電子機器用狭あい流路内強制流動沸騰冷却ジャケットの開発
Development of Cooling Jacket for Electronic Devices by Using Flow Boiling in Narrow Channels

Kobayashi Hiroyuki¹, Yuka Asada¹, Shouhei Kanazawa¹, Shinsaku Yoshii¹, Yasuhiro Shimamoto¹, Masato Hukagaya², Yoshiyuki Abe³, Mayumi Ouchi⁴, Masahide Sato⁴, Ken-ichi Imura⁴ and Haruhiko Ohta¹

¹Kyushu University, 744 Motooka, Nishi-ku, Fukuoka 819-0395
²SOHKi Co., Ltd., 2-42-4 Otemachi, Minato-ku, Nagoya, Aichi 455-0046
³National Institute of Advanced Industrial Science and Technology, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8568
⁴Utsunomiya University, 7-1-2 Yoto, Utsunomiya, Tochigi 321-8585

A cooling jacket for electronic devices, composed of a main heated channel with grooves and auxiliary unheated channels for additional liquid supply, was developed. The structure prevents dryout phenomena, i.e. the heat transfer limitation in boiling, by the reduction of substantial heated length. The heating surface, with a length of 30mm and a width of 30mm, was installed horizontally facing upwards in the cooling jacket. Test liquid was selected as FC72 to keep electric insulation from semiconductors integrated in the server. The measured critical heat flux (CHF) was larger than 33.3±10^4 W/m² (30mm width) and the inlet volumetric flow rate \( \dot{V}_m = 0.86/\text{min} \) (mass velocity \( \dot{G}_m = 372\text{kg/m}^2\text{s} \) and 466kg/m²s, respectively) at inlet liquid temperature \( T_{in} \approx 35^\circ\text{C} \) and test pressure \( P = 0.15\text{MPa} \). Larger CHF values compared to those for the channel without auxiliary unheated channels were confirmed.

**Key Words:** Flow boiling, Critical heat flux, Narrow channel, Electronic device cooling

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Fig. 1 Structure of cooling jacket

Fig. 2 Outline of liquid supply
3. Experimental Results and Discussion

3.1 Influence of Auxiliary Channels on Heat Transfer

The experimental results show that the addition of auxiliary channels significantly improves the heat transfer rate. The critical heat flux, as shown in Fig. 3, increases with the addition of auxiliary channels, indicating enhanced heat transfer. The heating surface temperature, depicted in Fig. 4(a), also decreases, suggesting a reduction in the thermal resistance. Additionally, the pressure drop, as shown in Fig. 4(c), remains relatively constant with the inclusion of auxiliary channels, indicating that the addition of these channels does not significantly increase the pressure drop.

3.2 Influence of Gap Size on Heat Transfer

The effect of gap size on heat transfer is illustrated in Fig. 4(b). As the gap size decreases, the heating surface temperature decreases, indicating improved heat transfer. The pressure drop, as shown in Fig. 4(c), also decreases with a smaller gap size, suggesting that the flow resistance is reduced.

4. Conclusion

The study highlights the importance of auxiliary channels in improving heat transfer in flow boiling systems. The results demonstrate that the addition of auxiliary channels can significantly enhance the heat transfer rate, reduce the heating surface temperature, and maintain a stable pressure drop. These findings have practical implications for the design and optimization of heat transfer systems.