AN1910

Application Note

Power Modules with Phase-Change Material

Final

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Microsemi
Power Matters.

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1 Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

1.1 Revision 1.0

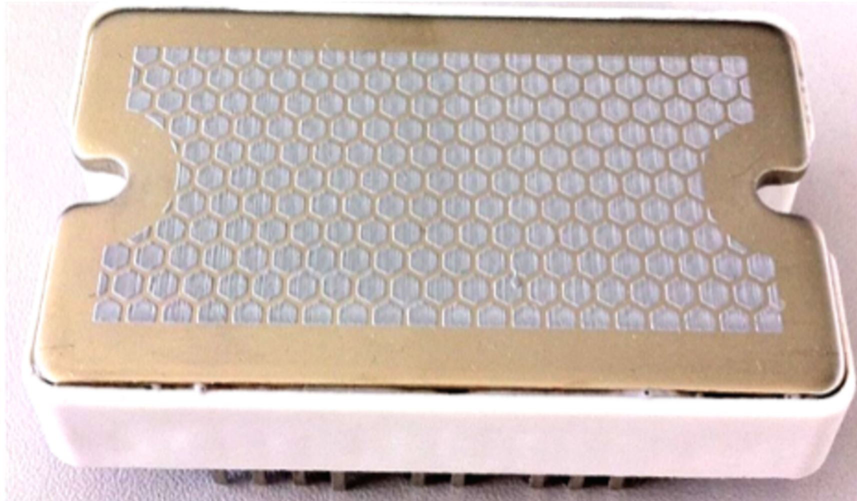
Revision 1.0 was published in February 2018. It is the first publication of this document.

2 Product Overview

This document shows how to correctly handle power modules with the pre-applied phase-change material (PCM). Power modules with the PCM have a thermal interface that fills microscopic gaps. This ensures a better thermal transfer between power semiconductors and heat sink. In addition, this helps keep the baseplate even.

Thermal performances are directly linked to material chosen and depend on the application process.

Figure 1 • Power Module with the Pre-Applied Phase-Change Material



3 Features and Properties

Microsemi uses Loctite PSX PCM. The thermal interface material is fluid when applied on the power module. The power module dries out over time and temperature. The thixotropy changes when the PCM heats up (around 45 °C). When this happens, the material changes from a solid state to a viscous state and spreads on the whole surface.

The following table shows the physical and thermal properties for the PCM . Please refer to manufacturer datasheet for more details.

Table 1 • Physical and Thermal Properties

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	

4 Optical Appearance

The following image show the pattern design for the PCM. The PCM is applied with a stencil printing process to control the layer thickness.

Figure 2 • Pattern_Design

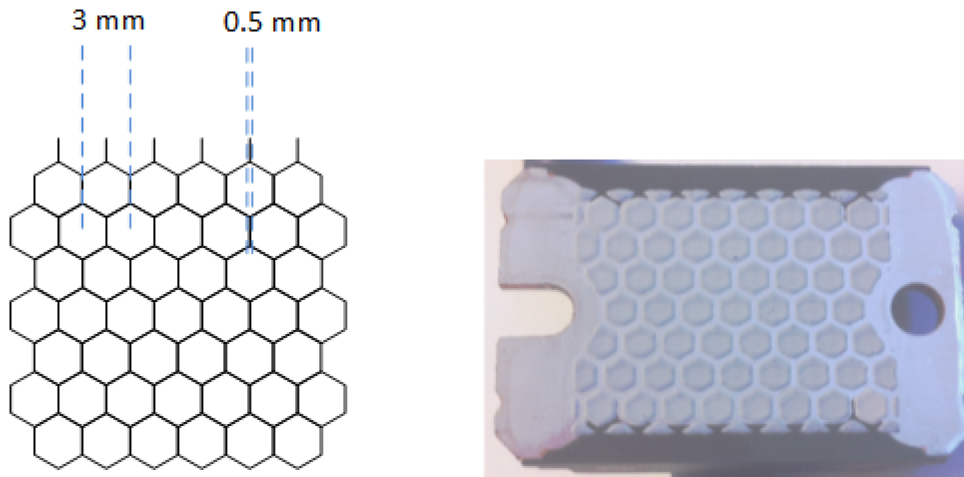


Table 2 • PCM Layer Characteristics

Parameter	Value	Unit
Thickness of the phase-change layer	150 – 200	µm
Diameter of the honeycomb pattern	2.0 – 3.0	mm
Space between honeycombs	0.5	mm

5 Storage

The following table shows the storage information for the PCM.

The Power Modules must be stored in their original packaging.

