



A16496-00
Tpcm 780 and Tpcm 780SP Series
Reliability Report
2012

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Section: 1 Overview

Purpose

To characterize the long-term performance of Tpcm 780 and Tpcm 780SP while being subjected to isothermal conditions, repeated extremes in temperature, and moderate heat - high humidity environments.

Fixture Setup

The test fixture for each condition is explained for each test in the respective portion of this document.

Conditions:

Thermal bake @ 100°C for 1750 hours

Thermal bake @ 125°C for 2000 hours

Thermal bake @ 150°C for 2000 hours

Thermal shock cycling 125°C to -40°C for 2000 cycles

HAST @ 85°C and 85% relative humidity for 2000 hours

HAST @ 45°C and 85% relative humidity for 2000 hours

HAST @ 40°C and 50% relative humidity for 6 months

After each 250 hour/cycle interval, samples from each condition were evaluated for thermal resistance (unless otherwise noted).

Batch numbers T5-102610, T8-120810 and T9-011211 were used for this testing.

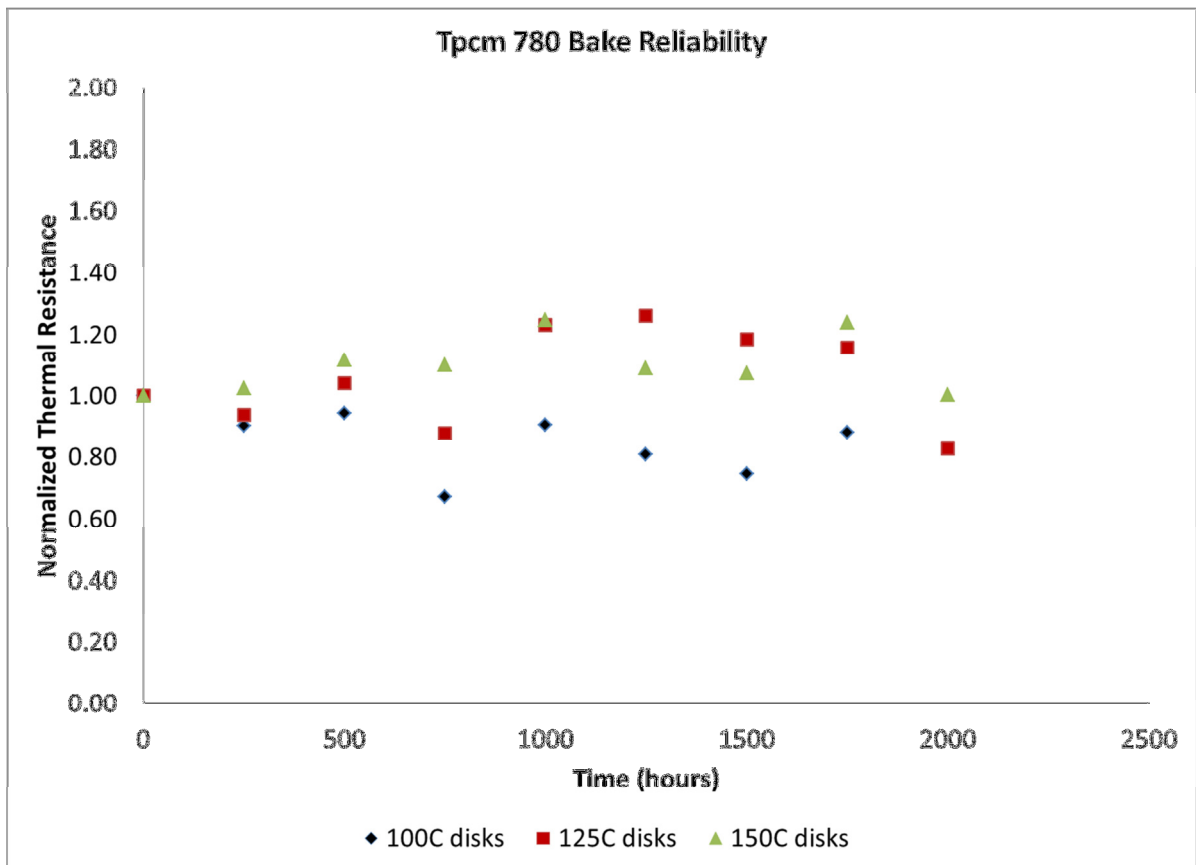
The thermal resistance in this document has been normalized to calculate the thermal resistance change in terms of the thermal resistance at time zero. The calculation is: thermal resistance from each interval divided by the original measured thermal resistance. For example: no change in thermal resistance would be indicated by a normalized thermal resistance of 1 while a doubling of thermal resistance is a normalized thermal resistance of 2.

