UAEU جامعة الإمارات العربية المتحدة United Arab Emirates University

The College of Graduate Studies and the College of Engineering Cordially Invite You to a

Master Thesis Defense

Entitled

HEAT TRANSFER INTENSIFICATION IN MICROCHANNEL HEAT SINKS (MCHS) - WAVY CHANNELS EMBEDDED WITH PIN FINS

by

Anas Mohammad Amin Alkhazaleh

Faculty Advisor

Dr. Bobby Mathew, Department of Mechanical Engineering,

College of Engineering

Date & Venue

2:00 PM

Thursday, 3 June 2021

https://teams.microsoft.com/l/meetup-join/19%3ameeting_ZDZhYjE5ZGItODBiNS00ZWFmLWEzNjAtOWVlMjRjYzY2MmVl%40thread.v2/0?context=%7b%22Tid%22%3a%2297a92b04-4c87-4341-9b08-d8051ef8dce2%22%2c%22Oid%22%3a%22ad62b117-c86e-47b8-b094-10e55a7a2027%22%7d

Abstract

This work conceptualizes heat sinks employing wavy/sinusoidal microchannels embedded with pin fins and subsequently analyzes their performance in terms of thermal resistance, pressure drop, maximum chip temperature, and the associated pumping power due to the pressure drop. The conceptualized wavy microchannel heat sink (MCHS) is mathematically modeled using a combination of governing equations including energy equations, continuity equation, and Navier-Stokes equations. The performance of the wavy microchannel heat sink embedded with pin fins is evaluated based on a parametric study covering multiple parameters; microchannel's amplitude, frequency, hydraulic diameter, pin fins' diameter, and location, and Reynolds number. The different mathematical models are solved numerically using computational fluid dynamics (CFD) techniques applying the different operating and geometric parameters. The performance of the wavy MCHS is also compared to the performance of other designs (straight, straight embedded with pin fins, and wavy microchannel heatsinks). The performance of selected cases of the studied wavy MCHS is investigated experimentally and compared with the simulation results to validate the results and obtain a better understanding of the actual performance of these designs. The performance of the wavy MCHS compared to the straight and straight microchannel embedded with pin fins heat sinks shows less thermal resistance for the wavy MCHS at the same operating parameters. Introducing pin fins to the wavy microchannel enhances the thermohydraulic performance achieving less thermal resistance but with a cost of an increase in pressure drop. Increasing both amplitude and frequency shows improvement in the thermohydraulic performance but also with a cost of an increase in pressure drop. The pressure drop associated with increasing the pin fins diameter happens to increase the pressure more significantly than the other geometric parameters. On the other hand, increasing the hydraulic diameter shows good improvement in the thermohydraulic performance, reducing thermal resistance and pressure drop. This work conceptualizes and analyzes a new heat sink configuration by using a wavy design embedded with pin-fins.

Keywords: Liquid cooling, heat sink, sinusoidal microchannel, wavy microchannel, pin fins, thermal resistance, pressure drop.