Supporting Information for *Lab on a Chip*

Direct measurement of the differential pressure during drop formation in a co-flow microfluidic device †

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A mathematical verification of the Equation (4)

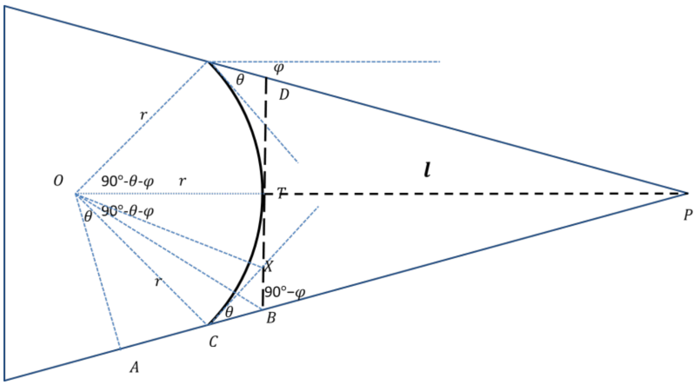

Figure S1 (same as Figure 2) A schematic expressing the detection of the curve radius, r, using easily-detected parameters. The taper represents the inner wall of the gas capillary. O is the centre of the interface sphere. OA is perpendicular to the wall, line BT is tangent to the interface sphere at T where T is the right top of the interface. P is the top angle of the taper, and l is the length of PT

$$< TOC = 180° - < OCX - \theta - \varphi = 90° - \theta - \varphi$$

$$\therefore < TOX = \frac{1}{2} < TOC = \frac{90° - \theta - \varphi}{2}$$

$$\therefore |CX| = |OC| \cdot \tan < TOX = r \cdot \tan\frac{90° - \theta - \varphi}{2}$$

$$\therefore \frac{\sin < CBX}{|CX|} = \frac{\sin < BCX}{|BX|}$$

$$\Leftrightarrow |BX| = |CX| \frac{\sin < BCX}{\sin < CBX} = r \cdot \tan\frac{90° - \theta - \varphi}{2} \cdot \frac{\sin\theta}{\sin(90° - \varphi)} = r \cdot \tan\frac{90° - \theta - \varphi}{2} \cdot \frac{\sin\theta}{\cos\varphi}$$

$$\therefore |BT| = |TX| + |BX| = |CX| + |BX| = r \cdot \tan\frac{90° - \theta - \varphi}{2} \cdot \left(1 + \frac{\sin\theta}{\cos\varphi}\right)$$

$$\therefore d = 2|BT| = 2r \cdot \tan\frac{90° - \theta - \varphi}{2} \cdot \left(1 + \frac{\sin\theta}{\cos\varphi}\right) \Rightarrow \frac{1}{r} = \frac{2\tan\frac{90° - \theta - \varphi}{2} \cdot \left(1 + \frac{\sin\theta}{\cos\varphi}\right)}{d}$$

Interfacial tension of experimental systems

Using a Video-based optical contact angle measuring instruments (OCA20, Dataphysics)， we have measured the interfacial tension between the experimental phases, shown in table S1

Table S1 Interfacial tension between the dispersed phase and other two phases in the experimental systems

	Octanol	air
Pure water	8.5 mN/m	71.3 mN/m
Water with 5% Tween 80	3.7 mN/m	28.1 mN/m

The effect of CLG to the flow

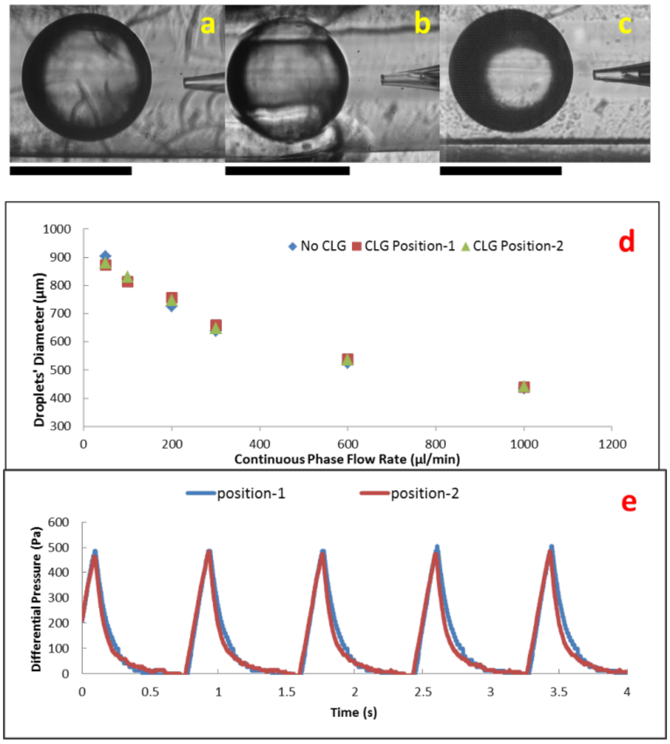

Figure S2. a) Co-axial capillary micro-structure without CLG inserted, the scale bar is 1mm. b) The same microdevice, with a CLG close to the dispersed phase channel wall, the scale bar is 1mm. c) The same microdevice, with a different CLG nearly co-axial with the dispersed phase capillary, the scale bar is 1mm. In (a)-(c), the continuous phase is octanol, the dispersed phase is pure water, and the flow rates are 100µl/min and 1µl/min, respectively. d) the diameter of droplets under the different conditions at different continuous phase flow rates and a constant dispersed phase flow rate of 1µl/min. e) a comparison of pressure measured with CLG in position 1 and in position 2. The experiment system is the same as that of (a)-(c), and the flow rates are 600µl/min and 6µl/min, respectively.

As the size of CLG is comparable to that of the dispersed phase capillary tip, it is necessary to make sure that the inserted CLG will not affect the flow. An easy way to verify this is to measure the droplets' size under identical flow conditions while varying the position of the CLG. In Figure S2, we compared three different cases: no CLG present, with a CLG close to the dispersed phase channel inner wall, and with a CLG which is nearly co-axial with the dispersed channel. As we expected, the diameter of the generated droplets is the same in all three cases, when the flow conditions are the same, as seen in Figure S2(d). Furthermore, we compare the results get by CLG in position 1 and in position 2, when the outer phase's flow rate is 600µl/min and the inner phase's flow rate is 6µl/min. we could find the two curves are similar, which means that whether the CLG is co-axial with the inner capillary does not affect the measurement considerably.

In conclusion, the existence or misalignment of the CLG does not to affect the flow of the co-flow junction system in this study.