A Novel Copper Bead Heat Sink for Computer Cooling

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Abstract

The power dissipation of CPU used in desktop computers has been steadily increasing with time. The tendency for a rise in the CPU capacity resulted at present in increasing heat release to 50-100W for desktop PC. The problem of the CPU cooling consists in restricting its temperature to 80-90 °C. Current desktop computers use a heat sink of approximately 60 × 80 mm2 base area. Desktop computers are typically cooled by heat sinks mounted on the CPU. There is also a fan installed to a heat sink forming an assembly that is attached to the CPU. Air is forced through the heat sink by the fan. The fan-heat sink mechanism will be the key component to solve the heat problems. We deliver a novel copper bead heat sink (CBHS), which is a heat sink combines a sinter hollow copper ball to be its fin, to increase the heat exchange surface area with cooling air. By the other way, we made a coaxial rotor on a fan to enhance the heat transfer coefficient of convection. The goal of this plan is to make a new fabrication process, and the new type heat sink can dissipate the heat effectively.

Preliminary result showed that the minimum value for the total thermal resistance is 0.48 °C/W under 65W input power. The heater surface temperature is around 51 °C. The results of the bead fan are almost the same by clockwise and counterclockwise. The holes on the bottom cannot bring better performance. The wind can't go through those holes into the sink center. Research work is continuing for the heat transfer enhance of CBHS.

Keywords

CPU cooler, Heat sink, Sinter sink, Copper bead sink

1. Introduction

Computer chip always accompanied by the increase of heat dissipation and miniaturization. Increased miniaturization, higher power densities, and demands on system performance and reliability in electronic systems have necessitated more aggressive heat removal techniques in the thermal management of electronic components.

In recent years, the data processing units (CPUs) in personal computers or workstation, has progressed dramatically, resulting in a significant increase in the heat fluxes generated in these microchips, which have reached 100 W/cm2 in the late 2000s [1]. For this reason, various types of cooling systems have been developed as thermal solutions. The fan-integrated heat sink is the most widely used type of the cooling device due to its high price-performance ratio.

Raj Bahadur and Avram Bar-Cohen try to design and optimization methodology of a thermally conductive polyphenylene sulphide (PPS) polymer staggered pin fin heat sink, for an advanced natural convection cooled microprocessor application, are described using existing analytical equations. [2] Emre Ozturk and Ilker Tari studied Three different commercial heat sink designs are analyzed by using commercial computational fluid dynamics software packages Icepak and Fluent [3].

Pin-fins, cross-cut fins, and augmented fins are studied and used of the approaches taken by different manufacturers to implementing fin segmentation.

Seo Young Kim and Ralph L. Webb do an analysis of convective thermal resistance in ducted fan-heat sinks. Analysis of convective thermal resistance for plate-fin, inline round pin-fin, staggered round pin-fin, and offset strip-fin heat sink has been performed in the present study [4]. Hun Sik Han et al. shows the heat sink design method for a thermoelectric cooling system. And the optimized louver fin heat sink has a lowest outlet air temperature with a reduced air flow rate due to a higher pressure drop [5]. Tae Young Kim et al. presents a special novel heat sink with moving fins inserted between cooling fins is suggested for electronics cooling applications. In the novel heat sink, instead of the fan module, moving fins are inserted in the intervals of fixed fins (cooling fins) for generating fluid flow [6]. In recent year, many paper to design the heat sink, whatever optimization, design and management, and new type of heat sink.

In this paper, we try to improve the overall surface area to enhanced the heat transfer translates directly into improved thermal performance. The paper used the bead to build a heat sink which can easy to increase the surface area directly.

