Viscous droplet mixing enhancement using an acoustically oscillating bubble

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With the rapid development of the bioindustry, there has been an increasing interest in biochemical analysis systems such as biochips and lab-on-a-chips, which has enphasized the significance of microfluidic control technology. Microfluidic control technology is composed of fundamental techniques for manipulating small amounts of fluid, including movement, mixing, and separation. Among these techniques, mixing is crucial in analyzing diverse processes, including sample preparation, dilution, and reaction. However, in microfluidic systems, the effect of viscous forces is dominant due to the small Reynolds number, so mixing can only be achieved through diffusion, resulting in very slow mixing speed[1].

This paper proposes a technology to enhance the mixing efficiency of viscous droplets in microfluidic systems using microstreaming, which occurs when bubbles formed in viscous droplets are oscillated by acoustic waves. Firstly, in order to investigate the characteristics of microstreaming generated by acoustically excited bubbles inside droplets, a high-speed camera and fluorescent particles are utilized to visualize the microstreaming occured when bubbles oscillated by acoustic waves of various amplitudes and frequencies. Next, to examine the effect of microstreaming on the mixing performance of the viscous droplet, the mixing rates of two fluids were compared with and without bubbles inside a viscous droplet composed of 60 wt% glycerol and safranin. As a result of the analysis, it was confirmed that the mixing efficiency of the two fluids with bubbles was much more improved than the mixing efficiency of the two fluids without bubbles.

The proposed mixing method is expected to be useful for various applications in related studies in the future.

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[1] Lee et al., *Sens. Actuator A Phys.*, **182**, 153-156, (2012)

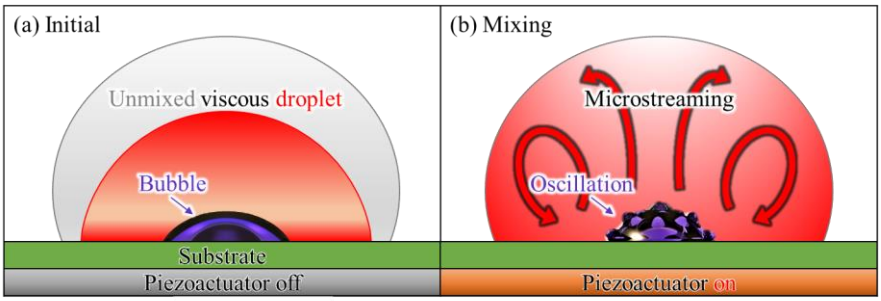

Figure 1: Concept diagram of the proposed viscous droplet mixing enhancement method using an acoustically oscillating bubble.