

Supplementary Information

Microfluidic generation of aqueous two-phase system (ATPS) droplets by controlled pulsating inlet pressures

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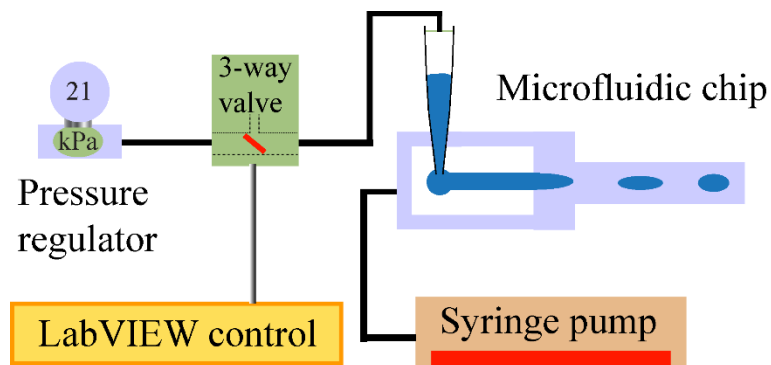


Figure S1. Schematic map of the ATPS droplet formation experimental configuration. The outer continuous phase PEG solution is introduced by a syringe pump. The inner discontinuous phase is supplied by a pulsating applied pressure. A DEX solution filled pipette tip is inserted into the inlet of the DEX phase and tubing (black line) is interfaced with the tip. A LabVIEW controlled pressure regulator is connected with a three-way solenoid valve to tune the compressed air with on-off cycles.

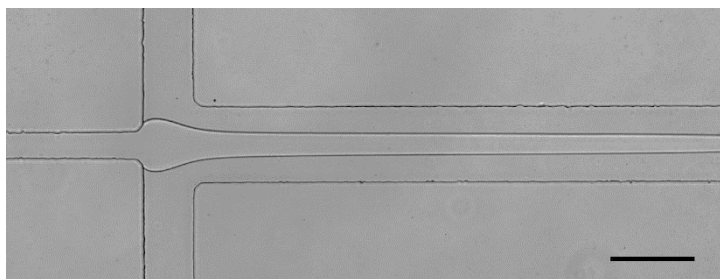


Figure S2. Continuous inner DEX solution and continuous outer PEG solution. The ultralow interfacial tension of the DEX and PEG solutions do not generate droplets. Rather, the fluids form a side-by-side flow pattern in a channel. Here, the outer sheath PEG flow rate is at $3 \mu\text{L min}^{-1}$ and the inner DEX flow pressure is set to a constant 21 kPa. Scale bar $200 \mu\text{m}$.

