Tpcm 580 Reliability Report

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Section: 1 Overview

Purpose: To test the **reliability** of Tpcm 580 as well as confirm that the thermal resistance of Tpcm 580 does not degrade as a result of thermal cycling, high temperature baking, or baking in a high humidity environment.

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 580 is to transfer heat from a hot component to a heat-dissipating device. Its functionality is measured by testing its thermal resistance. The thermal resistance range that defines the functionality of the Tgrease 580 is 0.008°Cin^2/W to 0.018°Cin^2/W at 50psi as measured by modified ASTM D5470.

Conditions:

Thermal bake @ 125°C for 1000 hours

Thermal bake @ 150°C for 1000 hours

Thermal cycling 130°C to -40°C for 500 cycles

Thermal cycling 23°C to 100°C for 1000 cycles

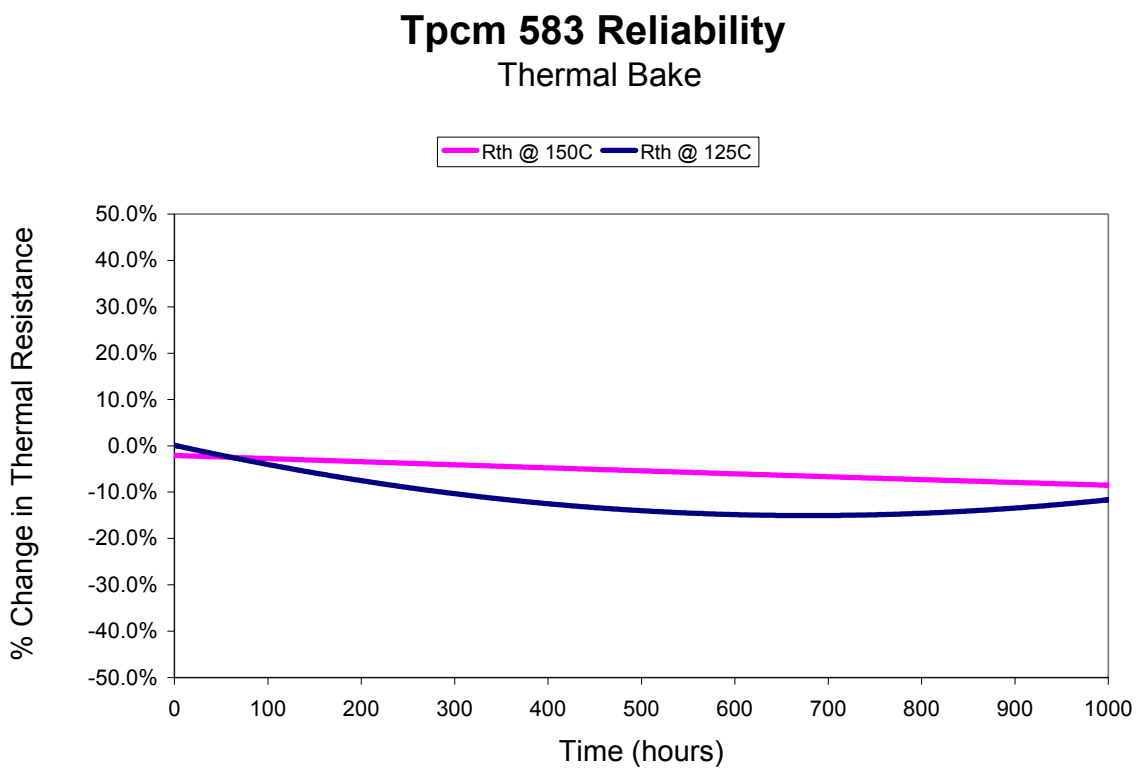
HAST @ 85°C and 85% relative humidity for 1000 hours

After each 250 hour/cycle interval, sample disks from each condition were evaluated for thermal resistance, and dry out of the grease between the disks.

