An electro-coalescence chip for effective emulsion breaking in droplet microfluidics

Supporting Information

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Other Experimental Details

Microfluidic water-in-oil emulsion production

Microfluidic flow focusing devices with geometries as shown in Fig. 1 are fabricated by soft lithography using PDMS 14 with a 10:1 ratio of pre-polymer to curing agent. The channel width at the cross-junction is 85 µm and the height is 25 µm. The microchannels were sealed by bonding the PDMS replica to glass slides using oxygen plasma treatment. The micro-channels were treated with 1H,1H,2H,2H-perfluorooctyl-trichlorosilane to render their surface hydrophobic.
Solutions were injected into the microfluidic device using gastight syringes (Hamilton 1700 series) mounted onto high-precision syringe pumps (Cetoni® neMESYS, 14.5 gear) connected to the device via PTFE tubing (Novodirect GmbH, ID = 0.53 mm, OD = 1.03 mm). Water-in-oil emulsion droplets were produced by injecting an aqueous solution containing cells or hydrogel precursors with HFE 7500 (3M®) containing a triblock copolymer surfactant (1 % w/w).7,15 Droplet production was monitored on an IX71 microscope (Olympus). The flow rates for the dispersed aqueous phases were in the range of 90 µL h-1, for the continuous phase 420 µL h-1. Roughly 106-107 droplets were collected for each individual experiment.

Agarose bead preparation

Ultra-low melting temperature agarose (2 w/v %, Sigma-Aldrich) was dissolved in cell culture medium DMEM (Invitrogen) and mixed with cell suspensions to reach a final cell concentration of 1.2 x 106 cells mL-1. A microfluidic flow focusing device was used to produce monodisperse droplets at a frequency of up to 1,500 Hz. During the droplet production, the temperature of the dispersed phase is maintained around 37 °C using heating pads placed beneath the syringes. The produced emulsion is collected in a syringe stored at 4 °C facilitating the gelation of agarose.

PAAm microgel preparation

Monodisperse polyacrylamide (PAAm) particles are prepared from a water-in-oil emulsion made in a PDMS-based microfluidic device with rectangular 25 µm x 25 µm channels. The dispersed aqueous phase is a solution of 60 g L-1 acrylamide (Aldrich) and 1.8 g L-1 N,N-methylenebisacrylamide (Fluka) along with 8.8 mmol L-1 ammonium persulfate (Sigma). The flow rates are 700 µL h-1 for the aqueous and 1200 µL h-1 for the oil phase. Thermal gelation of the aqueous droplets is achieved by storing the emulsion at 65 oC for 1 h.