Parallel Droplet Generation with Linear Concentration Gradient

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Conventional methods for generating concentration gradient have employed serial 2-fold dilution strategy. It is a simple way to generate the chemical concentration gradients in a single device. However, it has a low linearity on their gradient profiles as well as the limitation to generate non-linear gradient due to its dilution system. Moreover, improvement of linearity requires complicate design to precisely control the fluidic resistance, making the device to have low space efficiency because of its huge size.

We present a novel microfluidic platform producing monodisperse droplets with linear concentration gradient. It is achieved by simply tuning the flow resistance of two aqueous phases in each parallel droplet generator. We verified the linearity of the gradient by visualizing it with fluorescence. The results well-matched with the theroetical value which is obatained through calculating the flow resistance. We further demonstrated the controllability of the gradient profile by showing various types of slopes including 'V' and 'N'-shaped concentration profiles. We believe that our strategy has a great potential to be used in many bio/chemical assays.