Section: 2 Thermal Bake

- The bake samples were tested for thermal resistance (using a modified ASTM D5470) prior to baking and after baking.
- 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: Picture 1-4

Results:



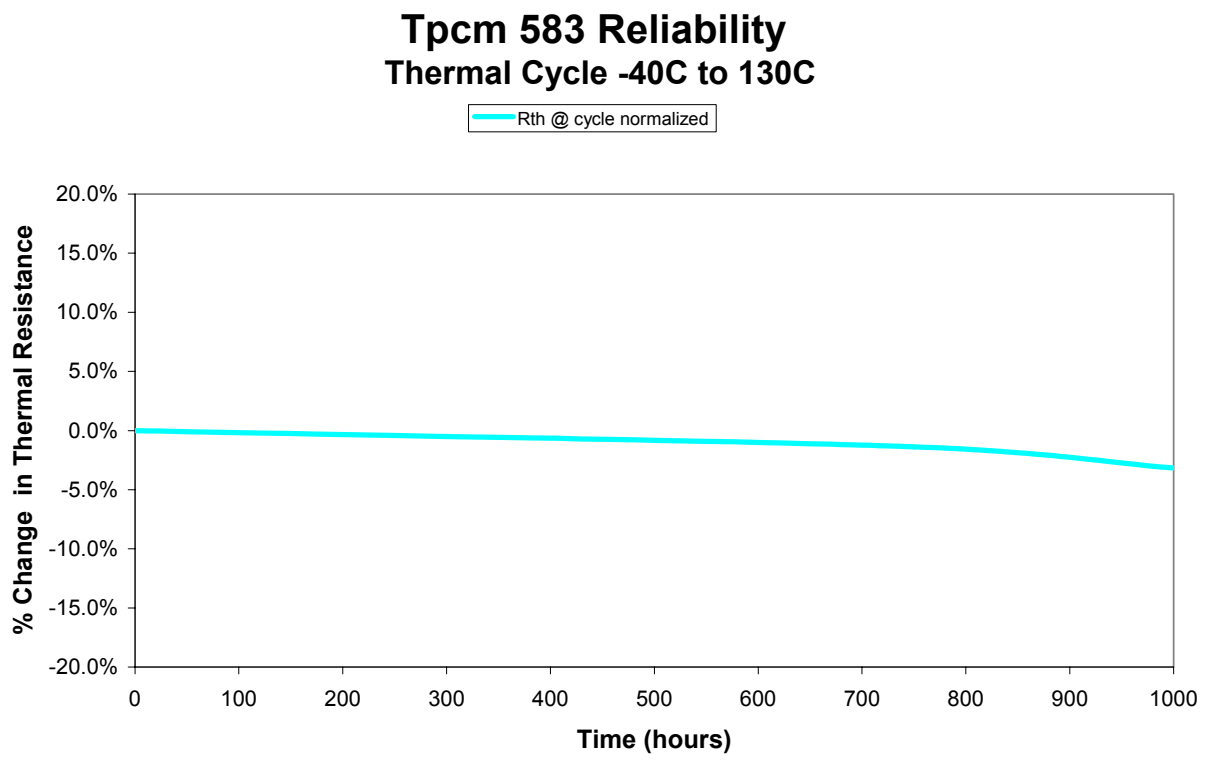
The thermal bake results at 125 and 150°C show a decrease in thermal resistance over time resulting in better overall thermal performance.

Section: 3 Thermal Cycling

TEST #1 – cycling in an Oven

- The cycling samples were tested for thermal resistance (using a modified ASTM D5470) prior to cycling then again at 250, 500, 750, and 1000 cycles.
- During testing and cycling, the samples were maintained between two round aluminum disks measuring one square inch in surface area. During cycling (-40°C to 130°C in an environmental chamber) clamps were used to hold a constant pressure on the sample. See Appendix: Picture 1-4

Results:



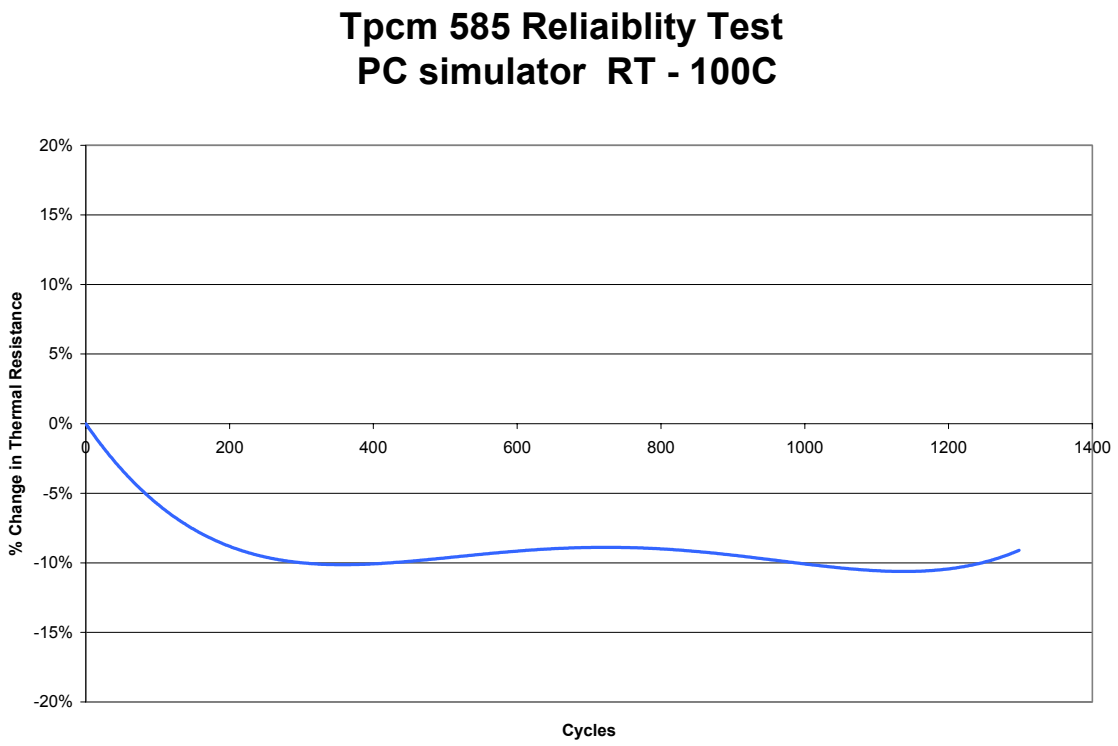
The thermal cycling results from -40°C to 130°C show an initial reduction in thermal resistance after the first 250 cycles. After 500 cycles, the thermal resistance stabilizes remaining lower than the resistance at time 0. Results show no degradation over 1000 cycles.

Test #2 – cycling with a PC Simulator

- The samples were thermally cycled using the PC Simulator.
- The 17mmx 17mm sample was applied onto an aluminum heat sink.
- The PC Simulator consists of a copper platen base 14 by 14 mm heated with two 75-watt heaters that are powered by a variable power supply. On top of the base a fan cooled die cast aluminum heat sink, 60 mm by 60 mm, removes heat. Thermal interface material is placed between the copper base and the heat sink. Thermocouples are located in holes drilled just below the center of the surface of the copper base and heat sink. A data logger records temperatures, voltage, and power every 15 seconds, and calculates thermal resistance. A timer controls the heating and cooling functions. See Appendix: Picture 5

Test Condition: Room Temperature (23°C) to 100°C cycle every 20 minutes
The thermal cycle unit power was adjusted to cause the copper base to reach 100°C. The tester was held in heating mode for 8 minutes, and cooled for 10 minutes. Temperature of the copper base remained slightly above 100°C for 2 minutes during each cycle. Pressure was maintained at 20psi.

Results:



