

Public Abstract

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Title:TWO-PHASE FLOW OVER FLOODED MICRO-PILLAR STRUCTURES WITH ENGINEERED WETTABILITY

With the increasing speed and functionality of electronics on one hand and the shrinking size of their components on the other, the power dissipation of such electronic devices has already reached beyond kilowatts/cm<sup>2</sup> at chip level and is projected to grow much further in coming years. To meet the ever increasing challenges posed by the thermal management of electronic systems, innovative technologies must be developed to dramatically improve the performance of two-phase thermal management systems. Such breakthroughs will not be possible without a thorough understanding of the fundamental surface science at micro/nano scales and exploration of micro/nano technology to enhance heat transfer performance, as heat transfer performance at the macro level is profoundly affected by physical phenomena occurring at smaller scales.

Conventional target surface is often made as a flat surface with highly wettable texture for pursuing thin film evaporation, which has negligible effect on improving heat transfer performance in the flooded conditions, which may occur in active cooling environments due to excessive coolant feeding. This work presents a combination of micro-pillar structures and engineered wettability for enhancing the heat dissipation when surface is flooded by liquid film, and further for preventing bubble volume accumulation caused film boiling by facilitating the vapor bubble departure. A numerical transient 3-D volume of fluid model has been developed to investigate the dynamic and thermal impact of structures with different pillar heights, pitches and engineered wettability on the bubble behaviors and cooling performance. The result indicates that when immersed by liquid film, the structure with relatively higher, slimmer pillars and dense pillar array performs better in thermal aspect. Engineered wettability on micro-pillars contributes to bubble removal and precluding vapor film formation.