

TEST REPORT

Tpcm[™] 5000 Thermal Reliability

No. : **A18454-00**
Date : **2021.10.18**
Page : **1 of 10**

Purpose

This report summarizes the thermal reliability testing of Tpcm[™] 5000 utilizing reliability test fixtures ideal for high performance thermal grease and phase change materials. The reliability test conditions are designed to characterize the long-term performance of the thermal material by subjecting the material in the test fixtures to high temperature isothermal conditions, repeated thermal shock conditions, and moderate heat and high humidity conditions.

Test Equipment

- 6 Tpcm 5250 samples disks measuring 1in² in area
- 12 aluminum disks measuring 1in² in area (with thermocouple holes)
- 6 Standard binder clips
- Thermal Shock and Environmental Chambers
- Reliability Test Fixtures
- ASTM D5470 Thermal Resistance Tester
- Data acquisition system for temperature monitoring

Test Fixture and Sample

The samples were placed and maintained between two aluminum disks measuring one square inch in surface area. Clamps were used to hold a constant pressure on the samples while in the environmental chamber. After each 500 hour/cycle interval, samples from each condition were evaluated for thermal resistance. The samples maintained between the disks were placed in a modified ASTM D5470 thermal resistance tester. Thermal resistance is recorded. Each condition has a total of 4 samples in test fixtures (exception is HAST and Thermal Shock -40C to 150C had only 3 samples each). 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.

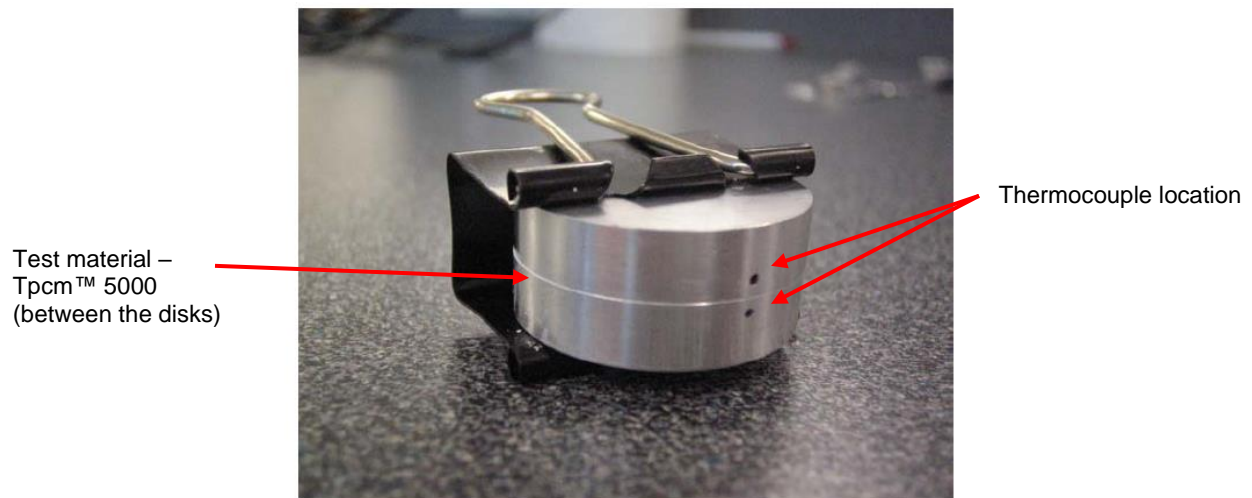
TEST REPORT

TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 2 of 10



Figure 5: Aluminum Disk measuring 1in² in area



TEST REPORT

TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 3 of 10

Figure 6: Aluminum Disks Clamped with Sample

Test material –
TpcmTM 5000
(between the disks)



Figure 7: Close-Up of The Aluminum Disks in the Thermal Tester

TEST REPORT

TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 4 of 10



Figure 8: ASTM D5470 Thermal Resistance Tester

Test Conditions

- Isothermal @ 125°C
- Isothermal @ 150°C
- HAST @ 85°C and 85% relative humidity
- Thermal shock from -40°C to 125°C (1 cycle is 30 minutes per condition, 10 second transfer)
- Thermal shock from -40°C to 150°C (1 cycle is 30 minutes per condition, 10 second transfer)

