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Experimental Investigation of Nucleate Pool Boiling Heat Transfer on Laser-Structured Copper Surfaces of Different Patterns

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Abstract : With reference to Energy Roadmap 2050, the minimization of greenhouse gas emissions and the enhancement of energy efficiency are the two key factors that could facilitate a radical change in the world's energy infrastructure. However, the energy demands of electronic devices skyrocketed with the advent of the digital age. 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 finding 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-structured 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-structured copper surfaces is superior to the bare copper surface in all aspects.

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