LIQUID-COOLED HEAT DISSIPATING DEVICE AND METHOD OF MAKING THE SAME

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ABSTRACT

A liquid-cooled heat dissipating device includes a chamber-confining body confining a liquid chamber adapted to receive a liquid coolant, and having a surrounding wall that surrounds the liquid chamber, a cover plate covering the liquid chamber and sinter-bonded to the surrounding wall, a liquid inlet spatially communicating with the liquid chamber, and a liquid outlet spatially communicating with the liquid chamber. A method of making the liquid-cooled heat dissipating device is also disclosed.
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CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a divisional of U.S. Application No. 12/802,214, filed on Jun. 1, 2010, which claims priority of Taiwanese Application No. 98118364, filed on Jun. 3, 2009, the disclosure of which are incorporated herein by reference in their entireties.

BACKGROUND OF THE INVENTION

1. Field of the Invention
This invention relates to a liquid-cooled heat dissipating device, more particularly to a liquid-cooled heat dissipating device made by sinter-bonding and to a method of making the same.

2. Description of the Related Art
Referring to FIG. 1, a conventional liquid-cooled heat dissipating device 9 is adapted to be installed on an electronic component (not shown), such as a central processing unit (CPU) of a computer, and to dissipate heat from the same. The liquid-cooled heat dissipating device 9 includes a chamber-confining body 91, a cover plate 92, an inflow tube 93, an outflow tube 94, a plurality of screws 95, and an annular seal 96.

The chamber-confining body 91 has a base wall 911, a surrounding wall 912 that is connected to the base wall 911 and that surrounds a liquid chamber suitable for receiving a liquid coolant, a plurality of screw holes 913 that are formed with the surrounding wall 912 and that threadedly engage the screws 95, and a plurality of dividing walls 914 that are formed on the base wall 911, that respectively have one end connected to the surrounding wall 912, and that divide the liquid chamber into a plurality of channels 915 which are interconnected. The inflow and outflow tubes 93, 94 are connected to the surrounding wall 912, and are in spatial communication with the liquid chamber (i.e., the channels 915).

The cover plate 92 is formed with a plurality of through-holes 921 that correspond in position to the respective screw holes 913 of the chamber-confining body 91. The screws 95 extend through the through-holes 921 of the cover plate 92 and threadedly engage the screw holes 913, thereby being able to fix the cover plate 92 on the chamber-confining body 91. The annular seal 96 is mounted on the surrounding wall 912 so as to prevent leakage of the liquid coolant.

In use, the liquid-cooled heat dissipating device 9 is connected to a pump for transferring the liquid coolant into and out of the liquid-cooled heat dissipating device 9, and the base wall 911 is attached to an electronic component (e.g., CPU). Heat generated by the electronic component is transferred to the liquid coolant in the liquid-cooled heat dissipating device 9 through the base wall 911. By virtue of the pump that can circulate the liquid coolant, the heat absorbed by the liquid-cooled heat dissipating device 9 can be transferred. Therefore, the heat from the electronic component can be dissipated, and a temperature of the same can be lowered.

However, since the screws 95, the through-holes 921, and the screw holes 913 are required to fix the chamber-confining body 91 and the cover plate 92 together, a production cost of the liquid-cooled heat dissipating device 9 is increased. Before operating the liquid-cooled heat dissipating device 9, the cover plate 92 and the chamber-confining body 91 must be assembled using the screws 95, thereby causing inconvenience. The annular seal 96 may go through aging and deformation such that leakage of the liquid coolant may eventually occur. Thus, the electronic component attached to the liquid-cooled heat dissipating device 9 may be damaged.

SUMMARY OF THE INVENTION

Therefore, the object of the present invention is to provide a liquid-cooled heat dissipating device that can overcome the aforesaid drawbacks of the prior art, and a method of making the same.

According to one aspect of this invention, a liquid-cooled heat dissipating device is provided, and includes a chamber-confining body confining a liquid chamber adapted to receive a liquid coolant, and having a surrounding wall that surrounds the liquid chamber, a cover plate covering the liquid chamber and sinter-bonded to the surrounding wall, a liquid inlet spatially communicating with the liquid chamber, and a liquid outlet spatially communicating with the liquid chamber.

