

On-Demand Generation of Monodisperse Femtoliter Droplets by Shape-Induced Shear

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Electronic Supplementary Information

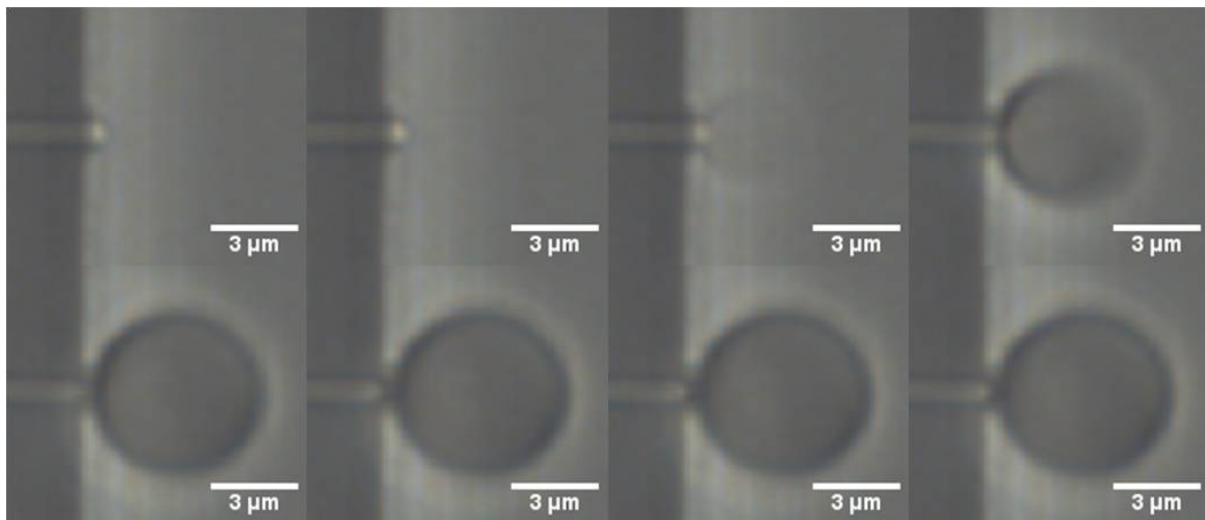
Bright field image sequences of droplet formation

The following movie files have been included in the Supplementary Information:

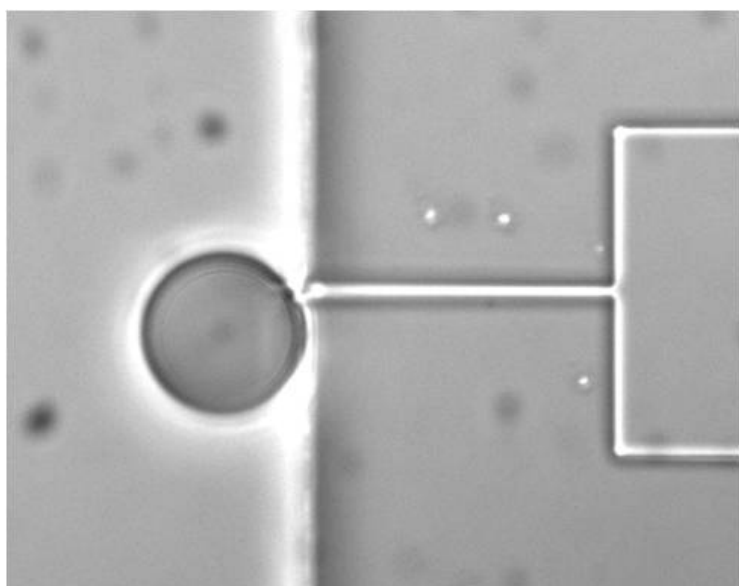
- Figure 2:
 - Collier ESI_Fig2movie.avi
- Figure 3: droplet formation intervals and size distributions as functions of $\Delta P = P_a - P_c$, taken from movies at different backing pressures:
 - Collier ESI_200 Pa 01 60ms.avi
 - Collier ESI_200 Pa 02 82ms.avi
 - Collier ESI_400 Pa.avi
 - Collier ESI_600 Pa.avi
 - Collier ESI_800 Pa.avi
 - Collier ESI_1000 Pa.avi

o Collier ESI_Fig3data.pdf (spreadsheet of droplet formation intervals and size distributions for Figure 3)

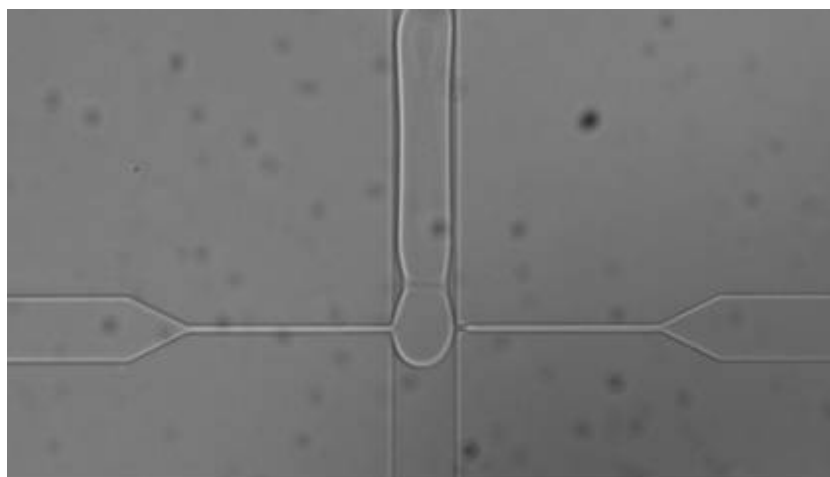
- Collier ESI_highspeed_images.jpg (sequence of images captured with high-speed CMOS camera, 841 μsec frame rate):



