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EXPERIMENTAL INVESTIGATION OF DROP EVAPORATION IN MICROGRAVITY ONBOARD CHINESE SATELLITE SJ10

Abstract

The space experiments EFILE (Evaporation and Fluid InterfaciaL Effects)of sessile drop evaporation process were performed onboard the Chinese Scientific Satellite SJ10 to be launched in the April of 2016. The scientific topic of the space experiments is focused on the development of the phase-change interfacial hydrodynamic theory by using microgravity environment and to obtain the novel knowledge on the coupling mechanism of evaporation and convection. The space experimental facility of drop evaporation and convection consist of a pair of drop evaporation test units, including two different heating substrates, two optical observation modules (CCD+back light), two liquid injection modules, two substrate sealing modules and environment monitor module (Fans+pressure measurement censors), electronic control module. Both copper substrate and PTFE substrate were used as drop evaporating plates at which heating temperature can be controlled from 30-50. Test liquid is pure ethanol. In orbit experiment process, the shapes of sessile droplet (volume and contact angle) have been recorded, and the heating temperature on the substrates, the heat flux between liquid drop and substrate and the pressure and humidity of air environment inside the set-up box, were measured and download on the earth. The duration of total experiments on orbit is about 25 hours in which 24 times of drop evaporations were carried out successfully on both PTFE and copper substrates respectively, for different heating temperature at the substrate and different injected volumes of drop. The largest sessile droplet with a diameter more than 10mm were created by injecting on the substrates in space. The variations of average evaporating rate of droplet for different heating temperature and drop volumes were obtained in space and compared to the corresponding case's results on ground. The experimental results show that the evaporation of liquid drop can be separated evidently into 3 stages: the warm up; the stable evaporating and the rapid extinct. The space experimental results show that, in microgravity condition, larger droplets are easy to be formed and the evaporating life time become evidently longer than that on the ground due to the absence of buoyancy convection in our space experiments. The comparison of space results with the 2D and 3D numerical simulation results will be also presented in present paper.

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