2. The copper bead heat sink (CBHS)

From the idea the CBHS is different to traditional plan fin heat sink. The fin of CBHS is made by many hollow copper spheres to build a heat sink. A CBHS configured shown in Figure 1. The fabrication processes include copper bead made, sintering bead fin and the coaxial rotor on a fan. This design is in order to increase the heat transfer area. Hollow structure not only cost down the price, but increase the effect of the heat reduction. There are 4 test devices in figure 2, which A and B shows the clockwise and counterclockwise bead fan plate. C and D are shown 6 holes and 12 holes on the bottom of the CBHS. Figure 3 shows the CBHS combine without and with a coaxial rotor on the center of the fan. The airflow made by fan will build a no wind area on the center of CBHS, which just like a typhoon eye. We hope the fan combine a coaxial rotor can agitated the air to improve the heat convection effect on the center of CBHS. Figure 4 shows the real picture of heat sink combine with a coaxial rotor fan. The manufacture cost is lower than 5 US dollar.

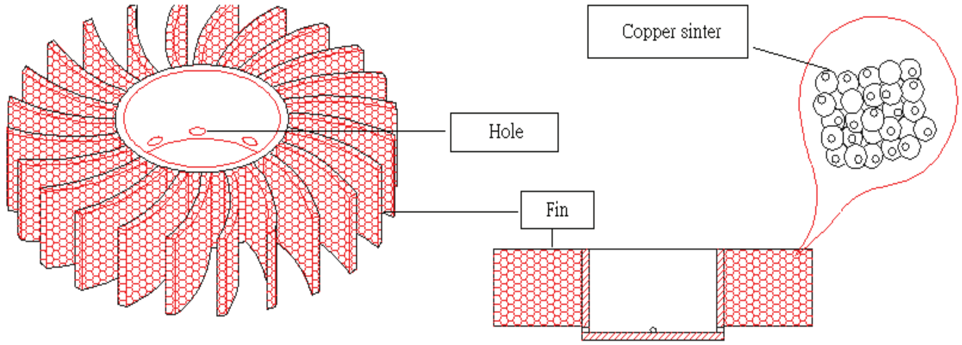

Figure 1: The schematic of copper bead heat sink (CBHS) and its component

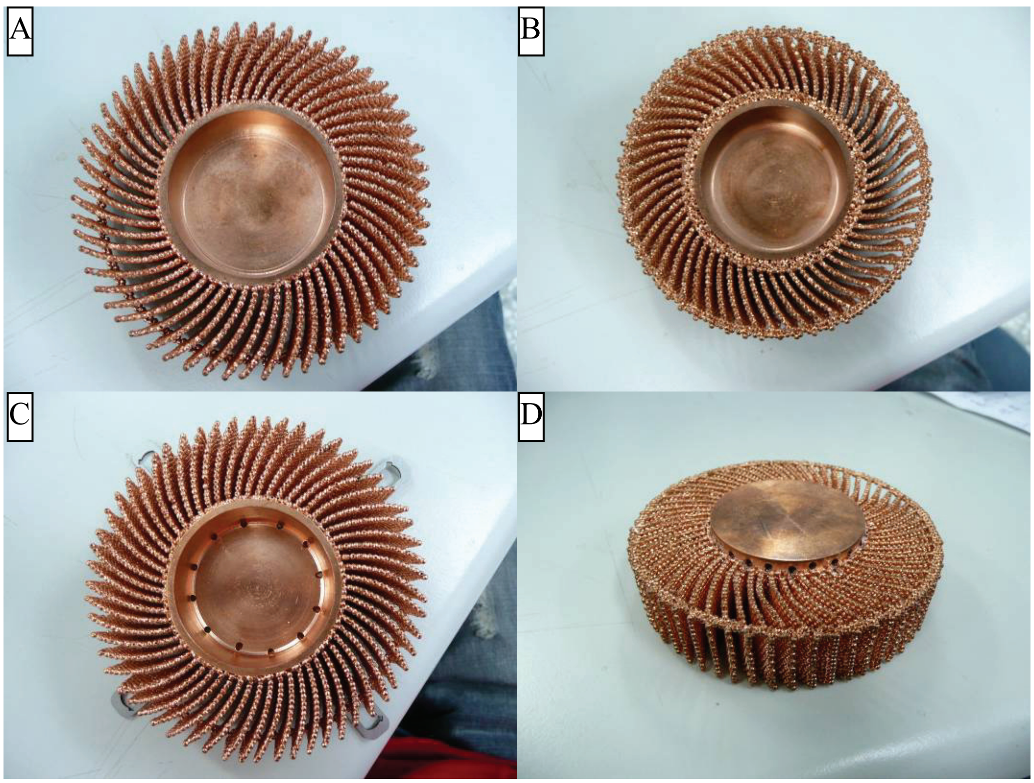

