

Supplementary information

AC Electric Field Controlled Multi-component Droplet Coalescence at Microscale

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Table.S1 Surface tension coefficient and conductivity of fluids

Fluids	Compositions	Surface tension coefficient¹	Conductivity ($\mu\text{S cm}$)²
Organic phase	5 wt% Span 80 in mineral oil	30.722	0
Aqueous phase 1	Deionized water	71.757	2.98
Aqueous phase 2	70 wt% glycerol in deionized water	67.263	1.26
Aqueous phase 3	70 wt% glycerol and 0.03 wt% PEO in deionized water	57.170	3.05
Aqueous phase 4	0.05 wt% SDS in deionized water	38.727	432.0
Aqueous phase 5	0.20 wt% Tween 20 in deionized water	39.219	20.00
Aqueous phase 6	0.1mmol/L NaCl in deionized water	71.496	27.5
Aqueous phase 7	1mmol/L NaCl in deionized water	71.841	147.9
Aqueous phase 8	100mmol/L NaCl in deionized water	72.785	1075
Aqueous phase 9	1000mmol/L NaCl in deionized water	74.487	8350

¹ The surface tension coefficients are measured by Dataphysics DCAT II using Wilhelmy plate method.

² The conductivities are measured by Proline Plus Meters.

Table.S2 Relative permittivity of fluids

Fluids	Compositions	Relative permittivity ¹
Organic phase	5 wt% Span 80 in mineral oil	2.8
Aqueous phase 1	Deionized water	80
Aqueous phase 2	70 wt% glycerol in deionized water	35
Aqueous phase 3	70 wt% glycerol and 0.03 wt% PEO in deionized water	116.92

¹ The dielectric constants are measure by filling the fluids into a capacitor. The capacitances are measured by a precision LCR meter (keysight E4980AL).

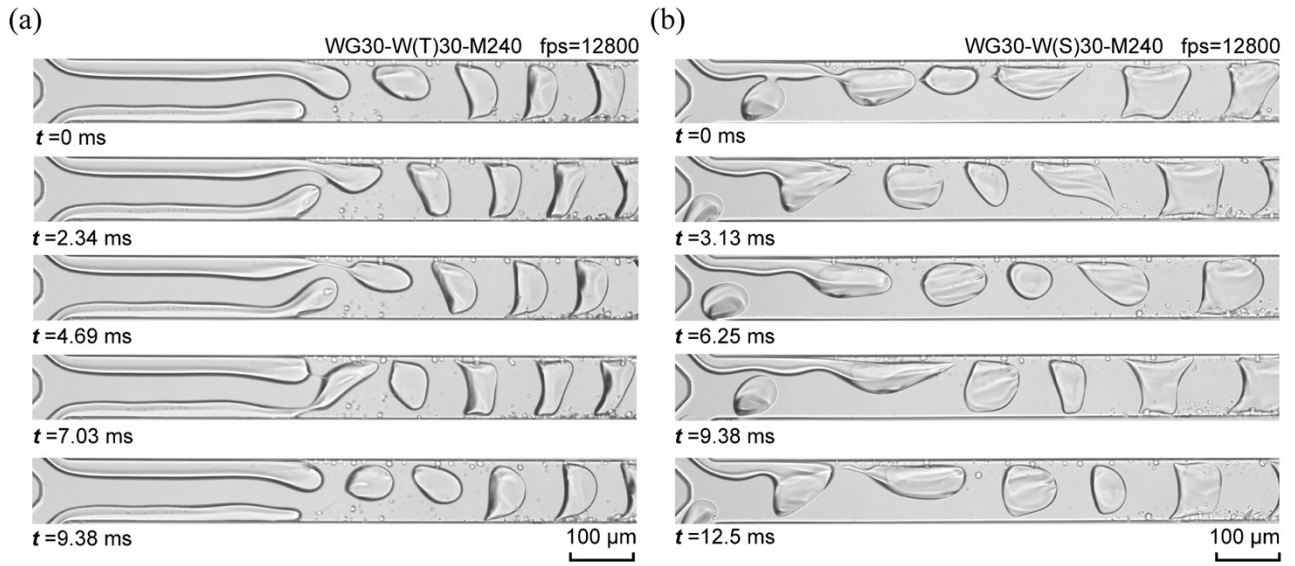


Fig. S1 Droplet dynamics affected by the surfactant under AC electric fields when U is 3000 V, and f is 100 Hz. The flow rate ratio is $Q_{WG}:Q_W:Q_M = 30:30:240 \mu\text{L h}^{-1}$. (a) The addition of Tween 20 at a constant ratio of 0.2% by weight. (b) 0.05 wt% SDS is added in the aqueous phase.

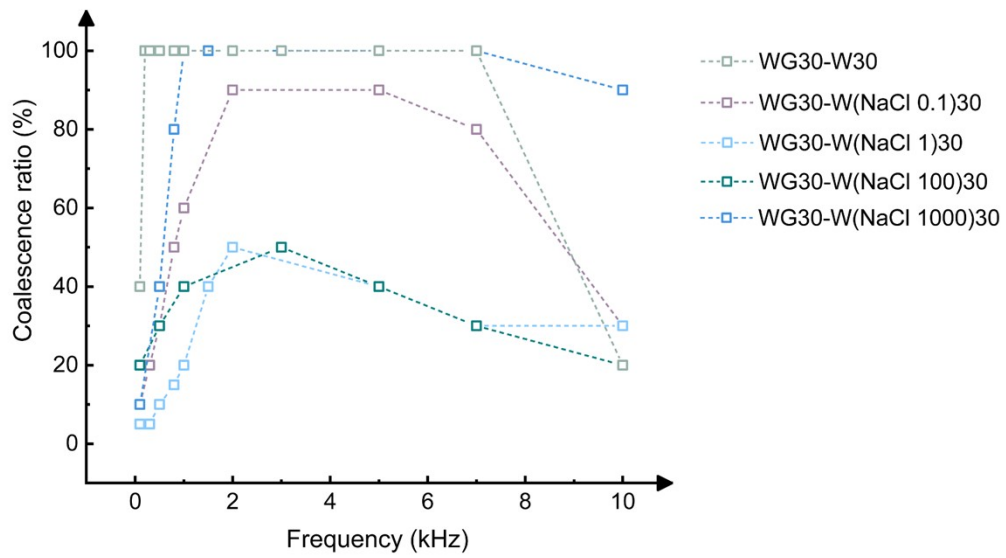


Fig. S2 Coalescence ratios varies with the applied frequency ranging from 0 ~ 10 kHz and different additions of NaCl in water when U is 400 V.

The caption list of the videos

Effects of the voltage under AC E-field 100 Hz (AVI)

Effects of the frequency under AC E-field 400 V (AVI)

Effects of the component ratio under AC E-field 500 V 100 Hz (AVI)

Influence of the electric permittivity in aqueous phase under AC E-field 1000 V 100 Hz (AVI)

Impact of surfactant under AC E-field 1500 V, 3000 V 100Hz (AVI)

Electro-mixing of colored droplets (AVI)