Section: 2 Thermal Bake

TEST #1 – ASTM D5470 – Between Component Bake

- The bake samples were tested for thermal resistance on a modified ASTM D5470
- During testing and baking, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During baking, clamps were used to hold a constant pressure on the samples.
- See Appendix: Pictures 1 – 4

Results:

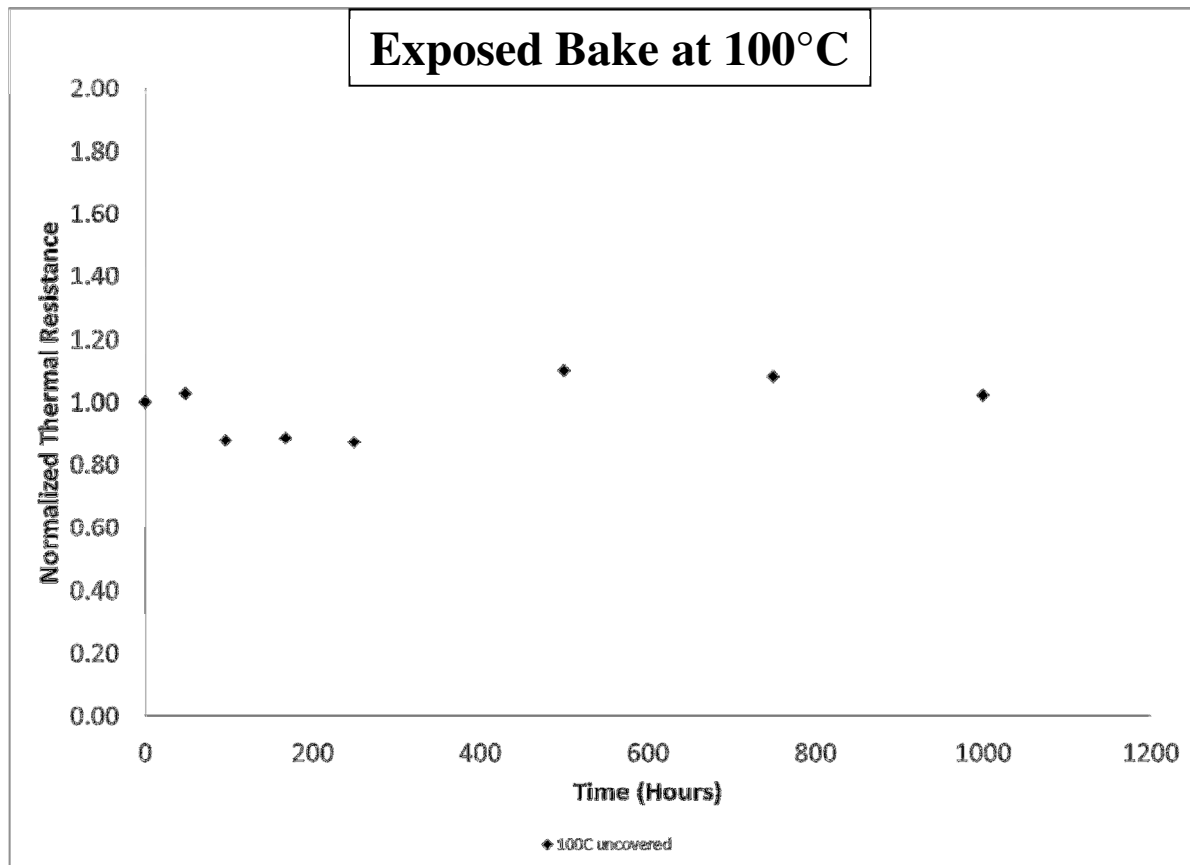


Covered bake samples show no significant change in thermal resistance after 2000 hours.

