MIZUTANI ELECTRIC IND. CO., LTD

Specialty manufacturer of heat sink products
Unique application of thermal analysis tool

MIZUTANI ELECTRIC IND.CO., LTD
http://www.mizuden.co.jp/

Established	1967
Business	Production and sales of radiators for semiconductors
President & CEO	Kazuo Mizutani
Head Office	Chiyoda-Ku Tokyo
Employees	80 employees as of March 31, 2009
Capital	90,000,000 JPY

MIZUTANI ELECTRIC IND. (hereinafter Mizutani Electric), a specialty manufacturer of heat sinks and radiators for electronic devices, has been using Cradle scSTREAM for thermal analysis. Computational simulation has enabled the company to decrease the amount of experimental testing needed and substantially reduce their product development lead-time. Now they want to take another step to advance their simulation capabilities by drawing on their past experiences. To learn more about how Mizutani Electric is advancing the use of simulation, we interviewed Yousuke Watanabe, assistant manager of the Mizutani Electric Technology Center.

Mizutani Electric, a top specialty provider of heat sinks and radiators for electronic devices since 1967, is involved in all aspects of the electronics cooling business. This includes design, thermal analysis, manufacturing, and sales. Their products are highly trusted by manufacturers of industrial equipment requiring high performance radiators. In 1996, Mizutani Electric opened a plant in Malaysia to meet growing demand in the overseas market. The Development Technology group in Japan is responsible for product development and analysis.

Yousuke Watanabe
Assistant manager of technology center
MIZUTANI ELECTRIC IND.CO., LTD

Semiconductors are used in almost all electronic devices and industrial equipment. Stable operation of these electronic devices and equipment is critical. The heat sinks and radiators protect the equipment by dissipating excess heat from around the heat source (Fig. 1).

A heat sink usually consists of blocks with fins attached to the blocks. The blocks receive heat by contact with the heat dissipater. Fins are thin flat surfaces attached to the block that release heat into the surrounding air. To further improve heat dissipation efficiency, an external fan can provide forced air cooling, a pump can provide water cooling, or heat pipes can be used. A peltier device can also be used to lower the temperature below normally expected values if necessary. The design requirements determine the cooling methods that can be used.

A conventional heat sink is produced by extruding semi-solid aluminum through a die. The performance of a heat sink basically depends on the amount of its surface area. Because of this, most design engineers try to increase the effective surface area to improve cooling performance. In recent years, however, customers have demanded smaller, lighter, and more efficient heat sinks because their devices have become smaller. This has caused major design challenges as the amount of space between the heat sink fins also becomes narrower to the point where they reach their performance limit.

To break through this constraint, Mizutani Electric introduced a method called calking. With calking, the heat-receiving block and the fins are created separately. The fins are pressed into grooves in the block. The fins are held in the grooves in the block by bending the base of the fins with a lock seaming method (this is called "Haze-ori" in Japanese). The fins are bent in half to make them stick closely to the grooves. At the same time, only the base of the fins are bent to make the heat sink lighter. In addition, the fins must be the appropriate thickness to avoid "hollows" which will decrease heat transfer performance.

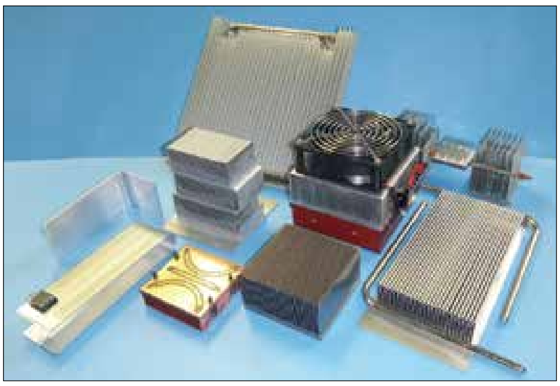

Fig. 1 Heat sink products of Mizutani Electric

The introduction of the new calked heat sinks satisfied customer demands by overcoming the limitations of the extrusion method. As a result, Mizutani Electric has shipped more than 100,000 "J-Fin (Registered utility model)" heat sinks to their customers.

