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Author: Mr. Tomoaki Sano
Tokyo University of Science, Japan

Prof. Ichiro Ueno
Tokyo University of Science, Japan

CORRELATION BETWEEN PARTICLE ACCUMULATION STRUCTURE (PAS) AND HYDROTHERMAL WAVE BY THERMOCAPILLARY-DRIVEN FLOW IN HALF-ZONE LIQUID BRIDGE

Abstract

We focus on particle accumulation structure (PAS) due to a thermocapillary flow in a liquid bridge, especially on correlation between the PAS and surface temperature distribution realized by hydrothermal wave (HW) instability. The liquid bridge is formed between top and bottom coaxial rods. The top rod is heated and the other is cooled to realize a designated temperature difference between the end walls of the liquid bridge. The height (H) and radius (R) of the liquid bridge are of 1.6 mm and 2.5 mm, respectively. The aspect ratio Γ (= H/R) is fixed at 0.64 through our experiments. We employ n-decane (Prandtl number Pr = 15.0) and 2-cSt silicone oil (Pr = 28.1) as the test fluids. We visualize the convection in the liquid bridge by suspending gold-coated acrylic particles in the fluid. It is known that the particles gather along closed orbits in the liquid bridge to form PAS after the onset of the HW instability. We observe the PAS with two high-speed cameras, and measure the surface temperature distribution with an infrared camera simultaneously to grasp spatio-temporal correlation between the PAS and the HW. We confirm the validity of our experimental system by making a comparison in the case of n-decane with the results by Schwabe et al. (Phys. Fluids, 2007). In order to take account of the effect of heat transfer between the liquid bridge and the ambient gas flow, we employ a coaxial shield to realize forced upward or downward flow at various flow rates in the ambient gas region. We observe similar PAS in shape for n-decane and 2-cSt silicone oil. We find out, however, significant differences in the correlation between the PAS and the surface temperature distribution due to the HW, especially in the position where the PAS comes closest to the free surface and the local minima of the surface temperature.