Figure 2: The real copper bead heat sink (CBHS) device with (A) clockwise bead fan (B) counterclockwise bead fan (C) 6 holes on the bottom of the CBHS (D) 12 holes on the bottom of the CBHS

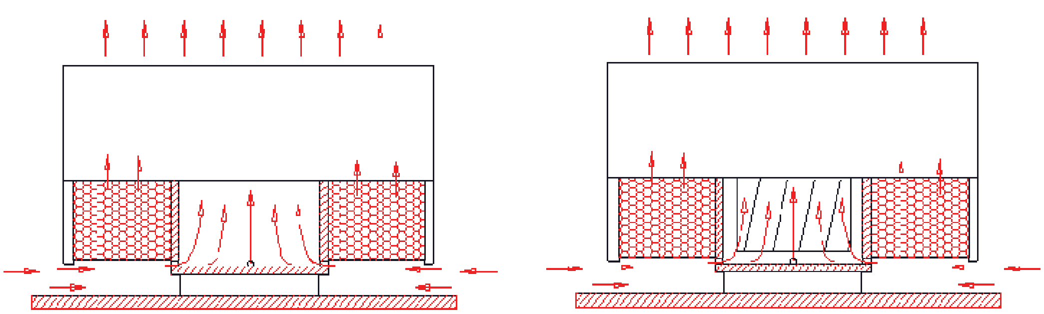

Figure 3: CBHS combine without and with a coaxial rotor on the center of the fan.

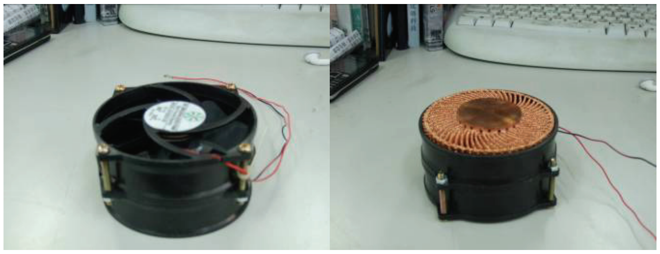

Figure 4: Real device of picture heat sink combine with a coaxial rotor fan.

3. Experimental Setup

The CPU cooling test apparatus are shown in figure 5 and figure 6. Figure 5 shows a CPU cooler device includes a heat input device、pressure gauge、temperature monitor and computer catch device. Figure 6 shows the heating system used a bar material thermal conduction test system. The cartridge heater is embedded in a square aluminum rod of 31 mm × 31 mm cross-section. There are three thermocouples (PT-100) installed in the top, middle and bottom of aluminum rod. The two thermocouples are used to calculate the heat flux and the surface temperature of aluminum rod. The third thermocouple used to check the calculation results. By the conception of Fourier Law and ASTM-5470 D Thermal Guard to calculate the heating surface temperature, thermal resistance and the heat flux.

