



TPCM 200SP Reliability Report April 2015



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Section: 1 Overview

Purpose: The purpose of this report is to summarize the current data for the thermal reliability testing of TPCM 200SP. Thermal reliability testing, in general, characterizes the thermal performance of a material in a laboratory simulated environment. The simulations include high temperature baking, high temperature baking with elevated humidity conditions, and repeated exposures to very cold and hot conditions.

Reliability is defined as:

1. The ability of an item to perform a required function under stated conditions for a specified period of time.
2. The probability that a functional unit will perform its required function for a specified interval under stated conditions.

The required function of TPCM 200SP is to transfer heat from a hot component to a heat dissipating device. Its functionality is measured by testing its thermal resistance. For the purposes of extended thermal performance evaluation, the repeated thermal resistance measurements are normalized to the values prior to exposure at the stated conditions. Thus, the change over time can be compared to the relative initial values and general trends can be determined.

TPCM 200SP is formulated to operate at a maximum temperature of 125°C. Thus, the bake condition at 150°C is an extreme condition and primarily intended to ascertain the ability of the material to perform at levels above the stated maximum for a short period of time.

Conditions:

Thermal bake 100°C for 2000 hours

Thermal bake 125°C for 2000 hours

Thermal bake 150°C for 2000 hours

Environmental chamber 85°C and 85% RH (HAST) for 2000 hours

Thermal Shock -40°C to 125°C for 2000 cycles, 30 minutes at -40°C followed by 30 minutes at 125°C constitutes one complete cycle.

After each 250 hour/cycle interval, samples from each condition were evaluated for thermal performance.

