Vincotech’s modules with pre-applied phase-change material

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Abstract

There are several advantages to using phase-change material (PCM) rather than conventional thermal grease as the thermal interface material (TIM) between the power module and heatsink. Vincotech offers modules with a layer of pre-applied PCM. The thermal interface material is applied in a layer with uniform thickness by a screen-printing process. This document describes the benefits of this phase-change material and provides tips on handling modules.

Introduction

Heat has to be transferred from the module to the heatsink and thermal interface material is a necessary evil that gets the job done. However, thermal resistance increases if the layer is too thin or thick. Vincotech has addressed this issue by supporting modules with a pre-applied layer of phase-change material. The module’s size and technology determines the layer’s thickness.

The phase-change material is solid at room temperature, so it requires no special care during transportation, handling and application. Because of its thixotropic consistency, the material softens but does not flow when heated during soldering. The surface needs protection only if the power module’s phase-change material comes into contact with other objects during or directly after soldering, for example, the soldering oven’s carpet. The screen-printing process is precise, thereby maximizing heat-transfer capability.

The next picture shows the backside of a flow0 module with pre-applied phase-change material.

Figure 1: Modules with applied phase-change material

The customer is spared the task of applying thermal interface material, thereby saving time and reducing the failure risk. No additional process step is needed at the customer's side.

The Phase-Change Material

Vincotech uses Loctite PSX-Pm phase-change material. It has the advantage that it can be applied by screen or stencil printing. It is fluid during the application and dries out over time and temperature. Another strong advantage can be seen in Table 1. The thermal conductivity is much higher compared to a lot of standard thermal greases. This result in a lower junction temperature compared to modules where usual grease is used. And for sure this material is silicone free. Once the phase-change material solidifies, the module may be handled like any conventional module. Here are some features of modules that are applied with this material:

- Faster, easier module mounting
- Optimized thickness of the thermal interface material
- Improved R_{th} and reduced risk of DBC crack
- Streamlined production; no need for screen-printing facilities
- Automated screen printing for utmost reliability
- No risk of smearing of the thermal paste, material is solid at room temperature
- Standard solder profile applicable (e.g. J-STD-001, J-STD-003)
- Compatible with Press-fit pins

The physical and thermal properties of the used phase-change material can be seen below. For more information please refer to the manufacturer's datasheet.

Parameter	Value	Unit
Specific Gravity	2	g/cm²
Thermal Conductivity	3.4	W/m*K
Phase Change Temperature	45	°C
Viscosity above phase change temperature	Thixotropic	
Color	Grey	

Table 1: Physical and thermal properties of the phase-change material

Vincotech's modules with pre-applied PCM

Vincotech offers its modules with a pre-applied layer of phase-change material. All modules are UL-listed; therefore modules with phase-change material are also UL-approved. They come in a standard blister box with a protective lid.

Modules should be stored in these blister boxes. No aging effect is known; means no expiration date.

This compound was subjected to a battery of tests like a TST and high temperature storage to verify its reliability.

The following figure shows the pattern of the applied phase-change material onto the modules backside in thickness and dimension after the screen printing.