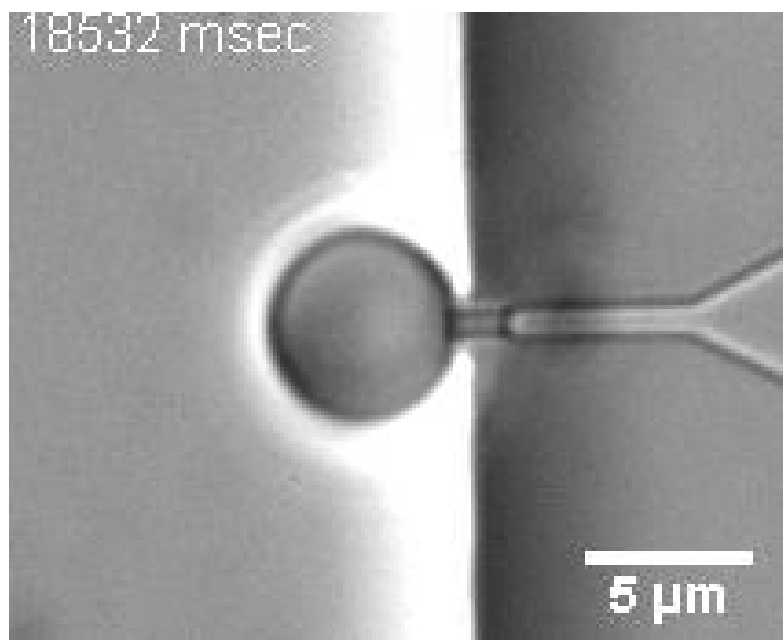
- Collier ESI_1 by 3 aspect ratio aqueous channel.jpg (1 μm wide x 3.3 μm high aqueous channel, droplets were larger, and required less backing pressure to form):



- Collier ESI_1 um tall oil channel.jpg (two apposed aqueous channels intersecting with oil channel; oil channel height is same height as aqueous channels, 1 μ m, which prevents droplet formation):



- Collier ESI_0.1percent_NP-PEG.jpg (with the addition of 0.1% v/v NP-PEG surfactant, a lower backing pressure was required to form droplets, and the time interval between droplets increased, due to time-dependent diffusion of surfactant molecules to the three-phase interface (oil/water/PDMS) at the aqueous channel orifice):



- Collier ESI_1percent_NP-PEG.avi (with 1.0% v/v surfactant, no droplets could be formed, instead, the aqueous phase flooded the oil channel)

Hard PDMS fabrication

Hard PDMS microfluidic device was produced using a protocol modified from Schmid et al. (H. Schmid and B. Michel, *Macromolecules* 2000, **33**, 3042-3049). To increase the mechanical stability of the device, two-layer PDMS devices were fabricated, consisting of a spin-coated thin layer of hard PDMS (h-PDMS) which was supported by a thick slab of soft PDMS (s-PDMS, Sylgard 184, Dow Corning, Midland, MI). Vinylmethylsiloxane-dimethylsiloxane copolymer (3.4 g, VDT-731, Gelest, Morrisville, PA) was mixed with 18 μL of the catalyst, platinum divinyltetramethyldisiloxane (Sigma-Aldrich), and one drop of 2,4,6,8-tetramethyl-tetravinylcyclotetrasiloxane (Sigma-Aldrich), and was degassed for 5 minutes. Methyl-hydrosilane-dimethylsiloxane copolymer (1 g, HMS-301, Gelest, Morrisville, PA) was added and thoroughly mixed immediately before spin coating (1000 rpm, 45 sec) onto the Si master to make the thin layer of h-PDMS (30-40 μm). This h-PDMS layer was partially cured for 3 minutes at 85° C. s-PDMS pre-polymer with a 10:1 mass ratio of base to curing agent was poured onto the coated master to a depth of 4-5 mm, and the two-layer device was cured for 1 hour at 120° C. The now completely cured two-layer PDMS device was released from the mold and inlet holes were punched using a Uni-Core 0.75mm hole-puncher (Ted Pella, Inc. Redding, CA). PDMS was spin-coated (10 μm -thick, 6500 rpm) onto #1 cover glass slips separately, and bonded to the two-layer PDMS replica by brief plasma treatment (10.5 W for 20 seconds, Harrick, Ithaca, NY). In order to enhance adhesion and render all the channel surfaces hydrophobic, the completed chips were cured for an additional 48 hours at 120° C.