TEST REPORT

TpcmTM 5000 Thermal Reliability

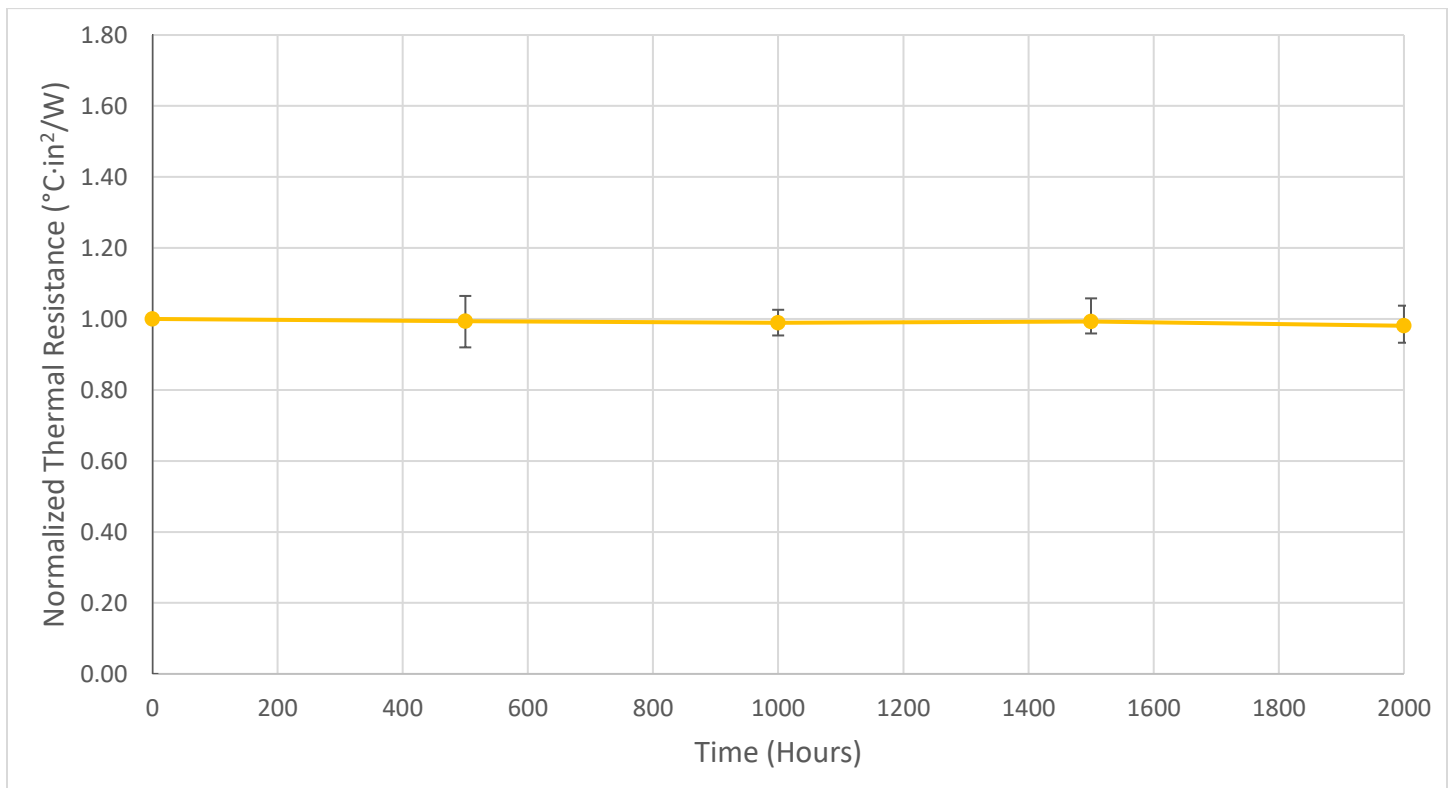
No. : A18454-00
Date : 2021.10.18
Page : 5 of 10

Results

Isothermal Bake

Isothermal bake was performed for 2,000 hours at 125°C and 150°C. The bake samples were tested for thermal resistance on a modified ASTM D5470 thermal resistance tester. During testing, the samples were maintained between two round aluminum disks measuring one square inch in surface area. Clamps were used to hold a constant pressure on the samples while in the environmental chamber. See Figures 1 & 2 isothermal bake results.

