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Conjugate Heat Transfer Analysis On Microchannel Heat Sinks For High Power LEDs

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Abstract

INTRODUCTION:

Light emitting Diode (LED) has been proved to be the best resource for commercial as well as industrial lighting applications. However, thermal management in high power LEDs is a major challenge in which the thermal resistance (Rth) and rise in junction temperature (TJ) are notable parameters. Heat dissipation in the LED has been partly achieved with the evolution of efficient heat sinks. This paper deals with the design of heat sink with innovative advective extended surfaces which contributes for the multi-dimensional heat dissipation. Also simulation of heat distribution over the proposed substrate design proved the influence of the design and material removal from the heat sink. It is suggested that the new design will help to reduce the junction temperature considerably thus enhancing the performance of LEDs.

USE OF COMSOL MULTIPHYSICS:

Heat transfer module have Conjugate Heat transfer Study as the sub module which efficiently calculates the conjugated heat transfer, i.e., the conduction in the solid and convection by the liquid within the computational domain. The multiphysics analysis helps in studying the influence of fluid velocity (in microchannels) on heat transfer rate of the proposed heat sink with advective extended surfaces. The innovative multi-dimensional heat sink with microchannels is designed with Solidworks and imported to COMSOL Multiphysics 5.1 using Livelink. The necessary inputs on the respective domain information, material, boundary inputs, etc are fed to COMSOL.

RESULTS:

The geometry of the Heat sink considered consists of 10 advective fins and the radial fins attached to the heat sinks vary from 5 to 10 for each simulation. For each increase in the number of radial fins, the Reynolds number is decreased accordingly in order to maintain the pumping rate of the fluid (air). Starting the simulation with the input data : Reynolds number 2000 and the number of radial fins is 5, we get the maximum temperature as 78.08^{o}C with the heat transfer coefficient as 10.87 W/m2.K. The numbers of fins are increased from 5 to 10 for which the Reynolds number is decreased from 2000 to 500 in each step. The maximum temperature obtained is in the range of 78.08^{o}C to 101.7^{o}C. It is evident from the results that the proposed heat sink with the advective heat fins contributes for maximum heat dissipation.

CONCLUSION:

The summarized results in table 1 were obtained by computing in COMSOL. The maximum temperatures for different inputs are simulated using conjugate heat transfer analysis. As long the input velocity is higher, the heat dissipated will be high. But the constraint of having the minimal pumping power of the

fluid is necessary as it is a major component in system design. The detailed analysis shows the importance of the proposed design with advective heat transfer surfaces. The pressure contours gives an absolute idea by which the nominal number of fins can be optimized for the reduced surface temperature as well as the reduced pumping power.

Reference

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Figures used in the abstract