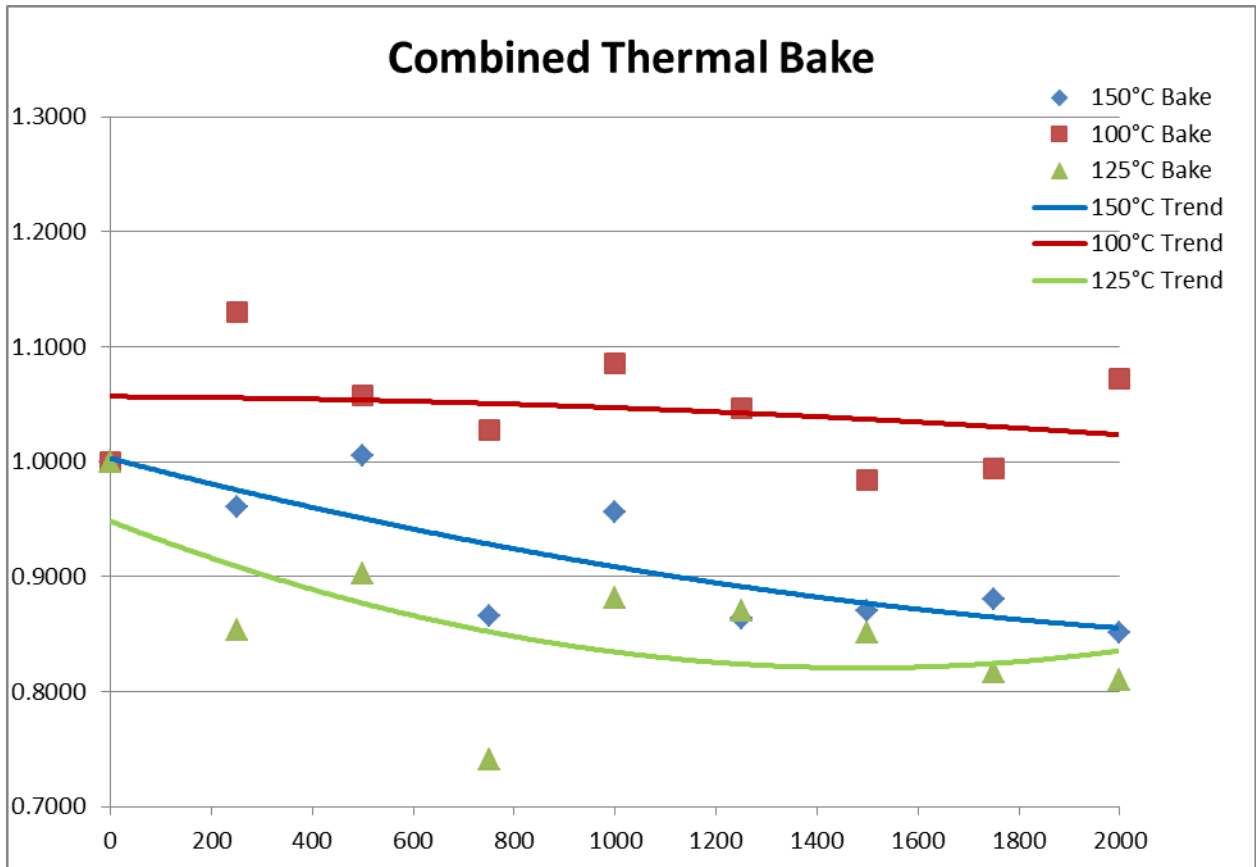
Section: 2 Thermal Bake

TEST #1 – ASTM D5470 in application – simulated by placing material between disks



- The thermal bake samples are tested for thermal resistance using a modified ASTM D5470 procedure prior to bake conditions and at every 250 hour interval until the bake conditions are completed.
- During testing and bake conditions, the samples are maintained between two round aluminum disks measuring one square inch in surface area.
- During bake conditions, clamps are used to hold a constant pressure on the sample.
- See Appendix: Pictures 1-4

Results: Thermal Bake Results



The current thermal bake trends indicate a general decrease in thermal resistance. Some variability exists in the data and can be seen in the graph. However, the data does show thermal stability at the stated conditions. The bake study is complete at 2000 hours.