The products are processed before the maximum storage time defined below. The processing units beyond the expiration date defined can reduce the process ability. This can cause parts to malfunction.

Table 3 • Ambient Conditions

Temperature	5 - 40 °C
RH	10 - 75%
Duration	12 months

6 Operation

The PCM layer is considered a functional area of the power module. When the PCM layer is soft, the surface is sensitive to dirt, dust, and other debris. Be sure to pay attention to the PCM layer integrity during operation.

When the PCM layer heats up, through manual or wave soldering, the shape of the pattern shape changes. This does not affect thermal behavior.

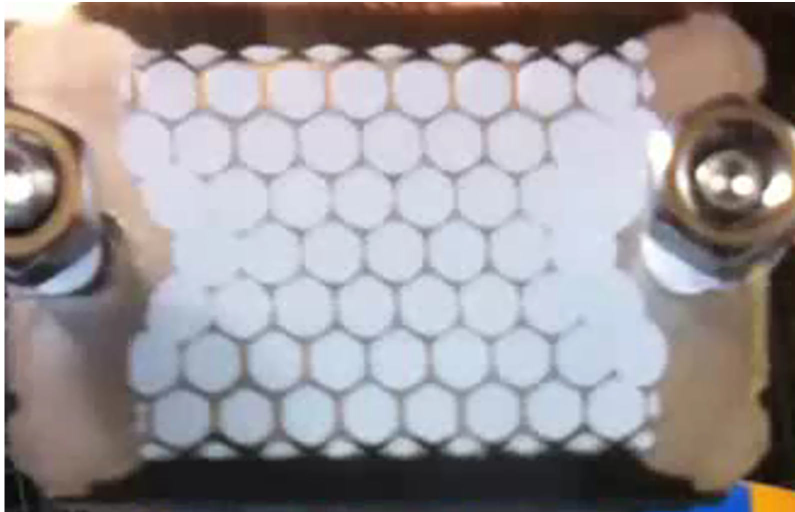
The mounting procedure is the same as the standard module mounting process. See the product specification or mounting instruction included with the power module.

When mounted, the temperature on the PCM must be greater than or equal to 45 °C. This allows the PCM to melt and creates a thermal connection between the module and the heat sink.

When heated, do not screw the units again.

The following image shows the PCM when heated at 33 °C.

Figure 3 • 33 °C PCM Spreading Over Temperature



The following image shows the PCM when heated at 40 °C.

Figure 4 • 40 °C PCM Spreading Over Temperature

The following image shows the PCM when heated at 50 °C.

Figure 5 • 50 °C PCM Spreading Over Temperature

The installation should be qualified by the customer. The final hardware configuration is customer dependant.

7 Power Module Replacement

To replace the power module, do these steps:

1. Use a squeegee or scrapper to remove the PCM (do not damage the heat sink).
2. Use isopropyl alcohol and an anti-static microfiber cloth to remove any excess phase-change material.

The following image shows the imprint of the PCM.

Figure 6 • PCM Imprint

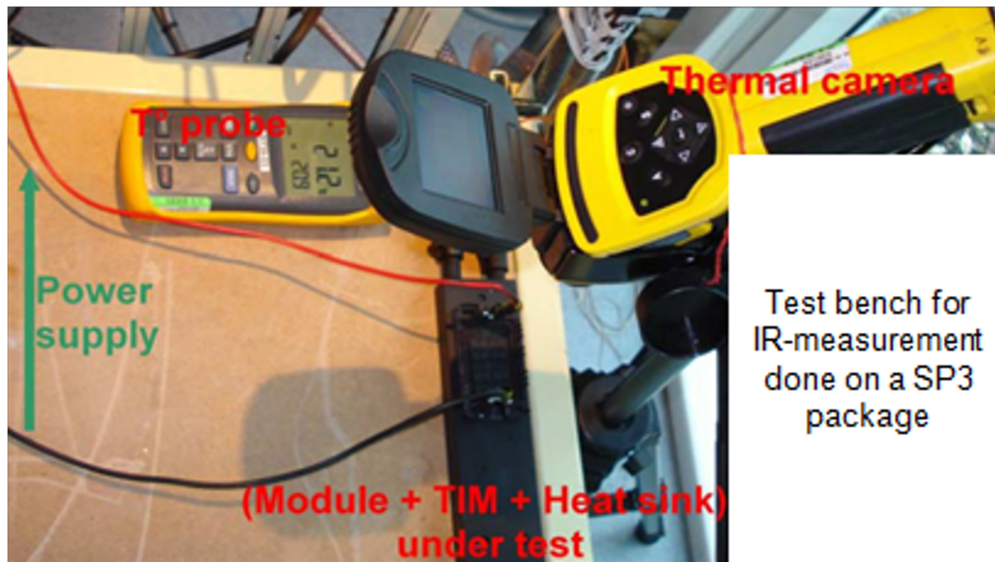
8 Evaluating Thermal Properties of a Given Design

Microsemi recommends the situ tests. These tests are the same used in the field. The Microsemi qualified Loctite PSX thermal performances use an IR-camera. This method required an open, blackened module without any gel inside. Operating a power module without silicone gel is not possible and a power source able to generate high currents at very low voltages is required.

