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EXPERIMENTAL INVESTIGATION OF INTERFACIAL INSTABILITY OF DROPLETS IN ACOUSTIC FIELD

Abstract

This paper describes the experimental investigation on the interfacial instability of the droplets for better handling of samples in midair. Acoustic levitation is highly applicable in the fields of analytical chemistry and biology because container-less processing can prevent undesirable wall effects, such as nucleation and contamination resulting from the container walls. Although many studies demonstrated the atomization behavior in single-axis acoustic levitation, the breakup characteristics of levitated droplets in ultrasonic phased array levitation have been less studied. Here, we visualized the atomization behavior of ethanol, ethanol solution, and silicone oil droplets using a high-speed camera. Based on high-speed visualization, the critical interfacial velocities of the levitated droplets immediately before their atomization were discussed and compared to the theoretical prediction. The time evolution of the interfacial velocity of the droplets was quantified, revealing the breakup mechanism, which can be triggered by the Kelvin–Helmholtz instability. After atomization of the mother droplet, daughter droplets were generated and spread radially from the droplet interface. The capillary wave on the atomizing droplet can determine the size distribution of the atomized daughter droplets. Although our experimental work illustrates the breakup mechanism of levitated droplets during acoustic levitation, direct measurement of the pressure field near the droplet interface as well as the unified understanding and analysis of the dimensionless number remains a significant challenge for future studies. Hopefully, our demonstration stimulates further research and deeper insights into improving the stability of droplet manipulation for levitated samples in order to realize futuristic applications on ground and space utilization.