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ENERGYPOLIS SEMINAR

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Enhanced Ambient Heat Rejection in Passive Thermal Management Systems

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The combined trends of increasing computing power with the miniaturization of electronic devices brought about new challenges in terms of ambient heat rejection. This work presents two technologies that can potentially increase the heat rejection rate to ambient air without using any moving part, thus ensuring a high reliability. The first technology considered uses ionic wind to increase the airflow through cooling passages. Ionic wind occurs when a high voltage potential is applied to an electrode with a large curvature such as a thin wire or a needle. Due to the strong electric potential close to the electrode, a Corona discharge occurs and air molecules are ionized. The resulting ions induce an airflow through collisions with neutral molecules. In this study, the Corona current is characterized experimentally and a numerical procedure is developed to solve the electrohydrodynamics. A custom-built test bench is used to validate the numerical model experimentally. It is shown that ionic wind can increase the heat removal rate by up to 100% as compared to natural convection only. The second cooling enhancement technology considered is the addition of a chimney on top of the heat sink to increase the airflow through the cooling channels. A semi-analytical model based on thermal- and fluid equivalent resistance networks is developed. Finally, a thermo-economic study is performed in order to compare the performance of both technologies versus natural convection only. A Pareto front combining the three technologies is constructed, allowing for cost-effective design decisions based on the cooling power requirements.

References:

[1] N. Gallandat and J. R. Mayor, "Novel Heat Sink Design Utilizing Ionic Wind for Efficient Passive Thermal Management of Grid-Scale Power Routers", *Journal of Thermal Science and Engineering Applications*, vol. 7, pp. 0310041-0310048, 2015

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Born in 1990 in Yverdon-les-Bains, Switzerland, Noris Gallandat graduated with a BSc in Mechanical Engineering from the Swiss Federal Institute of Technology Zurich (ETHZ) in 2012. During this time, he worked as an undergraduate research assistant in the field of hydrogen storage and CO_2 methanation at EMPA. He then went on to pursue graduate studies as a Fulbright Scholar at the Georgia Institute of Technology, where he obtained his PhD degree in 2015. His doctoral thesis focused on the enhancement of ambient heat rejection in passive thermal management systems.