Investigations on Micro Loop Heat Pipe: Design, Fabrication and Mathematical Modeling using Thin-film Evaporation Theory

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Since its inception, micro loop heat pipe has played a significant role in maintaining a constant thermal environment in applications where space is the primary constraint. Hence, it is a promising solution for passive thermal management in small wearable electronic devices like smartphones, smartwatches, ultra-thin laptop. Its most notable characteristics are gravity-independent operation and low maintenance cost due to the absence of any moving parts. In this study, a new design of micro loop heat pipe is presented. Its dimensions are optimized to maximize the heat transport capacity. It is fabricated on a silicon wafer using a relatively simple microfabrication technique. It is then filled with methanol and performance tested. Next, a new mathematical model is developed to investigate the performance of its evaporator. This model is based on evaporating thin-film in an extended meniscus inside a microchannel. Its novelty is that it combines two ideas: the use of the velocity slip boundary condition at the wall and modelling of both retarded and non-retarded components of disjoining pressure. This leads to better simulation of heat transfer phenomenon in the evaporator.