New Products

Thin Heatpipe with Maximum Heat Transfer Rate in Excess of 50 W

1. INTRODUCTION

As laptop computers and similar data appliances become progressively thinner and more compact, their CPUs and graphic memory controller hubs (GMCHs) generate more and more heat, imposing more severe burdens on heat dissipation and cooling arrangements. Generally, because of the limited space for cooling or heat equalization inside the chassis of such equipment, flattened heatpipes have been widely used, but the problem is that as heatpipes become thinner the heat transfer rate is reduced making it difficult to cope with smaller, thinner equipment. We have developed a 1-mm thick heatpipe to address the trend to thinner equipment and are pursuing development of heatpipes that satisfy the requirements of the market, but with increased generation of heat there is a need for thin heatpipes with a larger maximum heat transfer rate.

In this project we have applied our accumulated know-how and manufacturing technology, and have succeeded in overcoming a major difficulty in the past--development of a high-performance heatpipe with a heat transfer rate in excess of 50 W and a thickness of only 2 mm. This is twice the thickness of 1-mm heatpipes, but delivers more than three times the maximum heat transfer rate. In this way, where the conventional heatpipes dictated the use of multiple heatpipes because of low heat transfer rate it is possible to manage with only one, and the leeway that is provided with respect to space means that it can be applied to products in which it was not previously feasible. In the following we describe the structure of the 2-mm heatpipe and its performance.

2. STRUCTURE

Heatpipes for use at room temperatures, as in the cooling of laptop computers, normally comprise a container made of copper, the working fluid, which is water, and a wick to serve as the flow path for the working fluid. Heat is taken up utilizing the extremely high latent heat of the water acting as the working fluid, steam then moves to the cooling section, condenses to give up heat, and the condensed water travels along the wick back to the evaporator section to provide heat transfer. Heatpipes that operate in this way thus require a means of smoothly returning the working fluid from the condenser to the evaporator section (the wick). In the past, most heatpipes have been of the grooved type, with grooves cut in the inner surface of the heatpipe, or a sintered metal mass. As can be seen from Figure 1, however, the walls are comparatively thick so that any attempt to flatten them to achieve a thinner profile restricts the flow path for the steam and speeds up the rate of flow, causing a dispersion limit, in which the working fluid returning to the evaporator section is blown away by the steam, significantly deteriorating the heat performance.

To address this problem, Furukawa Electric has developed a heatpipe with stronger capillary action that promotes circulation of the working fluid by adopting a mesh-type wick and a thin-walled container, as shown in Figure 2, resulting in the world's thinnest heatpipe at 1 mm, capable of the transfer of more than 10 W of heat.

The 2-mm heatpipe developed in this project improves on the structure of the 1-mm heatpipe, with a thin-walled flattened copper container, in the flat portion of which a mesh that provides a steam flow path in itself is closely bonded. The use of this type of structure facilitates

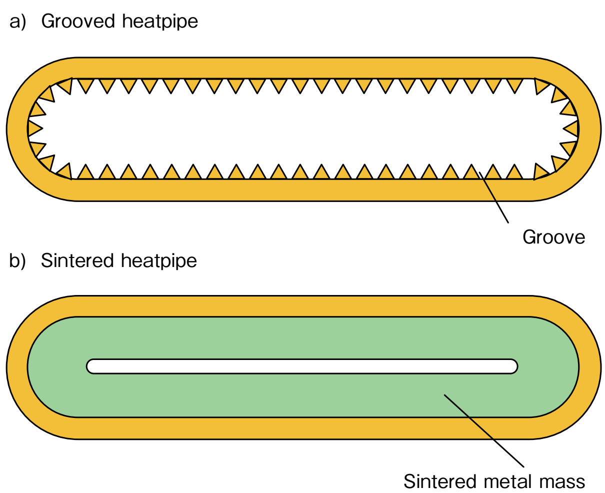

Figure 1 Structure of conventional heatpipes.

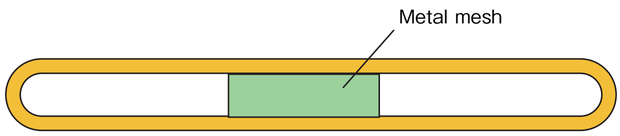

Figure 2 Structure of 1-mm-thick heatpipe.

smooth transfer of the heat from the heat source to the working fluid, realizing a heatpipe in which circulation of the steam and the working fluid takes place easily.

