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Experimental Investigation of Nucleate Pool Boiling Heat Transfer Characteristics on Copper Surface with Laser-Textured Stepped Microstructures

Authors : Luvindran Sugumaran, Mohd Nashrul Mohd Zubir, Kazi Md Salim Newaz, Tuan Zaharinie Tuan Zahari, Suazlan Mt Aznam, Aiman Mohd Halil

Abstract : Due to the rapid advancement of integrated circuits and the increasing trend towards miniaturizing electronic devices, the amount of heat produced by electronic devices has consistently exceeded the maximum limit for heat dissipation. Currently, the two-phase cooling technique based on phase change pool boiling heat transfer has received a lot of attention because of its potential to fully utilize the latent heat of the fluid and produce a highly effective heat dissipation capacity while keeping the equipment's operating temperature within an acceptable range. There are numerous strategies available for the alteration of heating surfaces, but to find the best, simplest, and most dependable one remains a challenge. Lately, surface texturing via laser ablation has been used in a variety of investigations, demonstrating its significant potential for enhancing the pool boiling heat transfer performance. In this research, the nucleate pool boiling heat transfer performance of laser-textured copper surfaces of different patterns was investigated. The bare copper surface serves as a reference to compare the performance of laser-structured surfaces. It was observed that the heat transfer coefficients were increased with the increase of surface area ratio and the ratio of the peak-to-valley height of the microstructure. Laser machined grain structure produced extra nucleation sites, which ultimately caused the improved pool boiling performance. Due to an increase in nucleation site density and surface area, the enhanced nucleate boiling served as the primary heat transfer mechanism. The pool boiling performance of the laser-textured copper surfaces is superior to the bare copper surface in all aspects.

Keywords : heat transfer coefficient, laser texturing, micro structured surface, pool boiling
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