TEST #2 – ASTM D5470 – Exposed Bake at 100°C

- The bake samples were tested for thermal resistance on a modified ASTM D5470
- During baking, the samples were applied to a single round aluminum disk measuring one square inch in surface area. The opposite surfaces of the samples were exposed to the environment.

Results:



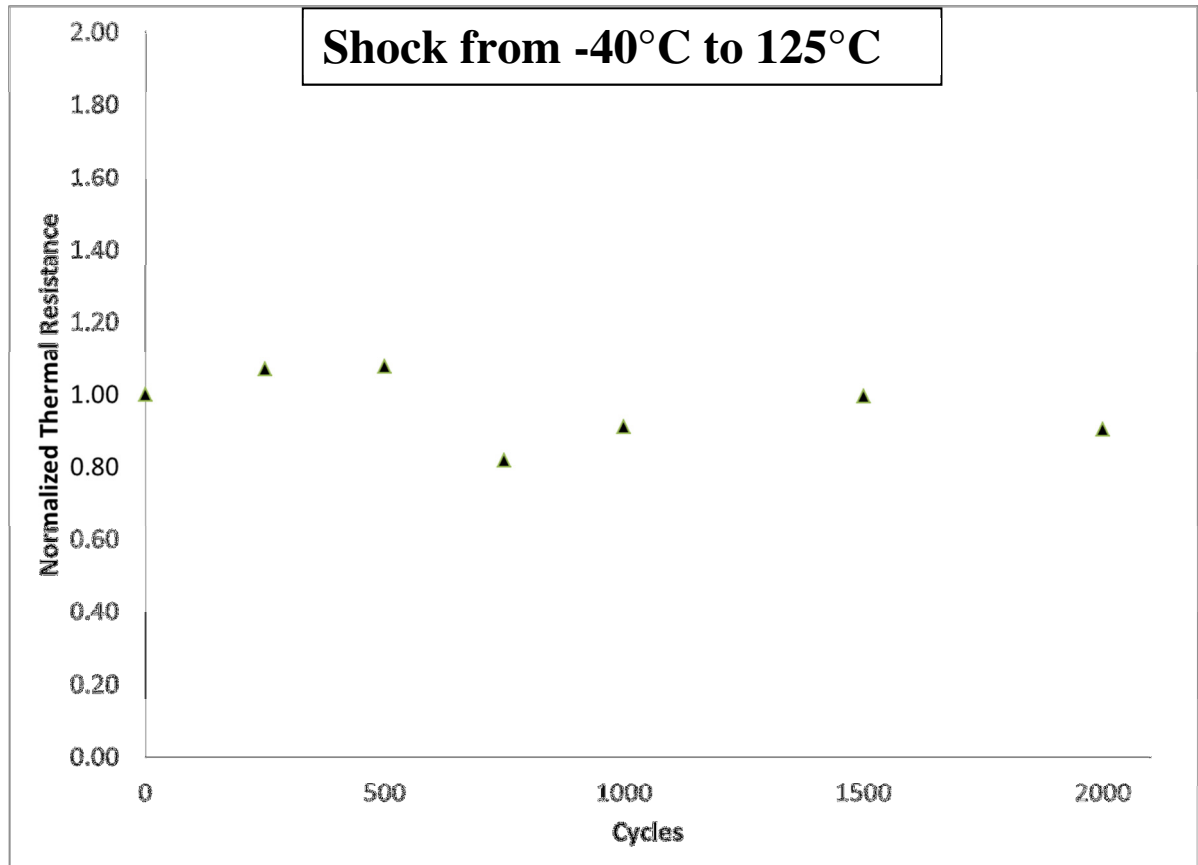
Uncovered samples baked at 100°C show no change after 1000 hours.