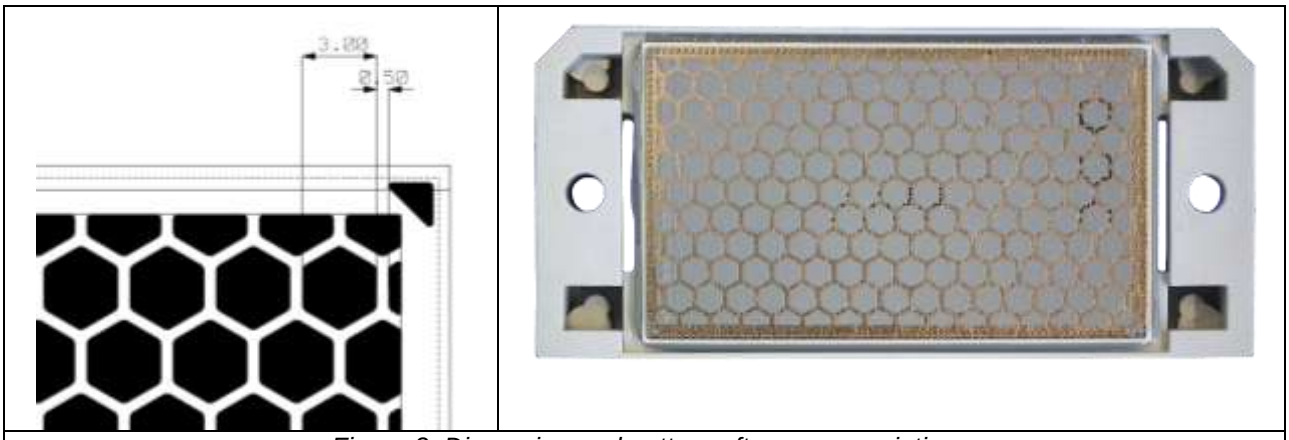

Figure 2: Dimension and pattern after screen-printing

The small triangle at the top right of the printed phase-change pattern is one of four corner markers used to align the press-in tool for modules with Press-fit pins.

Handling and operation

The module can be mounted to the heatsink after it has been soldered or pressed in. A special press-in block has to be used in case of modules with Press-fit pins. The press-in block has to have needles because the phase-change material would stick on this block if a flat block would be used.

The procedure is the same as the standard mounting process described in the housing specifications or handling instructions, apart from one major difference: Screws to the heatsink can be fastened and tightened in a single step. The phase-change material is solid at room temperature, so screws can be tightened immediately without having to give the material any relaxation time.

Upon initial start-up, the R_{th} between the junction and the heatsink of a system without soft material will be 10% to 15% higher than that of an operating system; that is, a system where the module is operating a temperature higher than 45°C and the phase-change material has attained its ultimate thickness. The higher R_{th} is not a problem because the heatsink temperature is below 45 to 50°C, a state at which chips cannot overheat. Time-to-melt is a function of temperature and the speed of temperature change. The material will not flow unless heat and force are applied.

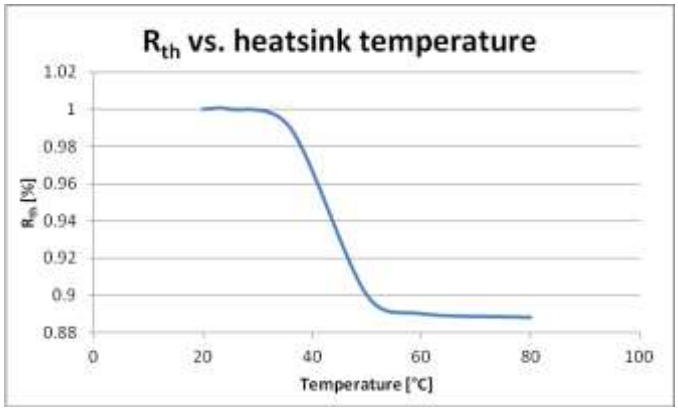

Figure 3: Thermal resistance versus heatsink temperature

Once the module has been mounted, the system should be heated up (e.g. during the system's burn-in test) while leaving enough time for the phase-change material to melt. If the temperature of the PCM exceeds 45°C, the material will melt, fill gaps and after a short time provide an optimal thermal connection between the module and heatsink. Screws do not have to be tightened again.

The phase-change material returns to its solid state when the temperature drops below 45°C. This means the material's phase changes every time it reaches 45 °C.

Conclusion

Vincotech offers modules with pre-applied phase-change material. This PCM is applied in a screen printing process that leaves an optimum and always consistent layer thickness. This phase-change material is thixotropic and therefore will not flow without the application of pressure. Standard soldering profiles may be used. A lid or a foil can prevent the phase-change material's surface from coming into contact with the soldering oven's carpet.

Power modules with Press-fit pins and phase-change material are compatible. Please refer to the module's handling instructions to learn more about this.