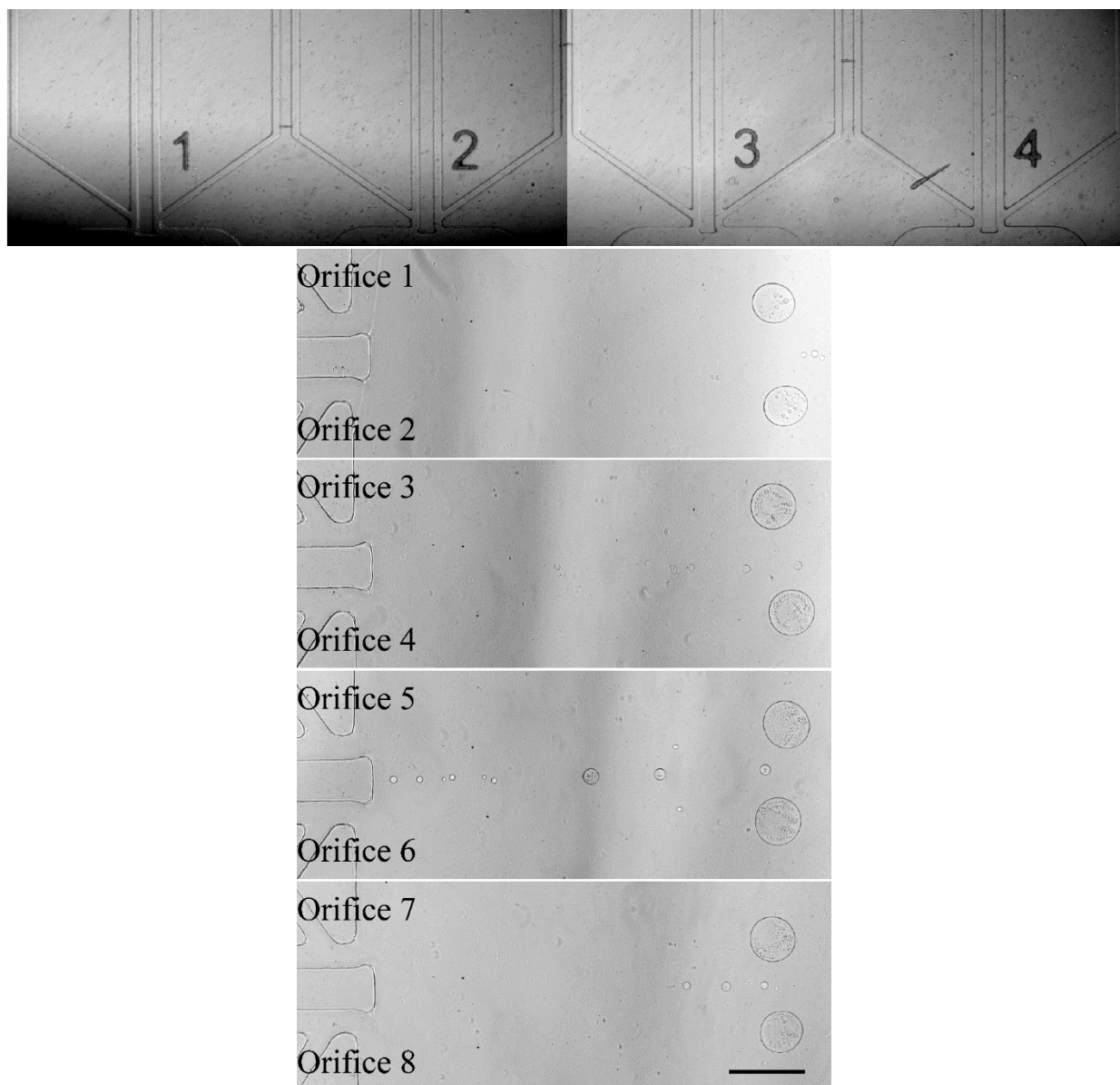


Figure S3. A parallel ATPS droplet generator with a zoomed-out image of the main channel layer (top) and simultaneous multiple-droplet formation (bottom). To demonstrate scaled-up multiple droplet formation, we prepared a two-layer PDMS channel with identical width and height of the eight orifices in a single microfluidic device. The first layer of the PDMS channel provides compressed air-controlled inlet flows with a single source of pressure. This channel is connected with a through hole to the second layer of the main PDMS-glass bonded channel. The second layer of the main channel has eight orifices and sheath channels, and provides fluids by a syringe pump. The overall size of the device is 10 mm \times 35 mm. For droplet formation experiments, we introduce 40 % (w/v) PEG for continuous phase and 5 % (w/v) DEX as disperse phase. Here, the outer sheath PEG flow rate is at 5 μLmin^{-1} and the inner DEX flow pressure is set to a 17 kPa. Pressure ‘on’ and ‘off’ times $t_{on} = 70$ ms and $t_{off} = 1,500$ ms, respectively. Scale bar 200 μm .

Supplementary Information Movies Legend:

Supplementary Information Movie 1:

Video shows a jet flow. The sheath flow of the PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the DEX solution has an applied pressure of 21 kPa with valve control $t_{on}=80$ ms and $t_{off}=100$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.

Supplementary Information Movie 2:

Video shows a jet with a wavy interface. The flow rate of the outer PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the pressure of the inner DEX solution is set to 21 kPa with valve control $t_{on}=80$ ms and $t_{off}=300$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.

Supplementary Information Movie 3:

Video shows droplet formation in ATPS. The flow rate of the outer PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the pressure of the inner DEX solution is set to 21 kPa with valve control $t_{on}=80$ ms and $t_{off}=2,100$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.

Supplementary Information Movie 4:

Video shows droplet formation within the upstream channel. The flow rate of the outer PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the pressure of the inner DEX solution is set to 21 kPa with valve control $t_{on}=80$ ms and $t_{off}=2,300$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.

Supplementary Information Movie 5:

Video shows sphere shape droplets forming in the reservoir. As a droplet reaches the reservoir, the droplet shape becomes spherical. The flow rate of the outer PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the pressure of the inner DEX solution is set to 42 kPa, with valve control $t_{on}=80$ ms and $t_{off}=1,300$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.

Supplementary Information Movie 6:

Video shows double droplets formed in a microfluidic channel. Two drops are being generated at a time continuously. The flow rate of the outer PEG solution is at $1 \mu\text{Lmin}^{-1}$ and the pressure of the inner DEX solution is set to 21 kPa with valve control $t_{on}=70$ ms and $t_{off}=600$ ms. The video has been recorded at a frame rate of 500 fps, and is being played back at 5 times reduced speed.