Section: 3 Thermal Cycling

TEST – cycling in a Shock Chamber (-40 °C to 125 °C)

- The cycling samples were tested for thermal resistance (using a modified ASTM D5470) prior to cycling and every 250 cycles up to 2000 cycles.
- During testing and cycling, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During cycling clamps were used to hold a constant pressure on the sample.
- A Thermal Shock Chamber was used to reduce the time needed to test 2000 cycles. The disks were held at each temperature for 30 minutes and the transfer time between temperatures is approximately 2 seconds. This allows for 24 cycles per day.
- See Appendix: Picture 1-4

Results:



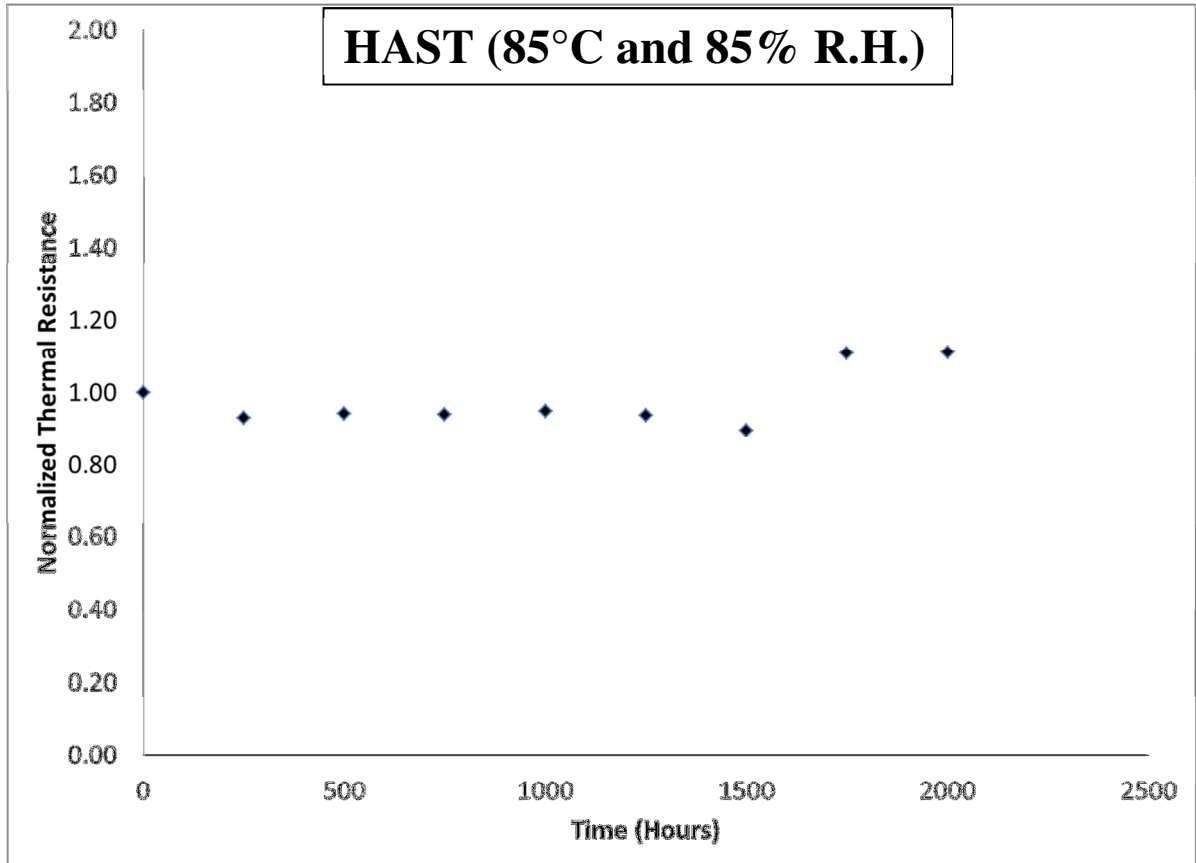
The thermal cycling results -40 °C to 125 °C show a reduction in thermal resistance after 2000 cycles.