While the usage and production method used for a heat sink depends on the customer specifications, Mr. Watanabe says their first priority in product development is "optimum design". Both economics and environmental considerations are driving the company to work hard to design smaller and lighter heat sinks using less secondary materials while meeting surface area requirements.

One Engineer for One Product

At Mizutani Electric one engineer is basically responsible for one product. Each engineer designs the product and executes the thermal analysis. Typically the engineer performs dozens of thermal analyses each year. Usually they work on several different custom products and, at times, also on the standard products. They will iterate on a design shape using thermal simulation and perform the evaluation assessment after production tests. Often to meet both economic and environmental constraints, they will assess a matrix of design options to determine the optimum product design for each customer.

Keys to Success: High Operability and a Multitude of Case Studies

Mizutani Electric chose scSTREAM for thermal simulation because of its high operability. Operability was a critical criterion when evaluating the variety of thermal-fluid simulation software available in the marketplace because the engineers using the software were not experts in computational simulation. Mizutani Electric was also impressed by the abundant number of heat sink related user case studies discussed at the Cradle user conference. Mr. Watanabe says, "Such informative user case studies gave us much needed information because we were newly getting started."

Reducing Lead-time Using Intensive Simulation Analyses and Building Expertise

One of Mizutani Electric's primary reasons for using simulation was to reduce product development lead-time. Before introduction of the software, engineers repeatedly conducted production tests to verify design changes. This often took several weeks to complete. CFD analysis has reduced the number of trial production tests needed to validate a design.

In addition, Mr. Watanabe points out that appropriately dealing with unknown and/or variability in physical properties is crucial for obtaining high accuracy results and speeding up the process. Mizutani Electric's extensive product and manufacturing experience has been important here. They can propose an optimum product design for their customers by resolving unknowns associated with physical properties using their vast product and manufacturing experience. Mr. Watanabe explains that "The effects of the physical properties are directly reflected in the simulation analysis results, but the thermal analysis for the experimental test results is less accurate. We can use the simulation analysis to conduct sensitivity analyses to understand which physical properties are most important. By doing this we can make the overall analysis process more accurate. This also enables us to make the most of our know-how as a heat sink manufacturer."

Mr. Watanabe goes on to say that they always try to design their analysis conditions so they can easily identify the causes for differences between the simulation and experimental results. There are always some differences between the simulation and experimental results. However, Mr. Watanabe says "We always work on improving our ability to trace the cause of the differences using the expertise we've accumulated over many years."

Analyses Enhance the Development of a New Product

Mizutani Electric's patented HEATLANE® Heat sink uses a HEATLANE® plate with a significantly higher thermal conductivity compared to conventional materials and designs. The plate is bent in layers and fins are connected to each layer. The very high thermal conductivity of the plate enables the HEATLANE® plate to conduct heat to the end of the plate much quicker than aluminum or copper boards.   When the fin is long, neither aluminum or copper can effectively conduct heat to the end of the fin. The HEATLANE® plate equalizes the heat in the heat sink and maximizes the efficiency in a small space.

The example in Fig. 2 uses a plate bent in an S shape which transports heat to the upper stage fin for the best dissipation performance. Mr. Watanabe explains, "We believe that we can potentially replace a conventional water cooling system with the HEATLANE® method."

Optimal fin heat dissipation will occur when the metal temperature is uniform across the fin. The analysis for a conventional fin revealed that the temperature varies greatly from one end to the other. scSTREAM was used to identify concepts that

Fig. 2 HEATLANE® Heat sink

could improve fin temperature uniformity. This analysis showed that heat dissipation efficiency could be improved 40% over a conventional fin by using special soldering techniques (Fig 3). Mizutani confirmed that the soldered fins performed in actual experimental tests just as scSTREAM predicted. This helped build their confidence in analytical simulation.

