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Heat Transfer Characteristics of the Graphite Pin-Fin Heat Sink

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This work experimentally investigated the heat transfer characteristics of the Graphite and Aluminum alloy pin-fin heat sinks. The results indicated that the cooling capabilities of the Graphite heat sink were 66% and 46% higher than those of the Aluminum alloy heat sink separately for the free and forced convections. However, the total mass of the Graphite heat sink was only half of the Aluminum alloy heat sink. Furthermore, the cost of the Graphite heat sink is very cheap. According to the present results, the total cooling capability of the Graphite heat sink is acceptable, especially for the free convection. Therefore, the Graphite will be the potential material of the heat sinks in the future.

Keywords: Graphite, Pin-fin heat sink, Heat transfer.

1 Introduction

The electronic products produce a large amount of waste heat when converting electrical energy during operation, thus, they must be equipped with cooling modules to maintain the working environment within an acceptable temperature range, so as to ensure the reliability and service life of the devices. The combined module of aluminum extruded pin-fin heat sink and fan is often used in the cooling module of 3C products. The fan rotates at rated power to generate air flow to blow into the heat sink, thus forcing convection heat exchange with the pin fins. It is an effective heat sinking method. The aluminum extruded pin-fin heat sink is also used in LED for heat sinking. Without using the fan, the waste heat of LED is transmitted from the substrate to the heat sink through heat transfer, and the natural convection between the high temperature heat sink pin-fins and the air accelerates the dissipation of heat to the environment. There are many studies on heat transfer of plate or pin fin heat sink. Vanfossen [1] and Brigham and Vanfossen [2] discussed the heat transfer characteristics of short pin-fin in staggered arrangement. The experimental result showed that the pin-fin in the height-diameter ratio H/d=4 transferred more heat than short pin-fin (H/d=1/2 and 2), and the average heat transfer of eight-row pin-fin array was higher than that of four-row pin-fin array. The average heat-transfer coefficient of pin-fin surface was higher than the endwall by 35%. Metzger et al. [3] studied the effect of the shape and arrangement of pin-fin on the heat transfer and pressure loss. The experimental result showed that the round pin-fin and the arrangement between staggered and in-line could enhance the heat transfer effect effectively; meanwhile, the pressure loss was not significantly increased. Although the oval pin-fin increased the heat transfer by 20%, as compared with round pin-fin, it increased the pressure loss by 2 times. The average heat-transfer coefficient of the pin-fin surface was about 2 times of the endwall. In the study of graphite heat sink, Chen [4] adopted experimental measurement and numerical simulation to discuss the heat dispersion of