Section 4: Thermal Bake in a HAST Chamber

Test #1 - 85°C/85% Humidity

- The HAST samples were tested for thermal resistance using a modified ASTM D5470 prior to HAST conditions, every 250 hrs, and after HAST conditions were completed (2000 hrs).
- During testing and HAST conditions, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During HAST conditions (85°C and 85% relative humidity in a HAST chamber), clamps were used to hold a constant pressure on the sample.
- See Appendix: Picture 1-4

Results:

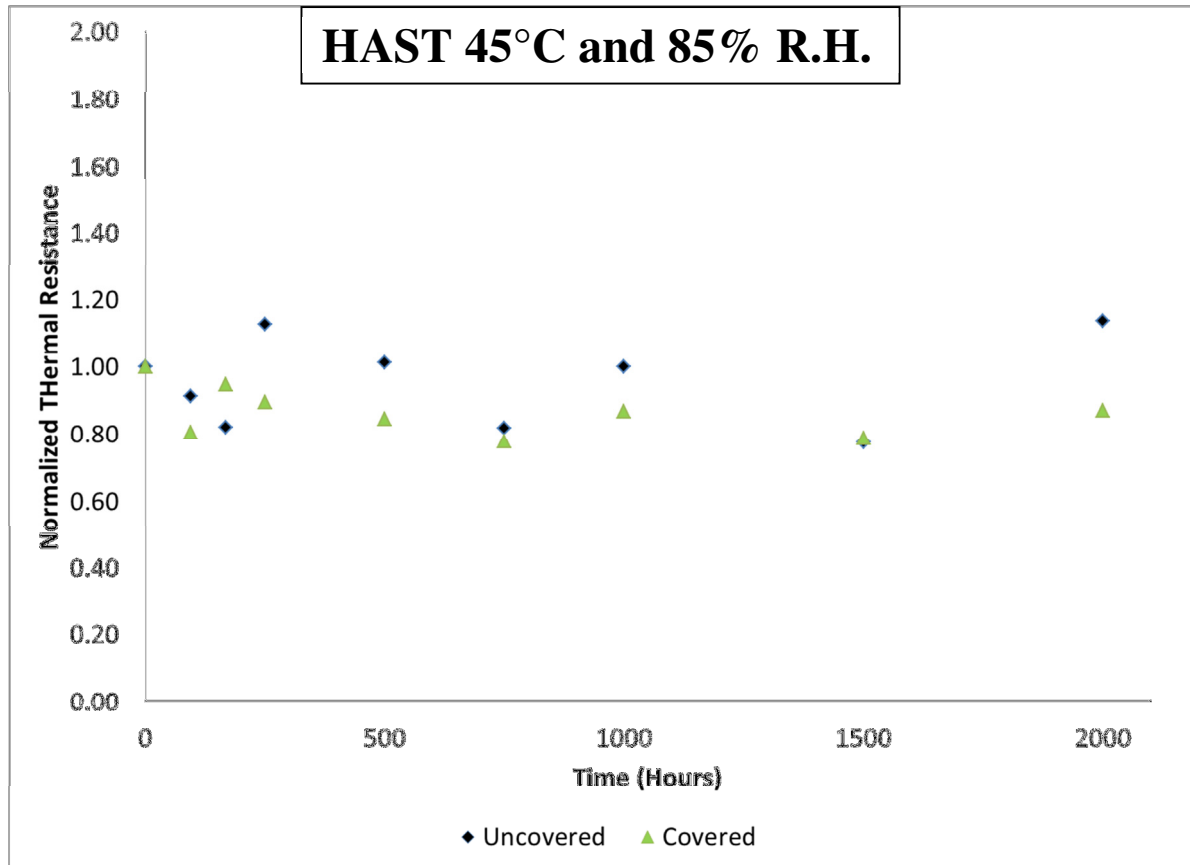


The HAST results show no significant change in thermal resistance after 2000 hours.

Test #2 – 45 °C/85% Humidity

- The HAST samples were tested for thermal resistance using a modified ASTM D5470 prior to HAST conditions, every 250 hrs, and after HAST conditions were completed (2000 hrs).
- During testing and HAST conditions, one set of samples (covered) were maintained between two round aluminum disks measuring one square inch in surface area. During HAST conditions (45 °C and 85% relative humidity in a HAST chamber), clamps were used to hold a constant pressure on the samples.
- See Appendix: Picture 1-4
- A second set of samples had a sample applied to one aluminum disk leaving one side exposed to environment.
 - A second disk was mated to the exposed sample surface prior to testing thermal resistance.

