Available online at www.sciencedirect.com

ScienceDirect

Procedia Technology 14 (2014) 520 – 527

Procedia Technology

2nd International Conference on Innovations in Automation and Mechatronics Engineering,

ICIAME 2014

Experimental Investigation of the Combined Effect of Coating and Header Combination in Microchannels

C. Anbumeenakshi [*1], M. R. Thansekhar [2]

Department of Mechnical Engineering, K.L.N. College of Engineering, Tamilnadu, India

Abstract

In the present work, a thorough experimental investigation was carried out to analyze the combined effect of coating and header combination on the pressure drop characteristics of microchannels, by using deionized water as the coolant for mass flow rate range of 50 – 120 kg/hr and a Reynolds number range of 200 - 600 in an Aluminium microchannel rectangular heat sink with 25 number of parallel rectangular microchannels. The microchannel, made of aluminium, was copper coated by using electro co-deposition technique. Pressure drop experiments were carried out on both the bare microchannel and copper coated microchannel for three different header combinations. The various cross sectional shapes used in this micro channel are triangular shaped header, trapezoidal shaped header and rectangular shaped header. It was found that the coating increases the pressure drop. Among various header combinations considered in the present experimental work, increase in pressure drop penality is less in trapezoidal header combination than other two header combinations viz. rectangular and triangular header combinations.

Peer-review under responsibility of the Organizing Committee of ICIAME 2014.

Keywords: microchannel, Pressure drop; header combination; coating

* Corresponding author. Tel.: 9994871427

E-mail address: [1] anbumeenakshi1981@gmail.com.

[2] thansekhar@yahoo.com

Peer-review under responsibility of the Organizing Committee of ICIAME 2014.

doi:10.1016/j.protcy.2014.08.066

1. Introduction

Microfluidics has become a subject of interest in recent times mainly due to its applicability to cooling of electronic devices and microchannel heat sink has received much attention because of its ability to produce high heat transfer coefficient, small size and volume per heat load, and small coolant requirements. Microchannel can be broadly applied to the cooling of electronic devices, laser diode arrays, lab – on chip devices, microfluidic pumps, high power resistive magnets, on board cooling of propellant motors in space crafts, high performance microprocessors, high energy LASERs ,automotive heat exchangers, fuel cell, sensor technology and other applications in bio mechanics. This increased the need for clear understanding of liquid flow in microchannels. In advanced modern computers the computing capability can be increased much faster but the limiting factor, is the heat generated by it. As the world is interested towards the micro and nano level products, the size of the product becomes small, the power of the chip increases, and the heat generation from the chip also increases. To remove the heat generated from the chip, liquid coolant is used. To remove the more heat generated from the chip more amount of coolant is used hence the mass flow rate of the coolant increases. If mass flow rate increases the pressure drop also increases. Techniques to reduce the pressure drop in microchannels have received much concern. The impact of coating in the microchannels on the pressure dop has also received much concern.

In the beginning of 1980s, Tuckerman and pease [1] conducted initial experiments on water flow and heat transfer characteristics in microchannel heat sinks that demonstrate the cooling of electronic components by the use of forced convective flow of fluid through microchannels. This opened a wide area in the field of electronics cooling and heat transfer in micro scale geometries.

Several studies on pressure drop measurement has been carried out experimentally and numerically in microchannel. J. M. Yin et.al. [2] carried out pressure drop measurements in microchannel heat exchanger. In their work they presented a pressure drop model which can be used to predict or optimize pressure and mass flow distribution inside the exchanger tubes. Bobbili et al. [3] carried out an experimental study in microchannel and found that flow maldistribution increases with increase in over all pressure drop in heat exchangers. Cho et al. [4] carried out experiment in microchannel heat sink and found that diverging channel with trapezoidal header is the best choice for considering the temperature distribution and pressure drop. Paisarn Naphon et al [5] carried out experimental work in microchannel heat sinks and found micro channel geometry configuration has significant effect on the enhancement of heat transfer and pressure drop. Xie et al.[6] carried out a numerical study and found that a narrow and deep channel with thin bottom thickness and relatively thin wall thickness results in improved heat transfer performance with a relatively high but acceptable pressure drop.

Morshed et al.[7] carried out experimental work in a copper coated single channel with electro co-deposition technique and found penalty in pressure drop of 15%. Sujit kumar et al. [8] carried out experimental study in a single channel made up of stainless steel substrate and found small difference in the pressure drop values between bare surface and coated surface. Vikash khanikar et al.[9] carried out experimental study in a single microchannel and found critical heat flux was enhanced by the increased heat transfer area associated with the CNT coating. The enhancement decreased following repeated tests as the Carbon nano tube fin effect was compromised by the bending of fins. Diao et al. [13] carried out an experimental study in rectangular microchannels, covered with nanoparticle covering obtained by the evaporation of nanofluids and found nanoparticle covering has a strong influence on the heat transfer behaviour.

From the literature studies, it is found that a lot of pressure drop studies in microchannel has been carried out without coating. Few works have been done on single microchannel with coating. Effect of coating on pressure drop characteristics in multiple microchannels has not been reported so far in literature. In the present work. microchannel test rig made of aluminium with 25 number of rectangular microchannels is copper coated by using electro co-deposition technique. And the effect of coating and inlet and outlet header combinations on pressure drop in microchannel test rig has been experimentally investigated. The various shapes used in this are rectangular shaped header, triangular shaped header and trapezoidal shaped header.