Potential of Genetic Algorithms for Design of Additively Manufactured Liquid Cooled Heat Sinks

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Abstract

The advancement of new manufacturing techniques such as additive manufacturing enable significantly greater freedom of design compared to conventional techniques. Of significant interest is what improvements could be made in the design of cold plates and heat sinks for electronics cooling. Greater design freedom could potentially enable new designs that reduce thermal resistance and hydraulic resistance, enabling the usage of higher power systems while maintaining an equivalent operation envelope. The potential of using genetic algorithms to produce optimum shapes for cold plate heat sinks is investigated in this thesis. A 50 × 10 mm area is established into grid space, with initial designs initiated by probability based on representative chip power distribution profiles. Two different power maps are used to develop optimized heat sink geometry, one being a generated symmetric map, and the other being a non-symmetric map based on a real processor. After the initial designs are developed and performance results determined from computational fluid dynamics, an optimization algorithm from the literature is utilized. Solution ranking is based on the system entropy generation rate, which is dependent on solution pressure drop and thermal resistance. Crossover, mutation and elitism operations are used to create new generations of designs, eventually leading to an optimized solution. Optimized results are compared with a baseline straight finned cold plate to determine the advantages of designing for an unrestricted manufacturing process. Results indicate that the optimization methods reduced entropy generation rate by 26.4% and 21.7% for the symmetric and non-symmetric power maps respectively.

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