Electronic Supplementary Information

3D Printing of Monolithic Gravity-Assisted Step-Emulsification Device for Scalable Production of High Viscosity Emulsion Droplets

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Keywords
Step-emulsification; 3D-printing; Emulsions; Microfluidics; Microparticle; Parallelization

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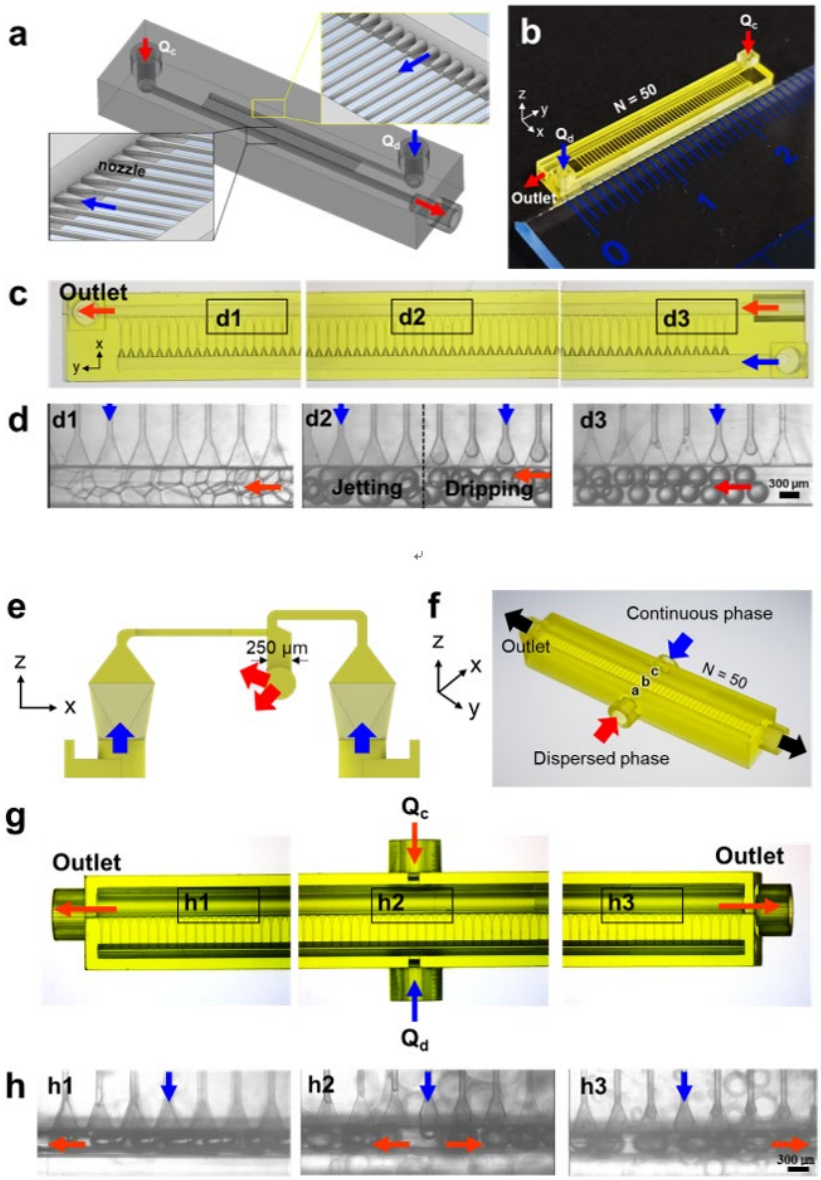

Fig. S1. (a) Schematics illustrating the 3D-printed step-emulsification device with one horizontal outlet. (b) Photograph and the (c) magnified photograph of the device. (d) Optical micrograph showing the droplet formation behavior at different drop generator nozzles (d1-d3). (e) Schematics illustrating the 3D-printed step-emulsification device with two horizontal outlets. (f) Photograph and the (g) magnified photograph of the device. (h) Optical micrograph showing the droplet formation behavior at different drop generator nozzles (h1-h3). The continuous phase is 2 wt% Span80 in mineral oil and the dispersed phase is DI water.