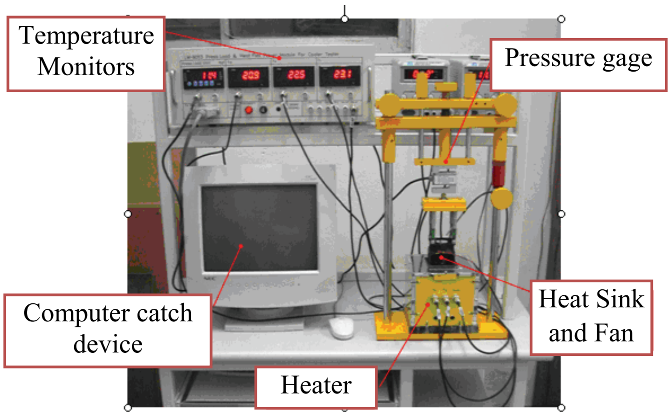

Figure 5: CPU cooler test device

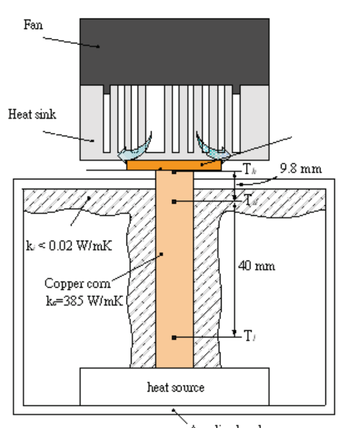

Figure 6: Heat input device

4. Test Result

Figure 7 to 8 shows that the variation of the heater surface temperature and thermal resistance as a function of time. Preliminary result showed that the minimum value for the total thermal resistance is 0.48 °C/W under 65W input power. The heater surface temperature is around 51 °C. The results of the bead fan are almost the same by clockwise and counterclockwise. The holes on the bottom can not bring better performance. The wind can't go through those holes into the sink center. Research work is continuing for the heat transfer enhance of CBHS.

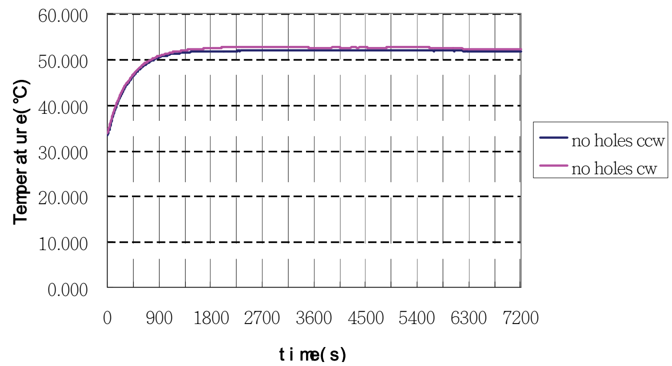

Figure 7: Variation of the heater surface temperature as a function of the time

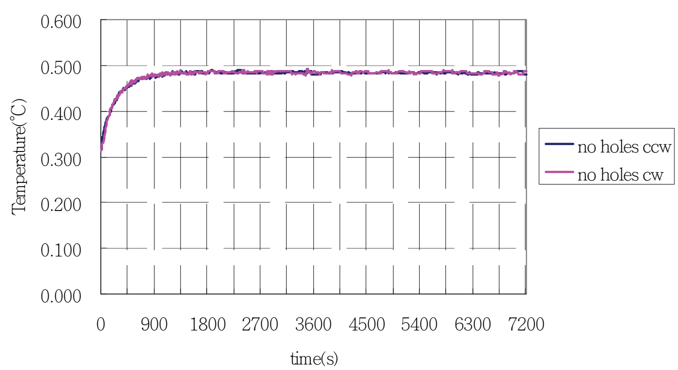

Figure 8: Variation of the thermal resistance as a function of the time

5. Conclusions

Preliminary result showed that the minimum value for the total thermal resistance is 0.48 °C/W under 65W input power. The heater surface temperature is around 51 °C. The results of the bead fan are almost the same by clockwise and counterclockwise. The holes on the bottom cannot bring better performance. The wind can't go through those holes into the sink center. Research work is continuing for the heat transfer enhance of CBHS.

The overall surface area compare with the same size stamping form heat sink will increase more than 4 times. By the other way, we also make a bowl type vapor chamber inside CBHS. Primary result show that the total thermal resistance will decrease to 0.24 °C/W. In the future study will use a special design to arrangement the bead which can decrease the pressure drop of air flow and increase the performance again.

Acknowledgments

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