Results:

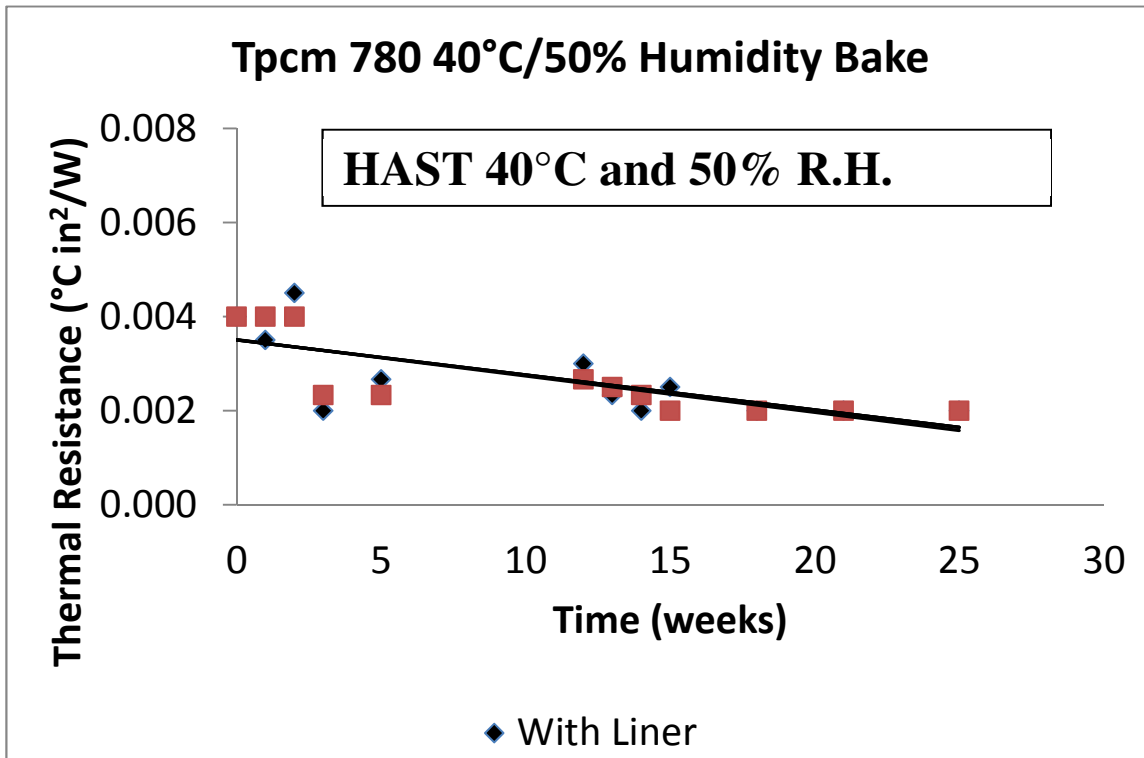


The *covered* HAST results show a decrease in thermal resistance over 2000 hours. The *uncovered* HAST samples show no change.

Test #3 – 40 °C/50% Humidity

- The HAST samples were tested for thermal resistance using a modified ASTM D5470 prior to HAST conditions, periodically, and after HAST conditions were completed (4200 hrs).
- The samples were stored in the oven with the supplied liner and with one of the supplied liners removed to maximize exposure.

Results:



The HAST results show a decrease in thermal resistance over 4200 hours.

Section 6: Conclusion

The graphs and data show that Tpcm 780 and Tpcm 780SP series phase change material performed on average the same or slightly better at the end point for Thermal Shock, Isothermal Bake, and HAST testing than before exposure. Any decrease in thermal resistance is most likely due to the materials natural ability to wet-out the surfaces further filling the microscopic voids on the surfaces of the heat-generating component and heat sink. Even though most voids are filled immediately there are smaller voids containing air that eventually become filled with the product. Optimal filler packing may also be occurring over time resulting in lower thermal resistance values. Based upon this data, no thermal degradation was evidenced and therefore, it is shown that Tpcm 780 and Tpcm 780SP series phase change material will continue to perform as designed in applications under harsh environmental conditions similar to those tested.

Appendix
Picture #1 Aluminum disk used for reliability testing



Picture #2 Aluminum disks clamped with PCM between them



Picture #3 Close-up of the aluminum disks in the thermal tester



Picture #4 ASTM D5470 thermal resistance tester

