Chapter 6
Closure

The aims of these extensive studies were focused on:

- Stabilize and control the conditions under which flow boiling process takes place in micro-/minichannels so that flow instabilities and flow reversals are mitigated and the critical heat flux (CHF) limit of two-phase microscale cooling can be extended, making this technology more stable and reliable for the effective thermal managing of next-generation electronics.
- Obtain a better fundamental understanding of the flow regime development, bubble dynamics, phase-change processes, heat transfer, and pressure drop characteristics in micro/minichannels.
- Demonstrate how two-phase micro/minichannel cooling systems can be developed for the effective thermal management of next generation electronics.

To fulfill these aims, flow boiling in expanding microchannels, expanding microgap, slopping fin microchannels, and stepped fin microchannels were proposed. Extensive experimental studies along with high-speed visualizations have been performed in these flow boiling microscale heat sinks to characterize the fundamental understandings including bubble dynamics, flow regime development, heat transfer, and pressure drop characteristics. In addition to that, the ability to mitigate flow boiling instabilities and hotspots is also evaluated for these heat sinks, and excellent reduction in flow boiling instabilities with increased critical heat flux limit has been achieved. Furthermore, the effect of expanding microchannel heat sink for scaled-up geometries in practical applications is evaluated. Results showed enhanced performances even in scaled-up system, and thus, these systems have potential in practical applications.

Although progress has been made to characterize the heat transfer, pressure drop, and instabilities during flow boiling in expanding microchannel heat sink, further detailed parametric studies are needed to advance this technique for practical applications. In addition to that, analytical study and numerical modeling are needed to validate the systems.

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