3. PERFORMANCE

Figure 3 shows the results of measurement of the maximum heat transfer rate for the 2-mm heatpipe developed in this project. As the figure shows, when the heatpipe temperature at the heat insulator section is kept at 50°C and it is operated horizontally, even the input of 50 W produces no sudden temperature rise at the evaporator section, demonstrating that the maximum heat transfer rate is in excess of 50 W. Normally in applications involving heat dissipation and cooling of laptop computers and similar electronics, the temperature inside the case may often reach 50°C or more, so that the maximum heat transfer rate will doubtless increase further.

And not only 2-mm thicknesses but even flatter configurations have made it possible to manufacture even thinner high-performance heatpipes. With greater flatness, the maximum heat transfer rate tends to be reduced, but it is still possible to deal with an area of thermal performance that are not covered by existing heatpipes. Figure 4 shows an example of the application of a heatsink using a heatpipe flattened to 1.5-mm thickness. Bends and steps can also be formed, and even assuming a case with multiple heat sources, it is possible to transfer 30 W of heat.

Figure 5 plots maximum heat transfer rate against heatpipe thickness. In grooved heatpipes, when the maximum heat transfer rate is large the degree of flattening is small, but as flattening increases the heat transfer rate drops rapidly. The 1-mm heatpipe, on the other hand, operates at a thickness unattainable by the grooved type, but its maximum heat transfer rate is not large. Through the development of this high-performance, thin-profile heatpipe, it has been possible to deal with a thin-profile, high-performance area of thermal performance that could not be covered by conventional grooved heatpipes or 1-mm heatpipes.

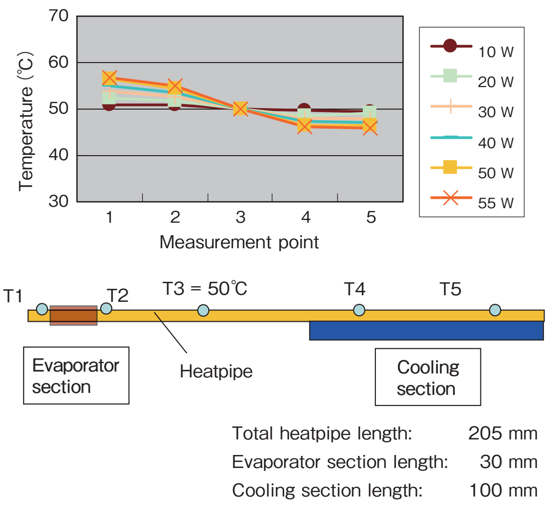

Figure 3 Maximum heat transfer rate of heatpipe.

4. CONCLUSION

Through development of the high-performance thin-profile heatpipe described here, Furukawa Electric has made it possible to use heatpipes in a wider range of applications, and has enabled more optimum proposals to be made. With respect to heatpipes, we are now proceeding to establish mass production and are scheduled to achieve this by the end of the current year.

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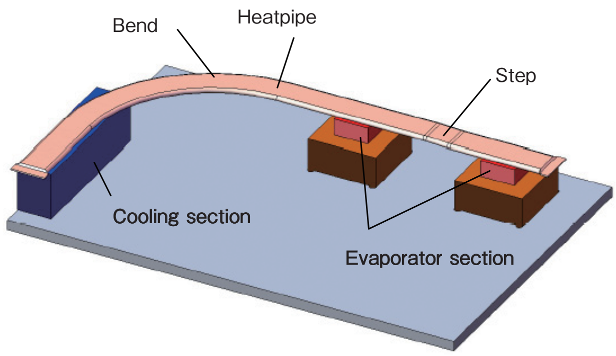

Figure 4 Example of application of thin-profile heatpipe

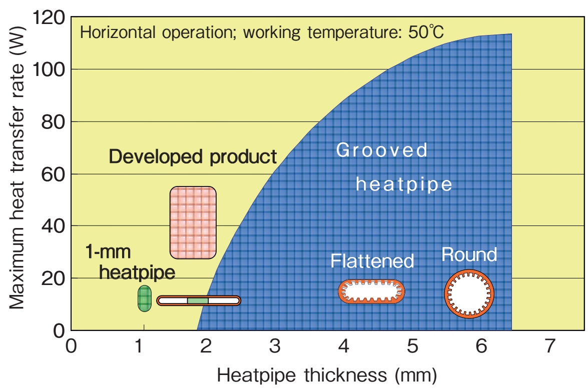

Figure 5 Heatpipe performance area.