A power supply is connected across the power resistor load and for better power dissipation accuracy measurement the current inside the resistor is precisely measured with an ampere meter.

The following image shows the thermal camera.

Figure 7 • Test Bench



The following image shows a picture taken with the IR-camera.

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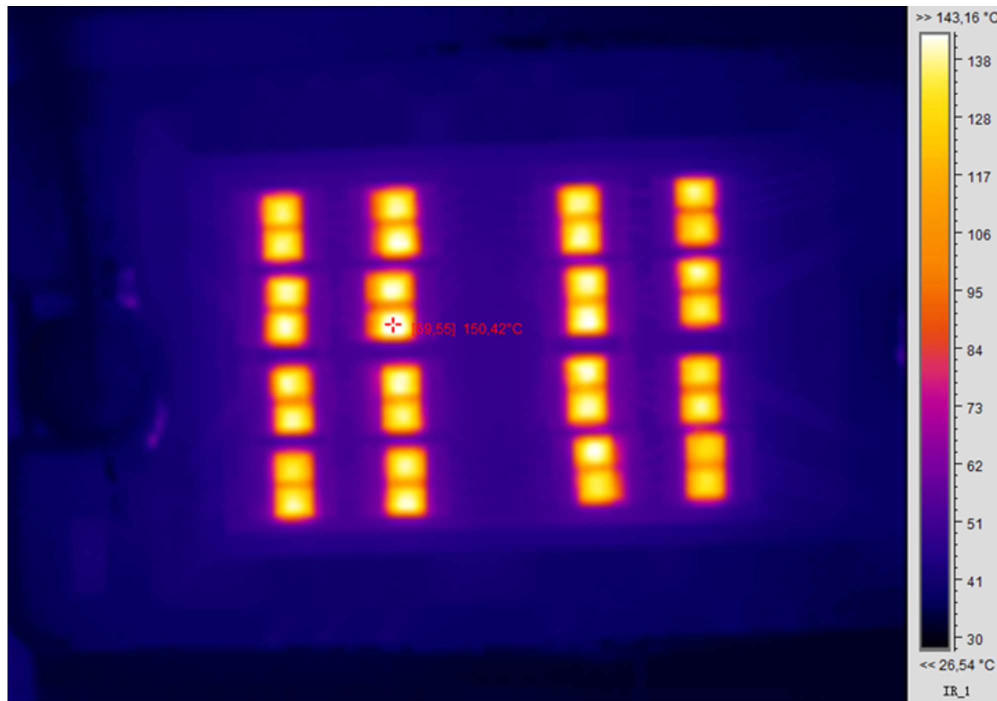
Figure 8 • IR Camera Picture

