

Chapter 1

Micro and Meso Scale Compact Heat Exchangers in Electronics Thermal Management – A Review

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Due to dramatic gains in functionality and speed, microelectronic components are experiencing ever increasing heat fluxes. Microprocessor heat fluxes are approaching $100\text{W}/\text{cm}^2$ on a spatially averaged basis on the chip of typical footprint area $1\text{-}5\text{ cm}^2$, with several times larger values locally in the logic regions. Power electronics devices are approaching heat fluxes in the $1\text{ kW}/\text{cm}^2$ range over footprint areas of 10 cm^2 or higher. Proper operation of the semiconductor devices typically requires maximum temperatures to be limited below $85\text{-}100^\circ\text{C}$ for microprocessors and $125^\circ\text{C}\text{-}150^\circ\text{C}$ for silicon based power electronics components.

During the past two decades dramatic advances have been made in microfabrication techniques. Many of the same manufacturing techniques developed for the fabrication of electronic circuits are being used for the fabrication of compact heat exchangers. In this paper we will review the advances in the fabrication and characterization of micro and meso scale compact heat exchangers for electronics thermal management, with a focus on the past decade. The review will focus primarily on single phase liquid cooling and two-phase cooling. A systems perspective will be taken, which involves transferring the heat generated in the electronic components through a path involving multiple media, leading to its ultimate rejection. Since this rejection is to ambient air for most ground based electronic equipment, liquid cooling schemes