Short-term Microgravity Experiment of Pool Boiling Heat Transfer Utilizing the Drop Tower Beijing

Jing Li [1], Wang-Fang Du [1], Yan-Fang Xue [2], Jin-Jia Wei [2], Jian-Fu Zhao [1,*]

[1] Key Laboratory of Microgravity, Institute of Mechanics, Chinese Academy of Sciences, Beijing, 100190, China

[2] State Key Laboratory of Multiphase Flow in Power Engineering, Xi'an Jiaotong University, Xi'an 710049, China

E-mail address: jfzhao@imech.ac.cn

Boiling is a very complex and illusive process with very high efficiency of heat transfer. In many sub-processes in boiling phenomenon, gravity can be involved and play much important roles. To reveal its influence, long-term, steady microgravity are needed. However, the opportunity is much limited. Thus, ground-based short-term microgravity experiment becomes an attractive alternative.

Experiments of transient pool boiling of highly subcooled FC-72 on a smooth silicon chip with the dimensions of $10\times10\times0.5$ mm^3 were studied in short-term microgravity condition utilizing the drop tower Beijing. Constant heating currents were switched on near the release of the drop capsule. The bubble behaviors and heat transfer of air-dissolved FC-72 on the silicon chip were obtained at the bulk liquid subcooling of 45 K and nominal pressure of 102 kPa. The steady ground experiments were also made for comparison. Fig. 1 shows the transient heating processes in the short-term microgravity experiments. Curves of the heating voltage and chip temperature clearly show that quasi-steady state of pool boiling can be reached within the short-term microgravity duration of 3.6 s.

Taking into account of the change of heater's thermal capacity and the heat loss to environment, heat fluxes to liquid were obtained, which also verified the achievement of quasi-steady state. Fig. 2 shows the comparison of the terminal heat transfer characteristics in the present experiment and those obtained from the control experiment in normal gravity. Data of Xue et al. (2011) with a similar heater were also shown in Fig. 2 for comparison. A different procedure, however, was adopted in Xue et al. (2011), in which a steady state of pool boiling was reached before the release of drop capsule. It's evident that the heat transfer is independent of gravity level under the present heat fluxes.

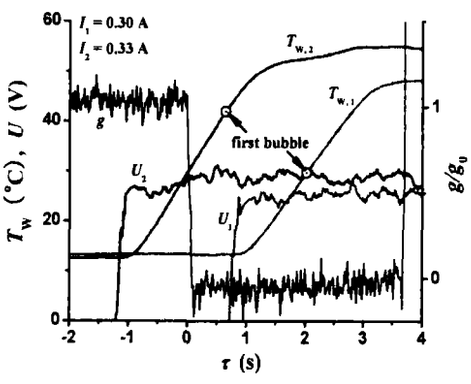

Figure 1: Processes of transient heating in drop tower experiments

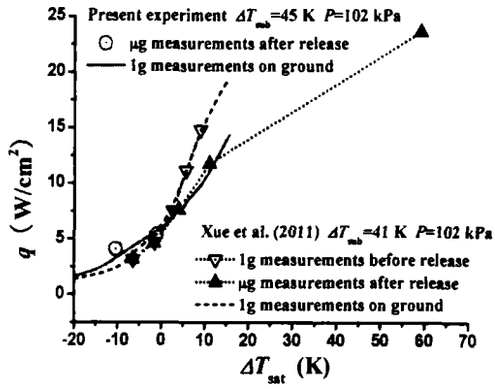

Figure 2: Comparison of boiling curve in different gravity

References

[1] Xue Y.F., Zhao J.F., Wei J.J., Li J., Guo D., Wan S.X. 2011. Experimental study of nucleate pool boiling of FC-72 on smooth surface under microgravity. *Microgravity. Sci. Tech.*, **23(S1)**: S75–S85.