Another concept nearing production release, "EC-JOINT (Registered utility model)", has been shown to improve heat dissipation efficiency by 20%. For this design, a heat pipe is connected to the side of the heat sink where the fins are located. No secondary material such as solder or adhesive is used because the heat pipe is tightly pressed into the heat sink to make direct contact. The heat pipe concept is both economical and environmentally friendly (doesn't require use of secondary materials). One critical design/manufacturing requirement is producing an extremely flat heat pipe so that it can make perfect contact with the heat sink. A special capability of "EC-JOINT" is that heat can be uniformly conducted across the entire fin even if the heat source generates heat in a local area or disperses it across the fin with a varying distribution. In addition, because the heat pipe is set to the side of the heat sink where the fins are located, design engineers can easily allocate parts to oneside of the base face. This places the parts on one side of the base face reducing its overall size. This is an extremely important benefit for Mizutani Electric customers.

Seeking Ways to Get Even More Benefits from Using Simulation

Mr. Watanabe also discussed future improvements for thermal analysis. Certainly simulation at Mizutani Electric has reduced the number of production tests needed to validate a design. This has shorted product development lead-time. But Mizutani Electric would like to take the next step by seamlessly integrating the company's accumulated know-how with the software tool to design new composite radiators that will be developed over the next few years. Mizutani Electric believes an opportunity exists to shorten development time even more for the new composite radiators by harnessing the lessons learned from previous analyses.

What is expected from CRADLE?

Mr. Watanabe says, "In scSTREAM Version 10 we can input an upper limit for heat transport that enables us to stop the computations and eliminate unnecessary analysis. This brought a great advantage to our product development." Mitzutani Electric also expects Cradle to improve the compatibility of the data between older versions of scSTREAM and the current version. At this time, data compatibility is primarily between the current version and the previous version. Mr. Watanabe says he is satisfied with the current functions in scSTREAM, but still has expectations to improve the usability of the software even more. He says, "It would be even more convenient if we could exchange model data between scSTREAM and HeatDesigner."

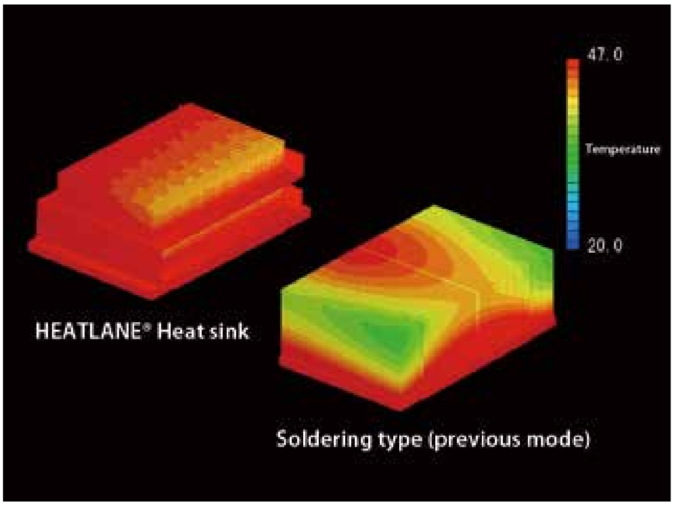

Fig. 3 The result comparison between the current and previous heat sinks

Fig.4 EC-JOINT (called ECO-JOINT)

Featured Software

scSTREAM

scSTREAM uses a structured mesh to model general purpose thermal/fluid applications where tiny details and curved surfaces are not critical for an accurate simulation. scSTREAM can both create the mesh and calculate the solution quickly and efficiently using the finite volume method. A one million element model only consumes 350MB of RAM. In addition to highly capable models for simulating complex physics, scSTREAM also includes a set of Visual Basic interfaces and table/function inputs that make it customizable.

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