According to another aspect of this invention, a method of making a liquid-cooled heat dissipating device is provided. The method comprises: providing a surrounding wall surrounding a liquid chamber adapted to receive a liquid coolant; providing a cover plate having an oxide layer; and covering the liquid chamber with the cover plate and sinter-bonding the cover plate to the surrounding wall by placing the oxide layer in contact with a top open end of the surrounding wall.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the present invention will become apparent in the following detailed description of the preferred embodiments of this invention, with reference to the accompanying drawings, in which:

FIG. 1 is an exploded perspective view of a conventional liquid-cooled heat dissipating device;
FIG. 2 is a schematic perspective view of the first preferred embodiment of a liquid-cooled heat dissipating device according to the present invention;
FIG. 3 is an exploded perspective view of the liquid-cooled heat dissipating device shown in FIG. 2;
FIG. 4 shows the steps of making the liquid-cooled heat dissipating device shown in FIG. 2;
FIG. 5 is a fragmentary sectional view of the second preferred embodiment of the liquid-cooled heat dissipating device according to the present invention;
FIG. 6 is a schematic perspective view of the third preferred embodiment of the liquid-cooled heat dissipating device according to the present invention;
FIG. 7 is an exploded perspective view of the liquid-cooled heat dissipating device shown in FIG. 6;
FIG. 8 shows the steps of making the liquid-cooled heat dissipating device shown in FIG. 6; and
FIG. 9 is a fragmentary sectional view of the fourth preferred embodiment of the liquid-cooled heat dissipating device according to the present invention.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Before the present invention is described in greater detail, it should be noted that the same reference numerals have been used to denote like elements throughout the specification.

[0024] Referring to FIGS. 2 and 3, the first preferred embodiment of a liquid-cooled heat dissipating device 101 according to this invention is adapted to lower a temperature of an electronic component (not shown) such as a CPU of a computer. The liquid-cooled heat dissipating device 101 includes a chamber-confining body 22 and a cover plate 23.

[0025] The chamber-confining body 22 confines a liquid chamber suitable for receiving a liquid coolant, and has a surrounding wall 221 that surrounds the liquid chamber, a base plate 21, and a plurality of dividing walls 224. The surrounding wall 221 has a top open end 222 and a bottom open end 223 opposite to the top open end 222, and is formed with a liquid inlet 24 and a liquid outlet 25. Each of the dividing walls 224 has one end connected to an inner wall surface of the surrounding wall 221. The dividing walls 224 divide the liquid chamber into a plurality of channels 225 that are interconnected. The liquid coolant is able to flow through the channels 225. In this embodiment, the surrounding wall 221, the base plate 21, and the dividing walls 224 are made of copper.

[0026] The cover plate 23 covers the liquid chamber, is made of copper, and has opposite top and bottom surfaces 231, 232. The cover plate 23 is sinter-bonded to the top open end 222 of the surrounding wall 221. The base plate 21 has opposite top and bottom surfaces 211, 212. In this embodiment, the base plate 21 is sinter-bonded to the bottom open end 223 of the surrounding wall 221.

[0027] The liquid inlet 24 and the liquid outlet 25 spatially communicate with the liquid chamber (i.e., the channels 225). The liquid coolant is able to flow into the liquid chamber via the liquid inlet 24 and to flow out of the liquid chamber via the liquid outlet 25. In this embodiment, the liquid-cooled heat dissipating device 101 further includes tubes 27 that are adapted to be coupled to a pump, and that are respectively connected to the liquid inlet 24 and the liquid outlet 25. The tubes 27 may be integrally formed with the surrounding wall 221 using a die-casting process, or may be attached to the surrounding wall 221 after formation of the surrounding wall 221. It should be noted that the liquid inlet 24 and the liquid outlet 25 could be formed at other positions (e.g., on the cover plate 23 and the base plate 21) as long as the liquid inlet 24 and the liquid outlet 25 are able to spatially communicate with the liquid chamber (i.e., the channels 225). Nevertheless, the liquid inlet 24 and the liquid outlet 25 are preferably formed at proper positions that can maximize a flow distance of the liquid coolant in the liquid-cooled heat dissipating device 101 so as to maximize a contact area between the liquid coolant and the liquid-cooled heat dissipating device 101.