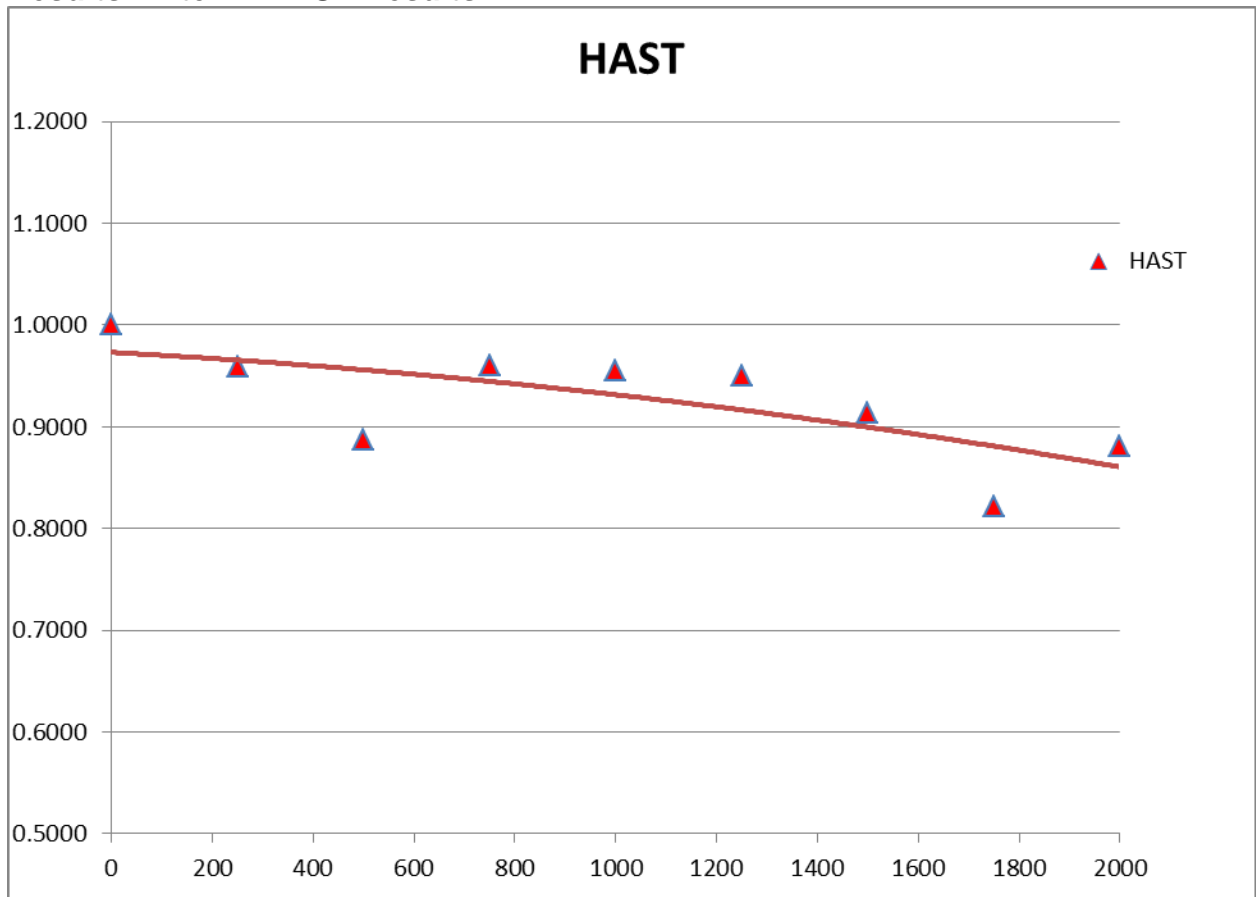


Section 3: Thermal Bake in a HAST Chamber

TEST #1 – ASTM D5470 in application – simulated by placing material between disks

- The HAST samples are tested for thermal resistance using a modified ASTM D5470 prior to HAST conditions and at every 250 hour interval until the study is complete.
- During testing and HAST conditions, the samples are maintained between two round aluminum disks measuring one square inch in surface area.
- During HAST conditions, clamps are used to hold a constant pressure on the sample.
- See Appendix: Pictures 1-4

Results: Interim HAST Results



The general trend under the 85°C and 85% RH HAST conditions shows a general decrease in thermal resistance. Thus the thermal performance under this specified condition is not degrading. The HAST study is complete at 2000 hours.