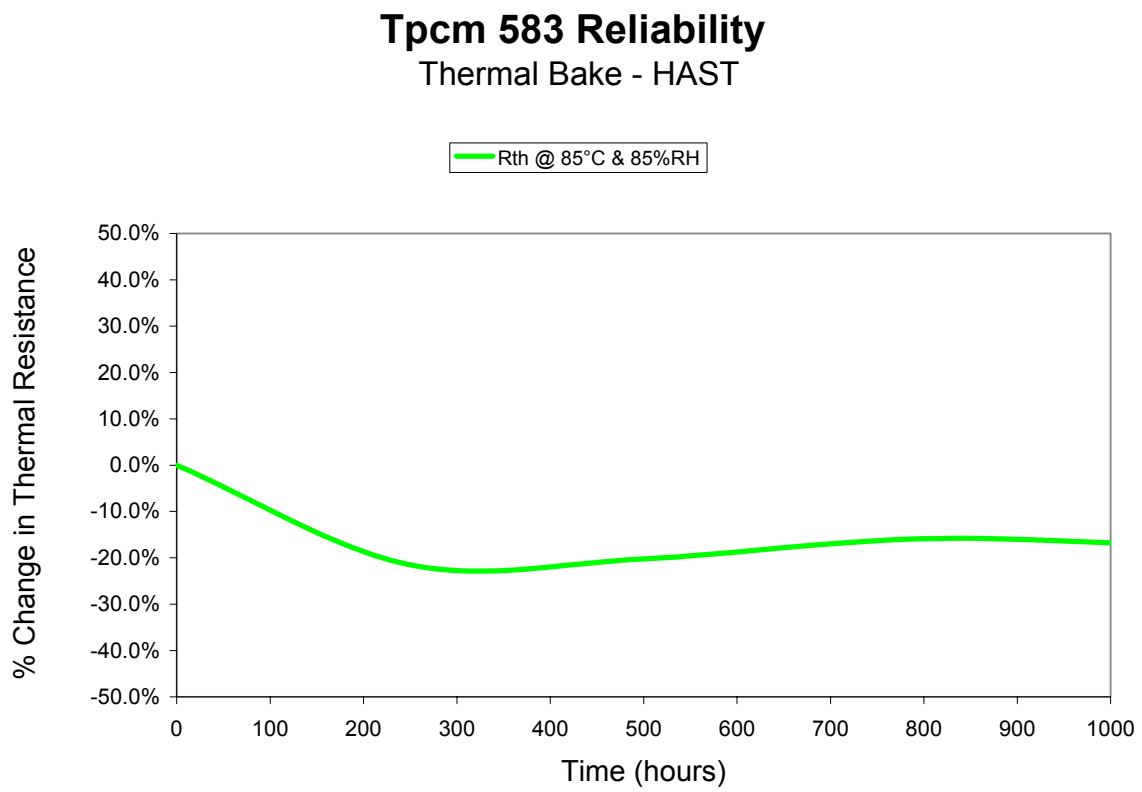
The thermal cycling results from 23°C to 100°C show an overall decrease in the thermal resistance of Tpcm 580 series.

Visual observations/inspection:
There was no pump out or separation of the phase change material throughout the testing. The PCM was soft and could be spread at 70C. It easily wiped away off the heat sink and copper heater after testing at a temperature of 70C.

Section: 4 Thermal Bake in a HAST Chamber

- The HAST samples were tested for thermal resistance using a modified ASTM D5470 at prior to HAST conditions, every 250 hrs, and after HAST conditions were completed (1000 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:



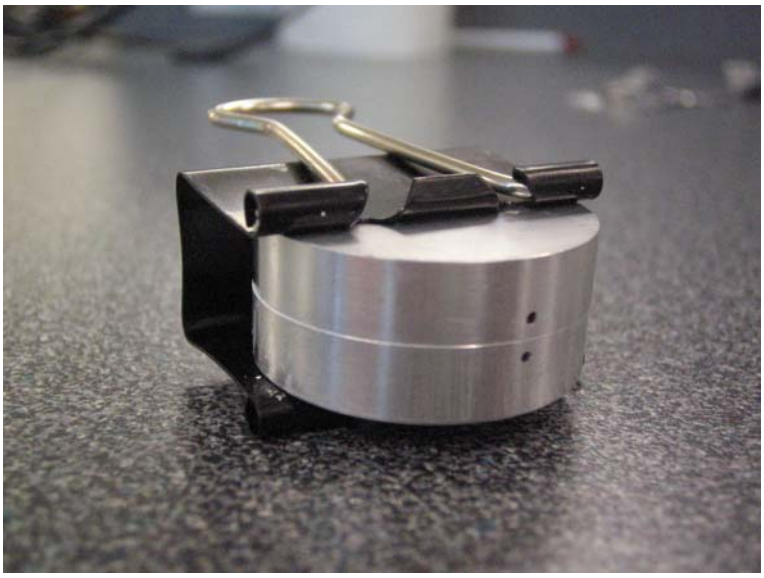
The HAST results show show a decrease in thermal resistance over 1000 hours resulting in better overall thermal performance.