[0028] Due to the sinter-bonding step, the metal materials of the cover plate 23 and the base plate 21, and the metal material of the surrounding wall 221 are melted to form eutectics. After the sinter-bonding step and a cooling step, there are no gaps formed between the cover plate 23 and the surrounding wall 221, and between the base plate 21 and the surrounding wall 221. Therefore, fastening members, such as screws, are not required for the liquid-cooled heat dissipating device 101 of this invention. Furthermore, the liquid coolant in the liquid-cooled heat dissipating device 101 of this invention can be prevented from leakage such that a waterproof seal is not needed.

[0029] In addition, the liquid-cooled heat dissipating device 101 further includes a plurality of thermally conductive elements 26 that are disposed between the dividing walls 224 and in the channels 225. The thermally conductive elements 26 can be connected to the base plate 21 or the dividing walls 224. In this embodiment, the thermally conductive elements 26 are copper balls and are connected to the dividing walls 224. The thermally conductive elements 26 are able to increase the contact area between the liquid coolant and the liquid-cooled heat dissipating device 101, thereby being capable of enhancing heat exchange efficiency.

[0030] FIG. 4 shows a method of making the first preferred embodiment of the liquid-cooled heat dissipating device 101. The method is described as follows.

[0031] The aforementioned surrounding wall 221 formed with a plurality of the dividing walls 224 and a plurality of the thermally conductive elements 26, the aforementioned cover plate 23, and the aforementioned base plate 21 are provided. Each of the cover plate 23 and the base plate 21 is subjected to an oxidation reaction so as to form an oxide layer 203 thereon. The oxidation reaction can be conducted through a thermal oxidation process or a wet oxidation process. The thermal oxidation process can be conducted in an atmosphere furnace, which has the oxygen content below 200 ppm, and at a temperature ranging from 400°C to 900°C for 5-60 minutes. The wet oxidation process can be conducted using an oxidizing solution containing an oxidizing agent. The oxidizing agent is selected from the group consisting of potassium persulfate, trisodium phosphate, sodium chlorate, sodium hydroxide, and combinations thereof. Specifically, the cover plate 23 and the base plate 21 can be disposed in the oxidizing solution so as to form the oxide layers 203 (i.e., copper oxide layers in this embodiment). Details of the wet oxidation process can be found in the applicant’s Taiwanese publication no. 200927481.

[0032] The oxide layers 203 of the cover plate 23 and the base plate 21 are respectively placed in contact with the top and bottom open ends 222, 223 of the surrounding wall 221. Subsequently, the cover plate 23 and the base plate 21 are sinter-bonded to the surrounding wall 221. In this embodiment, the sinter-bonding step is conducted at a temperature ranging from 1065°C to 1080°C, and at the oxygen content below 200 ppm (preferably below 20 ppm) for 10-60 minutes. The steps for sinter-bonding the cover plate 23 to the surrounding wall 221 and the steps for sinter-bonding the base plate 21 to the surrounding wall 221 can be conducted separately or together.

[0033] During the sinter-bonding step at the temperature ranging from 1065°C to 1080°C, the oxide layers 203 (i.e., copper oxide) of the cover plate 23 and the base plate 21, and the top and bottom open ends (i.e., copper) of the surrounding wall 221 are melted so as to form the copper-copper oxide eutectic (the eutectic temperature of the copper-copper oxide eutectic is about 1065°C). After the cooling step, the cover plate 23 and the base plate 21 are securely bonded to the surrounding wall 221. Preferably, the cover plate 23 and the base plate 21 can be sinter-bonded to the dividing walls 224 when the same are being sinter-bonded to the surrounding wall 221. Accordingly, the cover plate 23 and the base plate 21 can be more securely bonded to the chamber-confining body 22, and gaps can be prevented from being formed between the
dividing walls 224, and the cover plate 23 and the base plate 21. Accordingly, a flow direction of the liquid coolant in the liquid-cooled heat dissipating device 101 can be maintained, thereby preserving the heat dissipating efficiency of the liquid-cooled heat dissipating device 101.