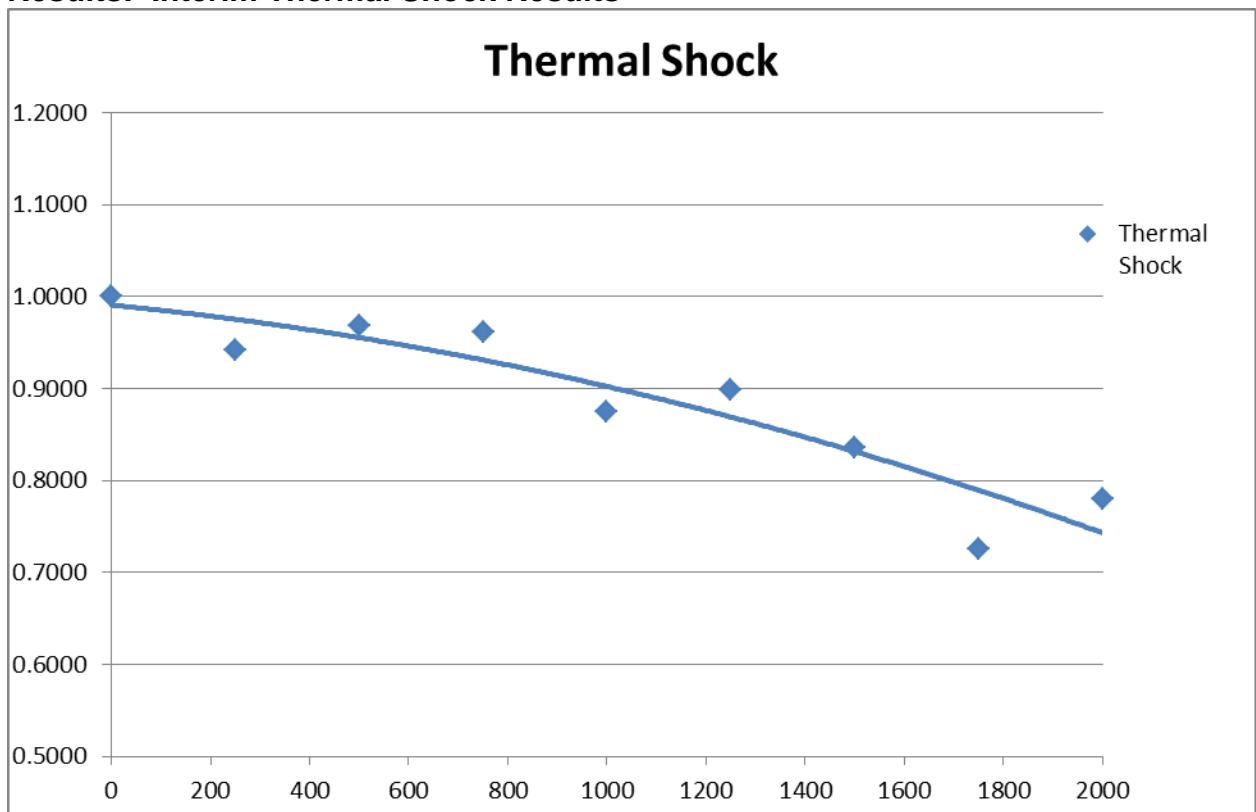


Section 4: Thermal Shock

TEST #1 – ASTM D5470 in application – simulated by placing material between disks

- The thermal shock samples are tested for thermal resistance using a modified ASTM D5470 prior to thermal shock conditions and at every 250 cycle interval until the study is complete.
- During testing and thermal shock conditions, the samples were maintained between two round aluminum disks measuring one square inch in surface area.
- During thermal shock conditions, clamps are used to hold a constant pressure on the sample.
- See Appendix: Pictures 1-4

Results: Interim Thermal Shock Results



The general trend under the -40°C to 125°C shock conditions shows a general decrease in thermal resistance. Thus the thermal performance is not degrading. The thermal shock study is complete at 2000 cycles.



Section 6: Conclusion

In general, the data appears to indicate that the thermal performance is not degrading over the simulated life of the material. All conditions follow this general trend. Some variability can be seen in the data. But, the general trend can be seen for each condition.

Visual observations have also been made at prescribed intervals as well. In general, the TPCM 200SP material exhibits some color change after exposure. Specifically, the thermal material turns from a "white" material to a "yellow" material. The bake conditions have the most visual effect on the material. See the figures below, for examples of this visual observation. The figures are from the 125°C condition, which is at the stated maximum operating temperature of the material.

Figure: 500 Hour observation at 125°C





Figure: 1500 Hour observation at 125°C



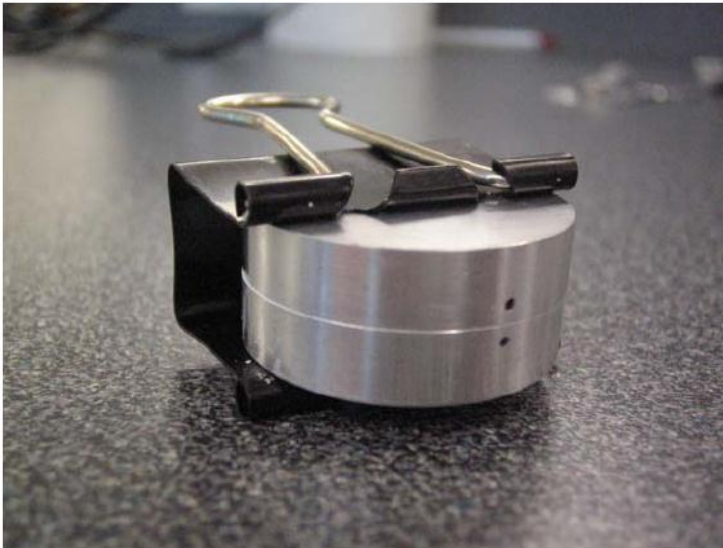


Appendix

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

