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Integrated flat heat pipe with a porous network wick for high-heat-flux electronic devices

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Abstract

A novel integrated flat heat pipe (IFHP) was constructed, which consists of an evaporator and a condenser with multiple channels fabricated in the fin heat sink. A layer of compressed copper foam was sintered on the inner surface of the evaporator bottom plate, and many copper foam bars were inserted into the channels, both of which formed a porous network wick. Experiments were performed under three inclination angles (θ=0°, 90°, and 180°), using acetone as the working fluid. Air and water cooling methods were used to cool the fin heat sink. Compared with the conventional flat heat pipe (CFHP), the IFHP presents good fin temperature uniformity and heat performance; it eliminates the contact thermal resistance between the heat pipe and the heat sink, expands the condensation area of the heat pipe, and reduces the temperature difference between the fin base and the fin end. When the heat flux reached 161.1 W/cm^2, the fin efficiency increased to 93% and the temperature at the center of the evaporator bottom surface was merely 68.7°C. For the IFHP, the optimal filling ratio and inclination angle are 30% and θ=0°, respectively, for which the best heat performance was achieved, and the minimum total thermal resistance was 0.33 K/W. In the case of water cooling, the heat flux could reach up to 350W/cm^2. The results indicate that the IFHP with copper foam as a porous network wick presents excellent heat performance, and is thus suitable for heat dissipation in high-heat-flux electronic devices.

Keywords: Integrated; Flat heat pipe; Copper foam; Porous network wick

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