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HEAT TRANSFER AND OPTIMIZATION STUDIES ON PCM BASED HYBRID HEAT SINKS WITH DISCRETE PROTRUDING HEAT SOURCES

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ABSTRACT The present study focuses on the numerical investigation of a PCM based hybrid heat sink for thermal management of protruding electronic components by solving three dimensional Navier-Stokes equations together with the energy equation using the enthalpy method. This novel approach for thermal management of micro-electronics incorporates useful aspects of both active as well as passive cooling techniques. An aluminium heat sink with n-eicosane as PCM is used in present study. Six protruding heat sources are placed over the substrate which mimic heat generating elements of electronic chips. In this hybrid approach a phase change material (PCM) is used to store the peak load of electronic components during transient working period and outside convection with extended surfaces is used for efficient release of heat to the ambient. Aluminium fins are used as thermal conductivity enhancer (TCE) in the PCM. Furthermore, the study focuses on the determination of optimal configurations for heat sink that maximizes the thermal performance. The thermal performance is quantified in terms of time to reach the set point temperature (315K) for electronic components to avoid malfunctioning and the time taken by PCM to re-solidify for next cycle of heating leading to a multi-objective optimization problem. The optimization problem is solved by using hybrid Artificial Neural Network (ANN) - Elitist Non-Dominated Sorting Genetic Algorithm (NSGA-II) approach. The fin thickness, length and pitch in x and y direction are considered as parameters which are crucial for both the objective functions. For carrying out the optimization, twenty seven design points are generated by half factorial design, which are then used to train the ANN to determine the functional relationship between the inputs and the outputs. The Pareto-optimal points were obtained in the defined domain of parameters and improvement of 5.5% and 21% have been observed in both charging and discharging time respectively, as compared to the PCM based heat sink without TCE (i.e fins).