

Hot-Press Manufacturing of Aluminum Based Multi-Layered Wick Structures for Enhanced Thermal Performance

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INTRODUCTION: Two phase passive heat transfer devices such as vapor chambers are used in modern miniaturized electronic devices and state-of-the-art CubeSat systems. These vapor chambers consist of three base components viz., substrate, wick structure and the working fluid.

PURPOSE: The complexity of design and fabrication using conventional manufacturing methodologies such as furnace sintering of the three-dimensional wick structures resulting in longer manufacturing timelines. The current state-of-the-art vapor chambers are solely made using copper as the base material due to its high thermal conductivity and diffusivity, however these properties hinder the manufacturability of the wick.

METHODS: In this study, aluminum is used as the base material for manufacturing of three-dimensional wick structures to address the aforementioned problems. Aluminum based multilayered wick structures are fabricated using hot-press sintering process. This novel manufacturing process depends upon temperature, pressure and time period which is then optimized based on design of experiments to determine the most efficient parameters for successful fabrication

RESULTS: Successful development of wick structures was observed when the aluminum particles are hot-pressed at temperature and pressure conditions of 200 °C and 1.379 MPa (200 psi). By varying the time period of manufacturing, the structural integrity of the wick structure changes accordingly.

CONCLUSION: Aluminum based multi-layered wick structures could be developed by hot-press manufacturing which is much easier to manufacture in comparison with copper based multilayered wick structures. Although, there is performance loss due to the material properties of aluminum, an overall weight of the wick structures is one-third of copper based wick structures.