0034 FIG. 5 shows the second preferred embodiment of the liquid-cooled heat dissipating device 101. The second preferred embodiment is similar to the first preferred embodiment except that each of the cover plate 23 and the base plate 21 provided in the second embodiment is a ceramic-copper plate, which includes a ceramic substrate 202 and two copper layers 201 formed on two opposite surfaces of the ceramic substrate 202. The method of making the second preferred embodiment is the same as that of making the first preferred embodiment.

0035 Since ceramic is a good insulating material, the copper layers 201 on the ceramic substrate 202 can be patterned to form circuit patterns suitable for electronic components. When an electronic component is electrically connected to the patterned copper layer 201 on the cover plate 23 or on the base plate 21, heat generated by the electronic component can be transferred to the liquid coolant in the channels 225 directly through the cover plate 23 or the base plate 21. Thus, a temperature of the electronic component can be lowered by dint of heat exchange. When the cover plate 23 or the base plate 21 serves as a circuit board, the heat from the electronic component can be more efficiently dissipated by the liquid-cooled heat dissipating device 101.

0036 Referring to FIGS. 6 and 7, the third preferred embodiment of the liquid-cooled heat dissipating device 102 according to the present invention is similar to the first preferred embodiment except that the base plate is connected integrally to the bottom open end of the surrounding wall so as to form the chamber-confining body 28 as one piece. Therefore, only the cover plate 23 is required to be sinter-bonded to the surrounding wall of the chamber-confining body 28. In this embodiment, the chamber-confining body 28 may be made of copper or a copper alloy.

0037 FIG. 8 shows a method of making the third preferred embodiment of the liquid-cooled heat dissipating device 102. The method of making the third preferred embodiment is similar to that of making the first preferred embodiment except that the aforementioned surrounding wall 221 and the base plate 21 are integrally connected. Consequently, the base plate 21 is not required to have the oxide layer 203 before the sinter-bonding step.

0038 FIG. 9 shows the fourth preferred embodiment of the liquid-cooled heat dissipating device 102. The fourth preferred embodiment is similar to the third preferred embodiment except that the cover plate 23 provided in the fourth preferred embodiment is the ceramic-copper plate. The method of making the fourth preferred embodiment is the same as that of making the third preferred embodiment.

0039 While the present invention has been described in connection with what are considered the most practical and preferred embodiments, it is understood that this invention is not limited to the disclosed embodiments but is intended to cover various arrangements included within the spirit and scope of the broadest interpretation and equivalent arrangements.

What is claimed:
1. A liquid-cooled heat dissipating device comprising:
a chamber-confining body confining a liquid chamber adapted to receive a liquid coolant, and having a surrounding wall that surrounds said liquid chamber;
a cover plate covering said liquid chamber and eutectic-bonded to said surrounding wall;
a liquid inlet spatially communicating with said liquid chamber; and
a liquid outlet spatially communicating with said liquid chamber;
wherein said surrounding wall of said chamber-confining body has a top open end eutectic-bonded to said cover plate, and a bottom open end opposite to said top open end, said chamber-confining body further having a base plate connected integrally to said bottom open end of said surrounding wall as one piece;
wherein said chamber-confining body is made of copper, said cover plate being a ceramic-copper plate that includes a ceramic substrate and two copper layers formed on two opposite surfaces of said ceramic substrate.
2. The liquid-cooled heat dissipating device of claim 1, wherein said chamber-confining body further has a plurality of dividing walls connected to said surrounding wall and dividing said liquid chamber into a plurality of channels that are interconnected.
3. The liquid-cooled heat dissipating device of claim 2, further comprising a plurality of thermally conductive elements disposed in said channels.
4. The liquid-cooled heat dissipating device of claim 3, wherein said thermally conductive elements are copper balls.

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