

Preface

The continuous miniaturization of electronic devices, coupled with advanced packaging technology, led to the ever-increasing packaging densities and the associated heat flux that need to be dissipated. Thermal management has become a critical requirement for high-power heat sources, such as electronic chips, heat exchangers, high-performance battery packs and high-power motors. Thus, micro-/minichannel with oblique fins stands out as one of the most promising solutions. This design is created by cutting secondary channels at an oblique angle with the straight fins on the planar surface. It offers several advantages such as compactness, light weight and higher heat transfer surface area to fluid volume ratio, greater temperature uniformity across the heat transfer and diverse thermal management applications. Most interestingly, this structure was shown to enhance heat transfer performance significantly with negligible pressure drop penalty. This is different from the conventional passive heat transfer enhancement techniques where trade-off in terms of pressure drop penalty is always associated with the improved heat transfer.

The objectives of this brief on thermal transport in micro-/minichannel are to (1) propose a novel planar oblique fin microchannel and cylindrical oblique fin minichannel heat sink design using passive heat transfer enhancement techniques, (2) investigate the forced convection heat transfer and fluid flow characteristic in both planar and cylindrical oblique fin structures through 3D conjugate numerical simulation and systematic experimental studies, (3) examine the feasibility of employing the proposed oblique fin microchannel heat sink in cooling non-uniform heat fluxes and hotspot suppression, (4) examine and investigate the influence of edge effect on flow and temperature uniformity in cylindrical oblique fin heat sinks through systematic numerical and experimental studies, (5) perform a similarity analysis to obtain a dimensionless grouping parameter to evaluate the total heat transfer rate of the oblique fin heat sink, (6) investigate the flow mechanism and optimize the dimensions of cylindrical oblique fin heat sink for good overall heat transfer performance using similarity analysis and parametric numerical investigations and (7) obtain generalized correlations to predict the heat transfer performance and pressure drop characteristics of the oblique fin minichannel heat sink.

This brief may have significant impact on providing an innovative cooling solution and understanding the flow physics behind oblique fin structure. The novel oblique fin micro-/minichannel heat sink could enhance the heat transfer performance significantly and make the heat source temperature more uniform and not compromise with high pumping power. The ability to locally tailor heat transfer performance can be crucial for hotspot mitigation as the electronic industry is moving towards more-than-Moore technologies. The proposed technique could lead to a smaller and lighter cooling system and increase the longevity of the heat source and save substantially more energy. The findings from this work could aid in the design, optimization and implementation of oblique fin heat sinks.

Singapore, Singapore

Yan Fan
Poh Seng Lee
Pawan Kumar Singh
Yong Jiun Lee

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Fan, Y.; Lee, P.S.; Singh, P.K.; Lee, Y.J.

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