MICROGRAVITY SCIENCES AND PROCESSES (A2)
Science Results from Ground Based Research (4)

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INVESTIGATION OF EVAPORATION PROCESS COUPLED WITH THERMOCAPILLARY CONVECTION

Abstract

The evaporation process coupled with thermocapillary convection was investigated numerically and experimentally on the ground and in the microgravity condition (drop tower). Both evaporating liquid layer and drops are studied. The results indicate that even a strong evaporating liquid/gas interface possesses interfacial tension and thermocapillary effects. In general, the thermocapillary convection in liquid is coupled with natural convection due to the buoyancy effect on the ground. For experimental investigation, small hanging drops and thin liquid layers were employed in order to reduce the buoyancy effect. The experimental results have shown that thermocapillary convection occurs in the liquid can evidently change the temperature distribution and thereby the energy and mass transfer, and enhance the evaporation process. For this study, a space experiment of evaporation drop on plate is designed to be conducted on board the Chinese recoverable satellite. The effect of thermocapillary convection on the evaporation will be emphasized in the experimental study, e.g. the effect on the mean evaporating rate and the possible deformation of drop's shape caused by different local evaporation rate on the liquid-gas interface. Two main conditions will be set. One is that liquid drop on plate has uniform temperature, with given initial ambient temperatures, expecting that thermal conductivity would play a dominative role to evaporate the liquid in this case. For the other condition, the liquid drop will be heated or cooled, imposing temperature gradient on the drop surface to introduce and enhance thermocapillay convection. The intensity of thermocapillary convection will be controlled by supplying electrical energy to the liquid. The ambient temperature and the temperatures both inside and near the drop interface at selected positions will be measured by thermocouples. Drop shape and its changing during evaporation will be captured and recorded by a high resolution CCD camera in real time. A quasi-steady evaporation experiment can be performed, in which the volume of drop liquid will keep constant during the experimental run. Through this evaporation experiment in microgravity, it is expected to have a better understanding of the evaporation mechanism.