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EFFECT OF THE INCLINATION ANGLES OF THE CAPILLARY TUBE ON THE NATURAL EVAPORATION OF ABSOLUTE ETHANOL

Abstract

Microchannel heat transfer plays an important role in microelectronics technology for heat dissipation, due to its high efficiency and low heat transfer temperature difference and flow resistance. To underpin the fundamental understanding of this technology, the natural evaporation process of absolute ethanol in a capillary tube at inclination angles ranging from 0° to 90° was investigated experimentally by exploring a spectrum of properties, such as Marangoni flow patterns, evaporation rate, heat flux, and temperature distribution. We found that the morphology of the meniscus is independent of the inclination angle when absolute ethanol evaporates naturally. Due to the different force distribution at the interface of the meniscus, the shape of the Marangoni vortex is gradually deformed by the increase of the placement angle. During the early stage of evaporation, the Ma number, evaporation rate, heat flux, and temperature distribution of the meniscus follow the law of resultant force distribution, namely 60° >0° >30° >90°. Therefore, when the inclination angle is 60°, the resultant force on the meniscus is the largest, which is 4.613mN. In this case, the Marangoni number, evaporation rate and heat flux density all reach the maximum, which are 1041.12, 1.64 μm/s and 10.96 W/cm^2,respectively. At the later stage of the evaporation, the meniscus retreats to the depths of the capillary tube with changes observed on the evaporation rate and the heat flux at the meniscus. Finally, when the inclination angle of the capillary tube was 0°, the maximum evaporation rate and heat flux was 0.92 μm/s and 6.16 W/cm^2, respectively. We prove the functional relationship between the Ma number in the capillary tube and the inclination angles under different inclination angles, and the coincidence degree is high.