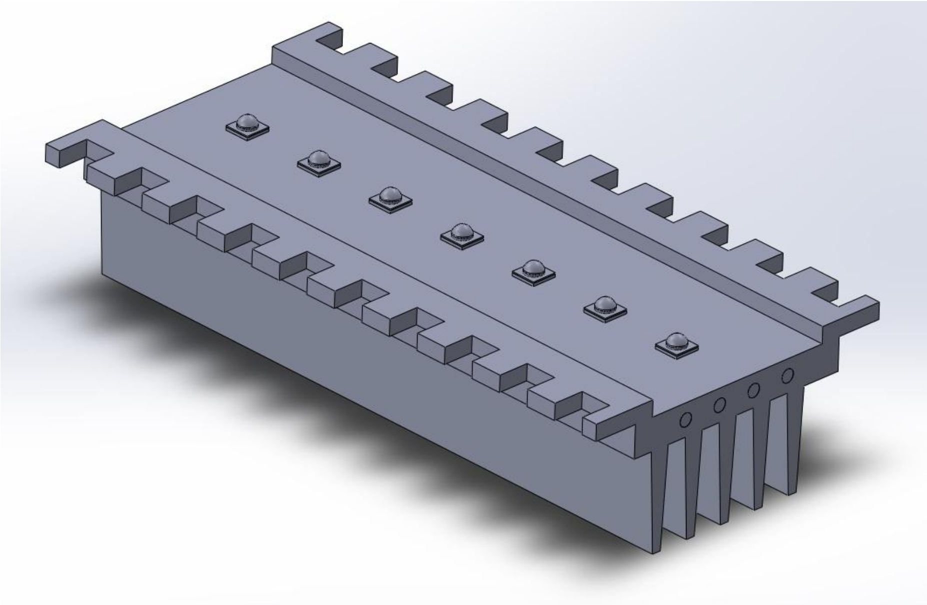

Figure 1: Advective Heat sink with the LED (Heat Source) Model

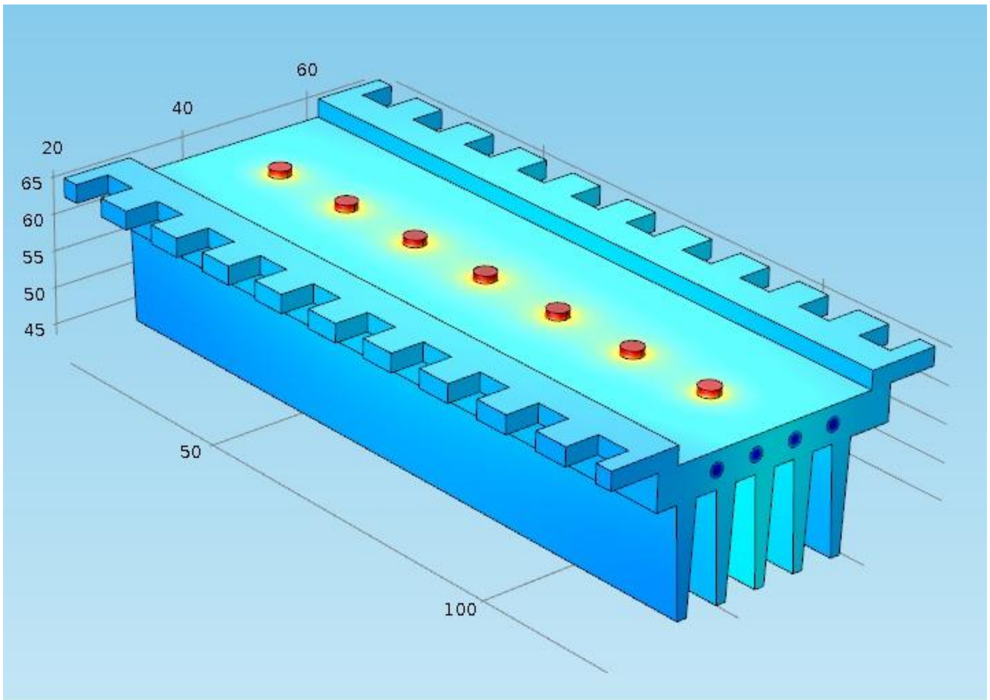

Figure 2: Conjugate heat transfer Analysis (Maximum temperature Distribution) on the Advective Heat Sink (considerate Model)

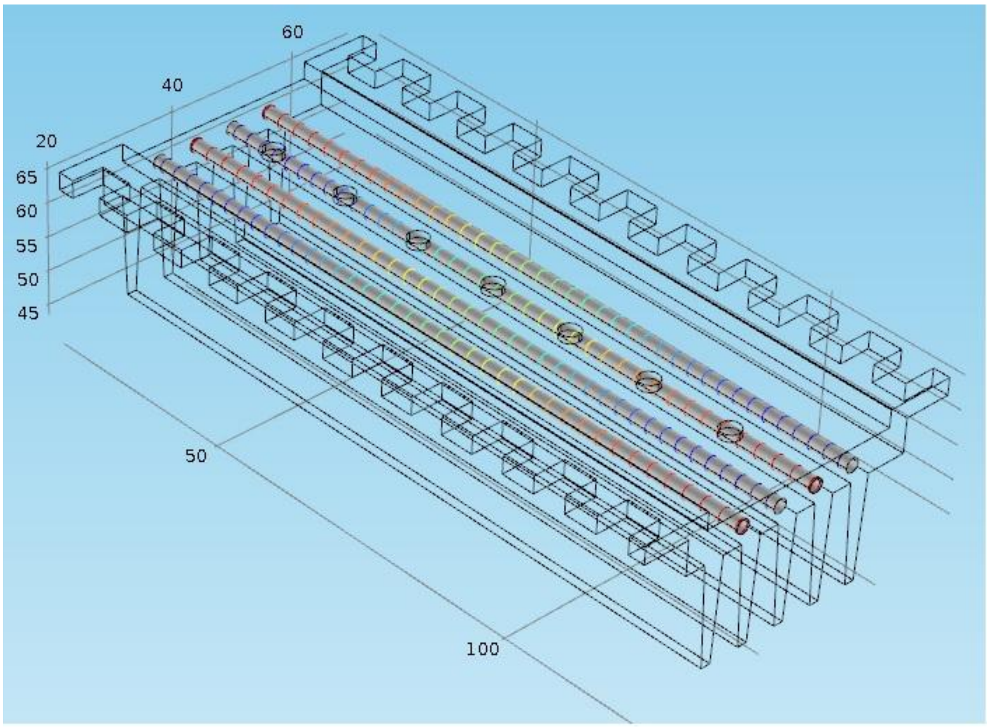

Figure 3: Conjugate heat transfer Analysis (Pressure contour) on the Advective Heat Sink (considerate Model)