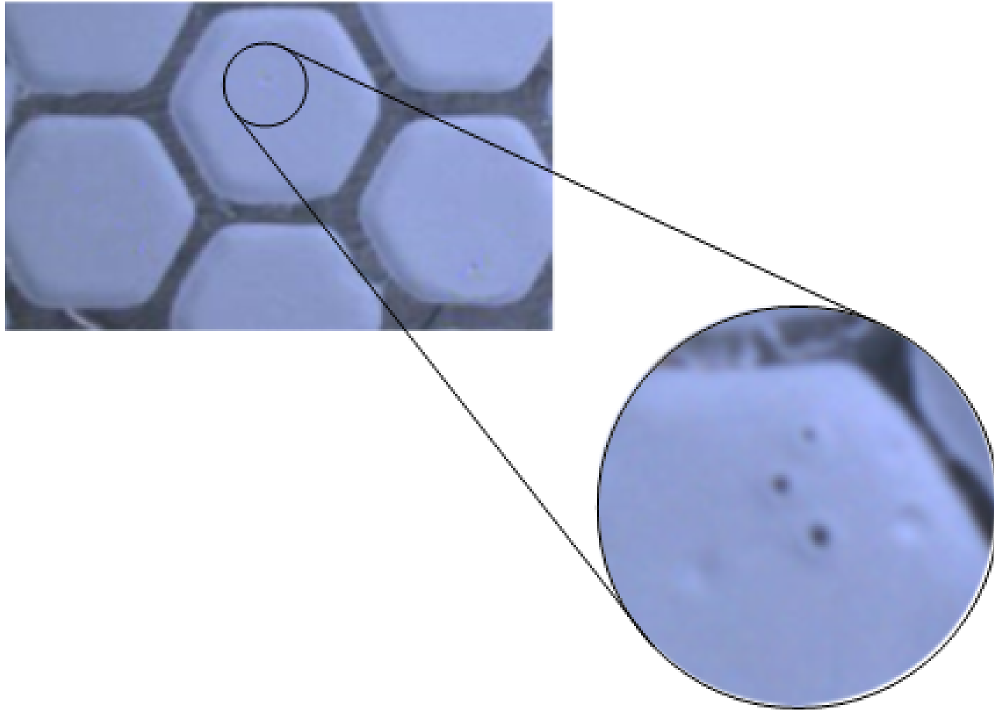


9 Acceptance Criteria

During module utilization, scratches and/or deformations on the PCM may be visible. This happens during unpacking or handling. These deviations will not affect the thermal performance of the material as long as the deformation does not exceed the criteria shown in the image below.

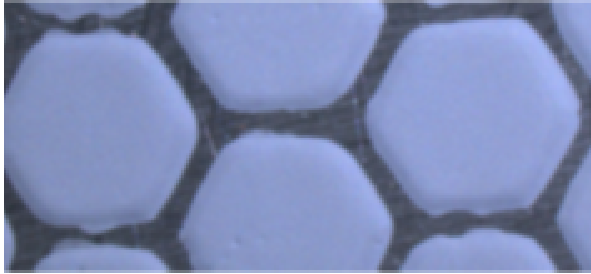
The following image shows the small pits and bubbles on the PCM.

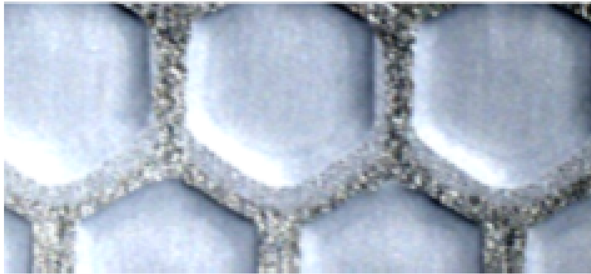
Figure 9 • Small Pits and Bubbles



The following image shows diffuse edges of a single honeycomb on the PCM.

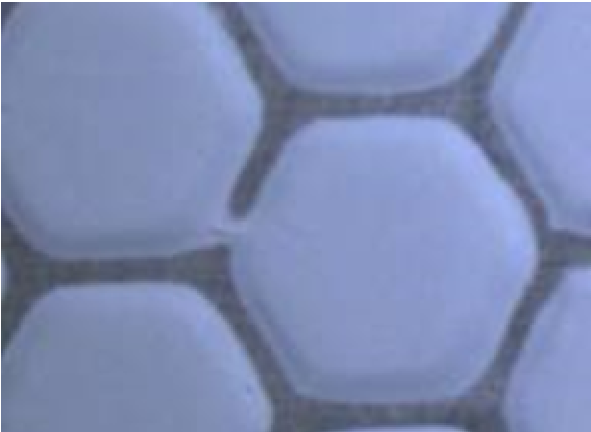
Figure 10 • Diffuse Edges of Single Honeycombs





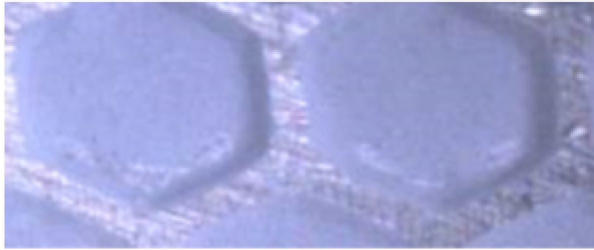
The following image shows the material inbetween the honycombds on the PCM.

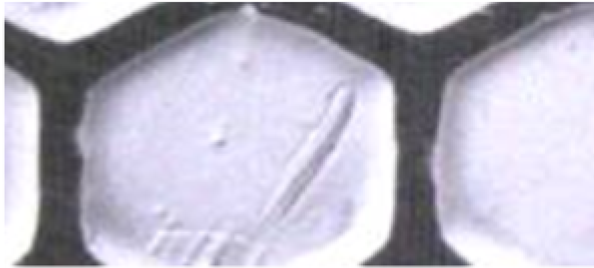
Figure 11 • Small Amount of Material Between Honeycombs



The following image shows the scratches and discoloration on the PCM.

Figure 12 • Discoloration and Scratches





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