Transitional regime of droplet generation in a microfluidic flow-focusing device

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We proposed new type of regime map of droplet generation in a microfluidic flow-focusing device. This map classifies different modes based on initial droplet tip position. A special bi-stability phenomenon was observed in the transitional regime between different modes.

Careful & precise liquid handling has always been a crucial part in various research activities in the field biology, biotechnology or microbiology. Recent development of microfluidics provides new and effective means of precise liquid handling. The key to this technique is the manipulation of liquids in the form of confined droplet. Droplet is used as transporter and micro-reactor of biochemical processes inside a microfluidic chip. Although droplet microfluidic has been used extensively for such application [1], the mechanics of droplet generation in such devices were note fully understood. In this study the generation of droplets in a microfluidic flow-focusing device was evaluated. This study compared two different droplet generation regime maps. As reported previously [2], the first map distinguishes different mode of droplet generation based on the position of pinch-off: at the cross-junction (DCJ), downstream of cross-junction (DC) and stable parallel flow (PF). The new second map proposes different regimes based on the initial position of droplet tip: approximately at the cross-junction (mode G1), downstream of cross-junction (mode G2) and parallel flow (PF). Although it sounds similar, the new map was able to clearly shown the occurrence of special phenomenon in the transitional between G1 and G2. The phenomenon is quite critical because there were two modes (G1 & G2) appears simultaneously during droplet generation and as the result, it produces two different droplet sizes (bi-stability). Four different channel geometry were used to evaluate the role of aspect ratio to droplet generation modes. In practical point of view, this finding may be useful as design consideration when using flow-focusing in a microfluidic device.

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