Effects of Heater Size on Subcooled Boiling in Normal Gravity and Microgravity

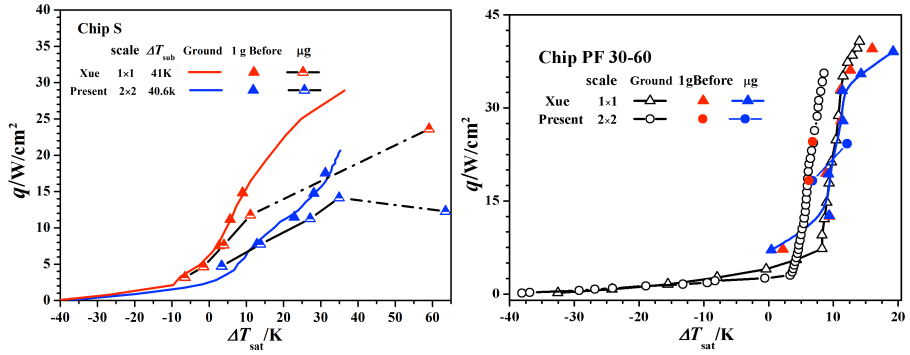
Jin-Jia Wei, Jian-Fu Zhao

Prof. Jin-Jia Wei
State Key Laboratory of Multiphase Flow in Power Engineering
School of Chemical Engineering and Technology
Xi'an Jiaotong University
Xianning West Road 28, Xi'an 710049, CHINA
E-mail: jjwei@mail.xjtu.edu.cn

Jin-Jia WEI is a professor of Xi'an Jiaotong University. He is the council member of both Chinese Society of Engineering Thermophysics and China Energy Society, and is also the editorial member of 5 international journals. He got degree of Dr. Eng. from Xi'an Jiaotogn University in 1998 and PhD from Kyushu University in 2002. His research interests include enhancement of boiling heat transfer for ground and space application, two-phase/drag-reducing flow and heat transfer, solar thermal Utilization and solar voltaic/thermal hybrid utilization. He published more than 200 papers, gave more than 10 invited talks in international conferences, and got two first-grade ministerial or provincial level science and technology awards and an Excellent Young Scholar Award of WU Zhong-Hua Fund from Chinese Society of Engineering Thermophysics. He is the Cheung Kong scholar chair professor of Ministry of Education, and also the winner of national science fund for distinguished scholars.

Abstract

Experimentally were conducted to study the effects of heater size and microstructure on subcooled pool boiling of FC-72 on silicon chips in both microgravity and earth gravity condition. A smooth surface and a micro-pin-finned surface with two different heater sizes of 2×2 m^2 and 1×1 m^2 were used in the experiment (chip S 2×2 and chip S 1×1 for smooth surface, chip PF30-60 2×2 and chip PF30-60 1×1 for micro-pin-finned surface). For smooth silicon chip, the nucleate boiling heat transfer performance is deteriorated with increase in heater size in both earth gravity and microgravity conditions. However, in microgravity, the q_{CHF} of chip S 2×2 was greater than that of chip S 1×1, contrary to the CHF characteristic in earth ground condition (Fig. 1a). It is found that at a very high heat flux, a smooth hemispherical bubble is generated on the surface of chip S 1×1 in microgravity, while on chip S 2×2 an oblate vapor blanket is formed, which indicates that boiling heat transfer mechanisms are different in both cases. The calculation shows that in microgravity the boiling performance is dominated by buoyancy for chip S 2×2, but it was dominated by surface tension for chip S 1×1. For micro-pin-finned surface in earth gravity, the nucleate boiling heat transfer performance on chip PF30-60 2×2 is better than that on a small heater size of chip PF30-60 1×1, but in natural convection region the situation is reversed. As shown in Fig. 1b, in microgravity, at a moderate heat flux the boiling heat transfer performance on chip PF30-60 2×2 is better than that on chip PF30-60 1×1. However, with the increase of heat flux the deterioration of heat transfer performance on chip PF30-60 2×2 is more obvious than that on chip PF30-60 1×1.



(a) smooth surface (b) micro-pin-finned surface

Fig. 1 Heater size effect on boiling heat transfer in normal gravity and microgravity