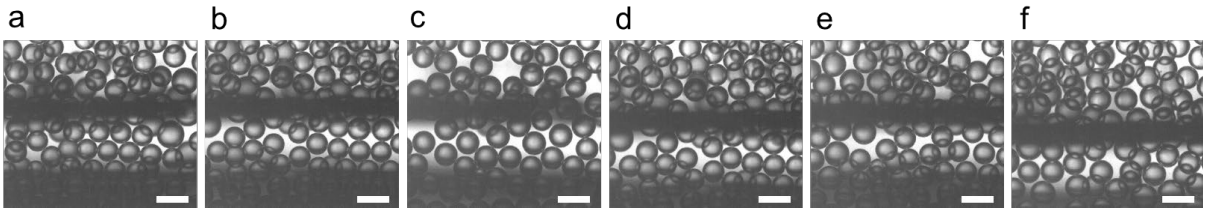

Fig. S2. Series of micrographs showing the monodisperse W/O emulsion droplets produced from the 3D-PSD at different flow rates. The average diameter of the droplets (*d*) are (a) 193.5 μm (CV = 3.2%), (b) 195.4 μm (CV = 2.1%), (c) 198.4 μm (CV = 2.6%), (d) 194.1 μm (CV = 3.2%), (e) 195.8 μm (CV = 2.5%), and (f) 193.4 μm (CV = 2.9%), which are operated at (Q_d = 5 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 10 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 20 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 30 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 40 mL h^{-1}, Q_c = 50 mL h^{-1}), and (Q_d = 50 mL h^{-1}, Q_c = 50 mL h^{-1}), respectively. Scale bar presents 300 μm.

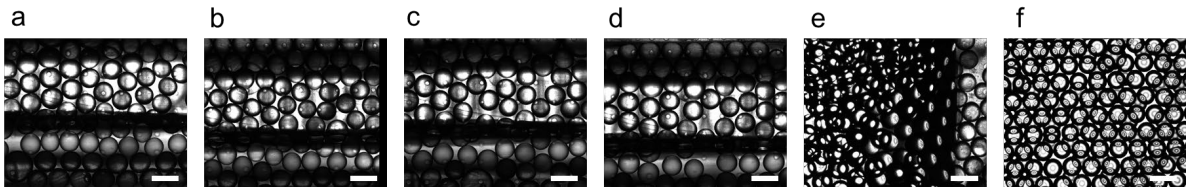

Fig. S3. Series of micrographs showing the monodisperse O/W emulsion droplets produced from the hydrophilically modified 3D-PSD at different flow rates. The average diameter of the droplets (*d*) are (a) 193.5 μm (CV = 3.2%), (b) 195.4 μm (CV = 2.1%), (c) 198.4 μm (CV = 2.6%), (d) 194.1 μm (CV = 3.2%), (e) 195.8 μm (CV = 2.5%), and (f) 193.4 μm (CV = 2.9%), which are operated at (Q_d = 5 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 10 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 20 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 30 mL h^{-1}, Q_c = 50 mL h^{-1}), (Q_d = 40 mL h^{-1}, Q_c = 50 mL h^{-1}), and (Q_d = 50 mL h^{-1}, Q_c = 50 mL h^{-1}), respectively. The continuous phase is 2 wt% PVA aqueous solution and the dispersed phase is DCM. Scale bar presents 300 μm.

Table S1. Physical properties and parameters used for the CFD simulation.

Notation	Description	Value
ρ_c	Density of the continuous phase	770 kg/m^3
ρ_d	Density of the dispersed phase	998 kg/m^3
μ_c	Dynamic viscosity of the continuous phase	3.0 x 10^{-3} Pa·s
μ_d	Dynamic viscosity of the dispersed phase	8.9 x 10^{-4} Pa·s
$^a\sigma$	Interfacial tension between the continuous and dispersed phases	0.0050 N/m
g	Gravitational acceleration	9.8 m/s^2
θ_{dc}	Contact angle between the continuous and dispersed phases on the channel wall	150˚