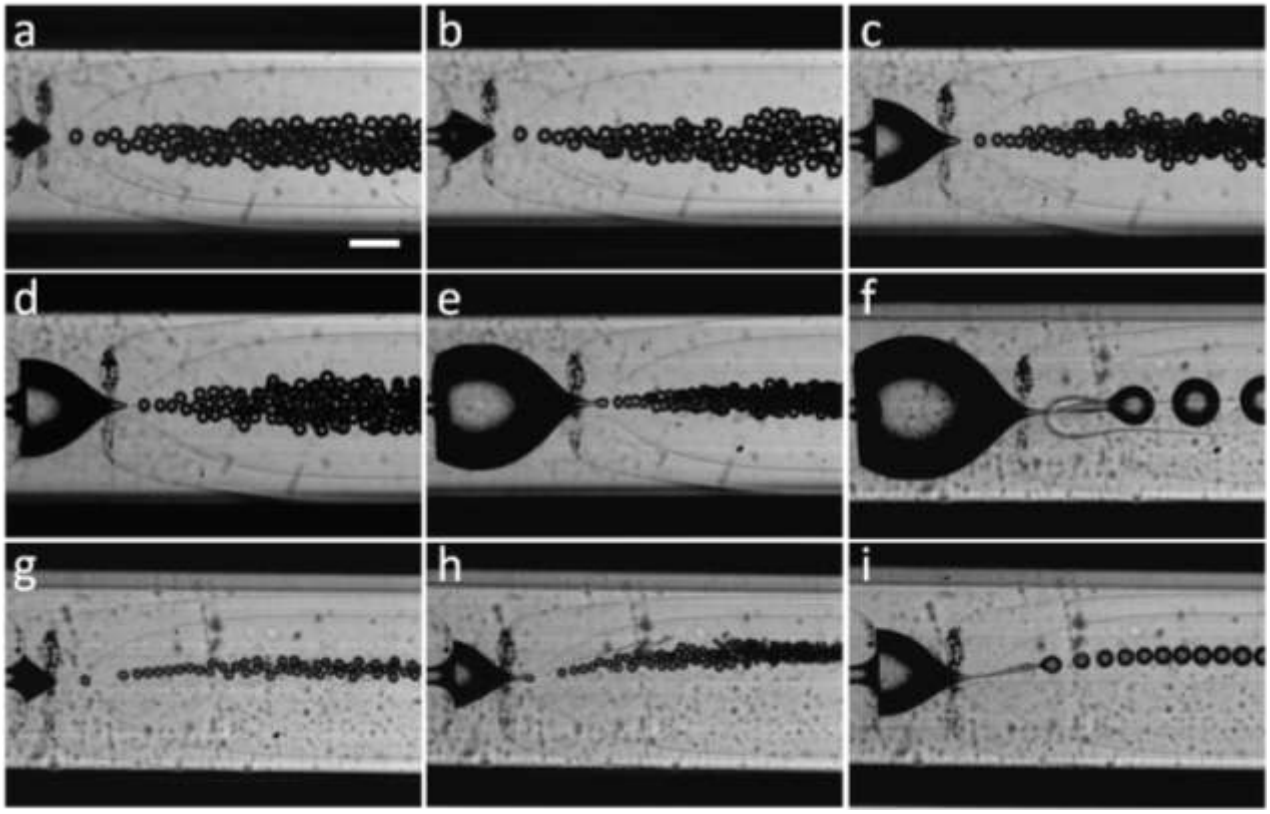

Figure S3. Changing the tip separation in a water, mineral oil system with Span 80 surfactant to generate the data used for Figure 4. a-f) Flow rate ratio is 10, the continuous phase flow rate (q_c) is 20 µL/min and the dispersed phase flow rate (q_d) is 2 µL/min. Tip separation varies from 50 µm up to 600 µm **g-i)** Flow rate ratio is 100, q_c is 20 µL/min and q_d is 0.2 µL/min. Tip separation varies from 50 µm to 300 µm. Scale bar is 200 µm.

Supplemental Video 1

As shown in Figure S1(b), a double emulsion was produced by using the formulation described above and a device with a 250 µm orifice. The inner and middle phase flow rates were maintained at 5 µL/min and the outer phase flow rate was 25 µL/min. Stable droplet generation can be observed over the 25 second period in the video and monodisperse droplets are shown in Figure S1(c).

1. J. D. Wan, L. Shi, B. Benson, M. J. Bruzek, J. E. Anthony, P. J. Sinko, R. K. Prudhomme and H. A. Stone, *Langmuir*, 2012, **28**, 13143-13148.