A Study on the Heat Transfer Characteristics of Thermal Grease with Various Nano Powder Materials

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1. Introduction

The heat Transfer performance of an electromagnetic device has a great effect on the performance and reliability of the device. The thermally conductive materials are added to remove the air layer between the heat spreader and the heat sink in the heat dissipation process of the electromagnetic device, so that the heat dissipation goes smoothly. On the other hand, the heat diffusion rate is slowed when thermal grease with added materials with low heat transfer performance are used. In this study, high thermal conductivity graphene and metal nanoparticles of various materials were mixed into heat grease, and the heat transfer rate was measured.

2. Materials and Experimental methods

Graphene thermal conductivity ranges up to 5000 W/m·K. Since it has a higher thermal conductivity than other materials, it is excellent as a heating material [1]. Recently, research has been actively carried out to utilize graphene in heating materials such as nanofluids and TIM (Thermal Interface Materials) [2-5].

Typically, the thermal dissipation performance of an electromagnetic device has a significant effect on the performance or longevity of the device. Particularly, even in the case of CPUs mounted on a PC, it is designed to maintain a maximum temperature of 70°C to 75°C when working at a normal temperature of 30°C to 50°C, but the heat dissipation performance is not smooth, which rises to a higher temperature. If the CPU temperature exceeds 90°C, the CPU's performance will be dramatically reduced, and the system will automatically power down to protect the CPU.

So, it is necessary to have thermal equipment with thermal grease and better heating performance. Fig. 1 is a SEM Image of the surface of a heat-spreader of a commercial CPU. There is an air layer between the heat-spreader and the heat-sink, which prevents heat exchange at the level of 0.025W/m·K. Therefore, it is necessary to apply thermally with excellent thermal conductivity between the heat spreader and the heat sink to ensure smooth heat exchange.

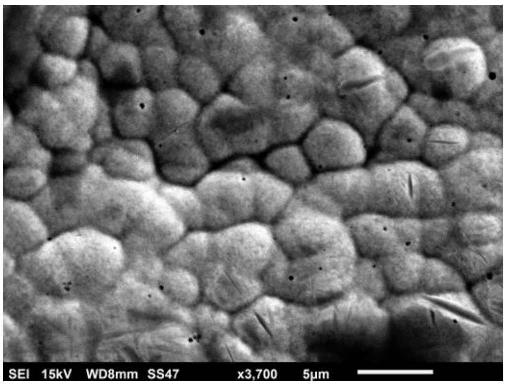

Fig. 1 SEM Image of surface of heat spreader


Fig. 2 Photography of PWE equipment

Also, it is necessary to apply thermally with excellent thermal conductivity between the heat spreader and the heat sink to ensure smooth heat exchange.

Figure 2 is a device photography that uses PWE (Pulsed Wire Evaporation method) to make metal into nano powder. The principle of supplying high electrical energy to metal wires in a short time is to manufacture nanoscale powder through evaporation and condensation process. During this process, an Ar vacuum was created inside the chamber to prevent the powder from oxidizing.

Figure 3 shows the process of producing nano thermograms in a schematic diagram. Because thermal grease is made of highly viscous fluid to keep its shape on top of a heat spreader for a long time and to prevent it from flowing down its surroundings, there were restrictions on stirring nanomaterials in a highly viscous state, as well as large vibrations of the impeller.

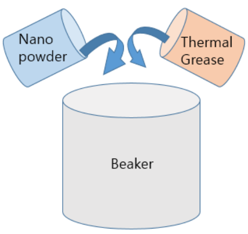

Fig. 3 SEM Image of surface of heat spreader

Methods for measuring heat transfer velocity were identified by a thermal imaging camera. thickness, the heat transfer velocity was measured by placing it on the heating plate and taking pictures of the surface of the top plate with thermal infrared camera. Because the higher the thermal conductivity, the faster the heat transfer rate is from the heating plate to the top plate, the faster the temperature rises, the better the heat transfer performance is.

3. Results and Discussion

Figure 4 shows the final temperature for all samples. It was found that all three types of materials had higher heat transfer performance than none of the non-applied test pieces, and that heat transfer performance also showed a tendency to increase as the nano powder content increased. You can also see that graphene, silver and copper are efficient in order.

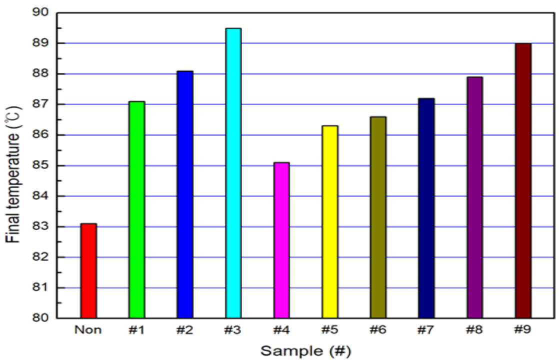

Fig. 4 Final temperature of all samples

Table 1 Heat transfer rate for all samples

Sample	16s (℃)	90s (℃)	Gradient (℃/s)	Percentage (%)
GN 1vol%	26.7	87.1	0.816	3
GN 2vol%	26.7	88.1	0.830	4.7
GN 3vol%	26.8	89.5	0.848	7
Cu 1vol%	26.5	85.1	0.792	standard
Cu 2vol%	26.6	86.3	0.807	1.9
Cu 3vol%	26.5	86.6	0.812	2.5
Ag 1vol%	26.8	87.2	0.816	3
Ag 2vol%	26.7	87.9	0.827	4.4
Ag 3vol%	26.8	89.0	0.84	6

Table 1 shows the average slope from the point of 16 seconds, which represents the difference in the significant temperature change, to the last measurement data, 90 seconds. In the T-t graph, the slope indicates the rate of temperature rise in ° C/s. The higher the slope, the faster the temperature rise, and therefore the better the heat transfer performance. This is because the thermal conductivity of graphene and silver is higher than that of copper, and the surface area is relatively large for heat exchange among the particles because the number of powders is 3 vol% rather than 1 vol%.

4. Conclusion

In this study, nanoparticles were produced using nanofluids of various metals such as copper and silver manufactured by PWE method. By measuring the heat transfer velocity using a thermal infrared camera, the results of the comparison were as follows.

To stir nanofluids in thermally, silicon oil or thermograms with lower viscosity should be used when stirring large quantities of nanofluids.

GN 3vol% sample showed 90°C in 90 seconds, which was the most efficient, and Cu 1vol% sample was the least efficient at 90 seconds to 85°C. Based on the comparison analysis, the GN 3vol% sample was 4% more efficient and the Ag 3vol% sample based on Cu 1vol% sample.

Acknowledgment

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