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EXPERIMENTAL INVESTIGATION OF EVAPORATION OF MULTICOMPONENT DROPLET BY ACOUSTIC LEVITATION

Abstract

Acoustic levitation method (ALM) can hold droplet in container-less by forming an acoustic standing wave between the horn and the reflector. This levitation method has a wide range of applications in the fields of material processing, biology and analytical chemistry, because container-less processing could prevent nucleation and contamination due to the container wall. Although perfect sample manipulation with ALM has been highly expected recently, this has not been achieved partly because of thermofluid nonlinearity. Evaporation of sample which is one of the important process for container-less processing. However, evaporation of multicomponent droplets in single acoustic levitator is still unclear. It is crucial to understand the non-linear behavior of the evaporation phenomenon on the levitated multicomponent droplets. The purpose of our study is to understand the evaporation of an acoustically levitated multicomponent droplet and manipulate the evaporation process of sample. In this paper, we report the experimental investigation on the evaporation process of pure and multicomponent droplets and the results compared with theory. The evaporation processes and the temporal evolution of the surface temperature of a droplet were measured by using the high speed camera and radiation thermometer, respectively. Input frequency of sound wave was 19.3 [kHz]. A transducer-reflector gap was set at 48 [mm]. A sound pressure in the test section was 1.2-1.9 [kPa]. We used water, ethanol, methanol, hexane, acetone and pentane as test samples to clarify the effect of the saturated vapor pressure on an evaporation process. In the case of ethanol, methanol and acetone droplet evaporated with two different evaporation stage. From this result, it is indicated that the water vapor in the air was condensed during the evaporation process of the water-soluble droplet. Due to the condensation from the air the experimental data did not agree with the basic theoretical prediction by d^2 law. In the evaporation process of the first stage, the modified theory considered the forced convection around the droplet was quantitatively consistent with the experimental results. Also, we used ethanol solution, methanol solution and acetone solution as binary droplets. The concentration of ethanol, methanol and acetone was set at 25, 50 and 75 wt%. As the concentration increased by the evaporation, the transition time from the first to the second stage also increased by preferential evaporation. It is indicated that the transition time can be also predicted by d^2 law.