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Enhanced Boiling Heat Transfer Using Wettability Patterned Surfaces

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Abstract : Effective cooling technology is required to secure thermal stability in extreme heat generated systems such as integrated electronic devices and power generated systems. Pool boiling heat transfer is one of the powerful cooling mechanisms using phase change phenomena. Critical heat flux (CHF) and heat transfer coefficient (HTC) are main factors to evaluate the performance of boiling heat transfer. CHF is the limitation of boiling heat transfer before film boiling which occurs thermal failure. Surface wettability is an important surface characteristic of boiling heat transfer. A hydrophilic surface has higher CHF through effective working fluid supply to local hot spots. A hydrophobic surface promotes the onset of nucleate boiling (ONB) to enhance HTC. In this study, superbiphilic surfaces, which is combined with superhydrophillic and superhydrophobic, are applied on boiling experiments to maximize boiling performance. We conducted pool boiling heat transfer using DI water at a saturated temperature and recorded bubble dynamics using a high-speed camera with 2000 fps. As a result, superbiphilic patterned surfaces promote ONB and enhance both CHF and HTC. This study demonstrates the enhanced boiling performance using superbiphilic surfaces by effective nucleation and separation of liquid/vapor pathway. We expect that further enhancement of heat transfer could be achieved in future work using optimized patterned surfaces.

Keywords : boiling heat transfer, wettability, critical heat flux, heat transfer coefficient
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