Section: 5 Conclusion

In all tests, the Tpcm 580 series shows a reduction in thermal resistance from time zero or from the first cycle. This reduction in thermal resistance remains through all the tests. Tpcm 580 series when subjected to any of the stress tests above only improves in performance. Therefore Tpcm 580 series will perform its required function as stated in the introduction and is **reliable**.

Appendix

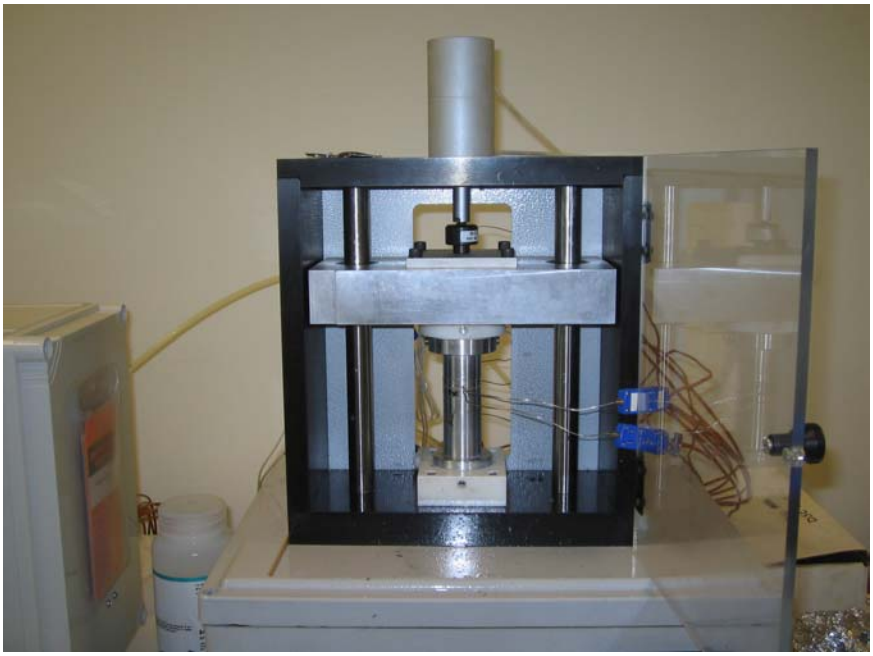
Picture #1 Aluminum disk used for reliability testing



Picture #2 Aluminum disks clamped with grease between them

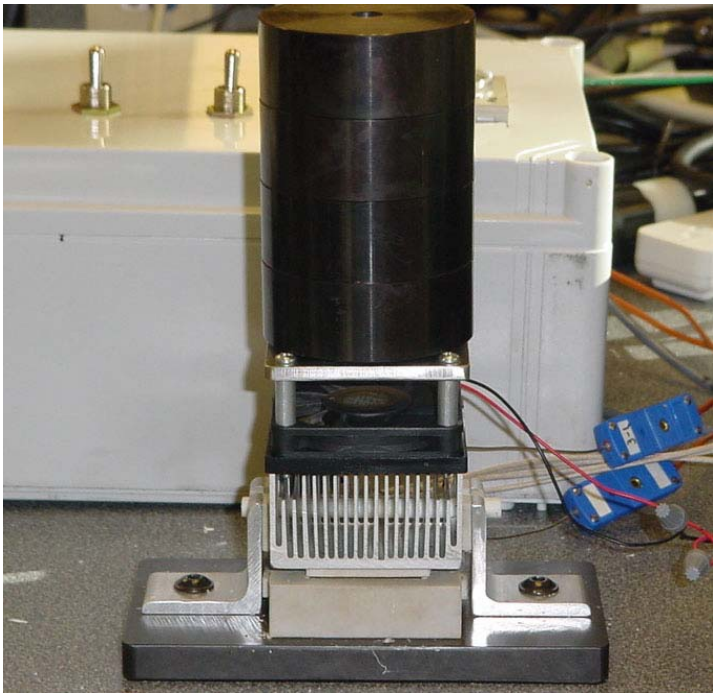
Appendix

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



Picture #4 ASTM D5470 thermal resistance tester

Appendix



Picture 5 – Photograph of thermal cycling apparatus