

Thermal Modeling of Tablets: Temperature Management using Phase Change Materials

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ABSTRACT

The performance of portable electronic devices (smart phones and tablets) has become an increasingly important area of study for both industry and researchers. Thermal management is a serious concern for the current generation of devices but will become increasingly critical as companies strive to further increase the computing power of portable electronic devices. Conventional electronics cooling methods such as air cooling are problematic due mainly to size constraints. Current generation devices are tightly packed with components, void spaces are often on the order of a few millimeters wide. Innovative and carefully designed passive cooling strategies are required. One opportunity for improving the thermal performance of devices is onboard thermal storage. This method takes advantage of the variable nature of the heat dissipation in portable device. A phase change material (PCM) is integrated into the passive cooling system of the device, when the device is active a portion of the dissipated heat is stored in the phase transition of the PCM, this heat is then rejected to the surrounding later during a period when the device is idle. The use of latent heat thermal storage in controlling the transient response of electronic devices has been proposed and investigated by several authors. However, most of these studies are focused on the behavior of the PCM and do not expand their focus to the larger engineering issues associated with integrating latent heat thermal storage into modern devices; others are simply outdated. The goal of this work is to develop a representative thermal model of a modern portable electronic device to determine definitively if phase change, latent heat, thermal storage can be used to positively affect the thermal performance of these systems.

A three dimensional thermal model of a tablet computer was created using the finite element solver Comsol MultiPhysics 4.4. The model includes hundreds of components and multiple discrete heat sources. The transient thermal performance of the simulated device was compared before and after the implementation of the PCM thermal storage. The study focused mainly on three aspects. Firstly, is there room in a modern device to include a sufficient volume of PCM to make a positive change to the operation time of the device. Secondly, how does the inclusion of thermal storage effect the dissipation of heat from the device. Lastly, if it is found that incorporated PCM is possible and effective, what PCM phase transition temperature is ideal.