Figure 1: Isothermal Bake Results: 125°C

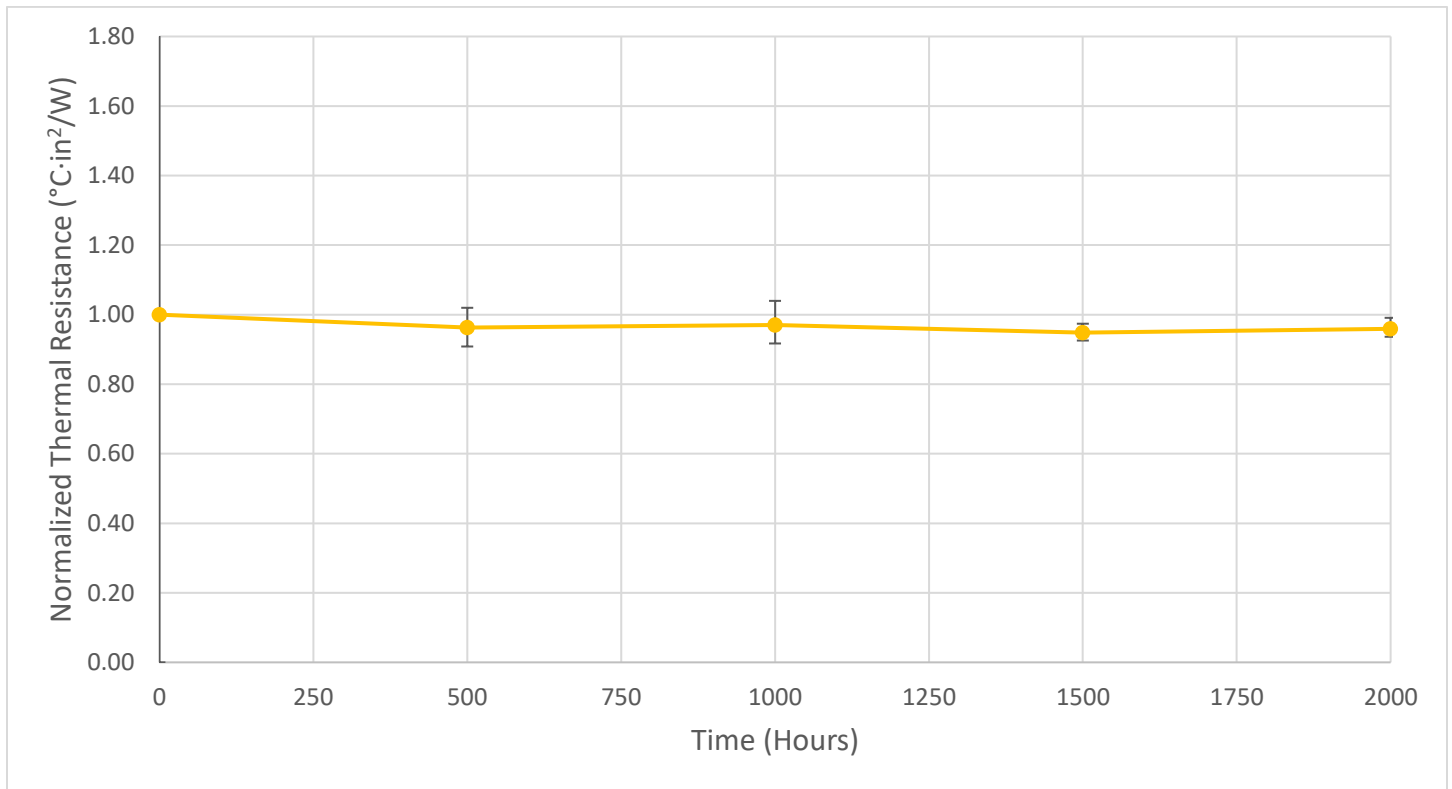


TEST REPORT

TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 6 of 10

Figure 2: Isothermal Bake Results: 150°C



TEST REPORT

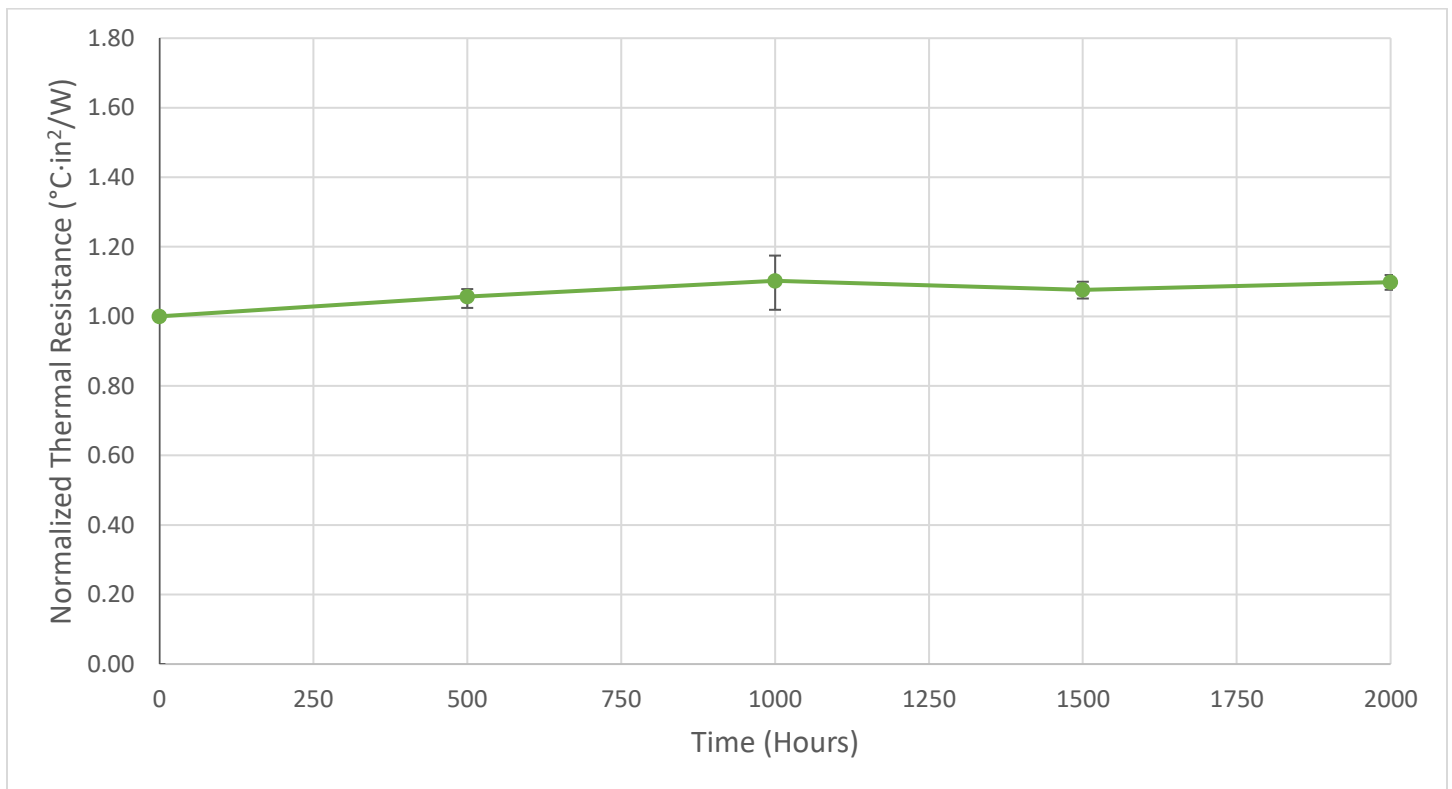
TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 7 of 10

HAST

HAST was performed for 2,000 hours at 85°C and 85% relative humidity. The HAST samples were tested for thermal resistance on a modified ASTM D5470 thermal resistance tester. During testing, the samples were maintained between two round aluminum disks measuring one square inch in surface area. Clamps were used to hold a constant pressure on the samples while in the environmental chamber. See Figure 3 for HAST results.

Figure 3: HAST Results: 85°C/85%RH



TEST REPORT

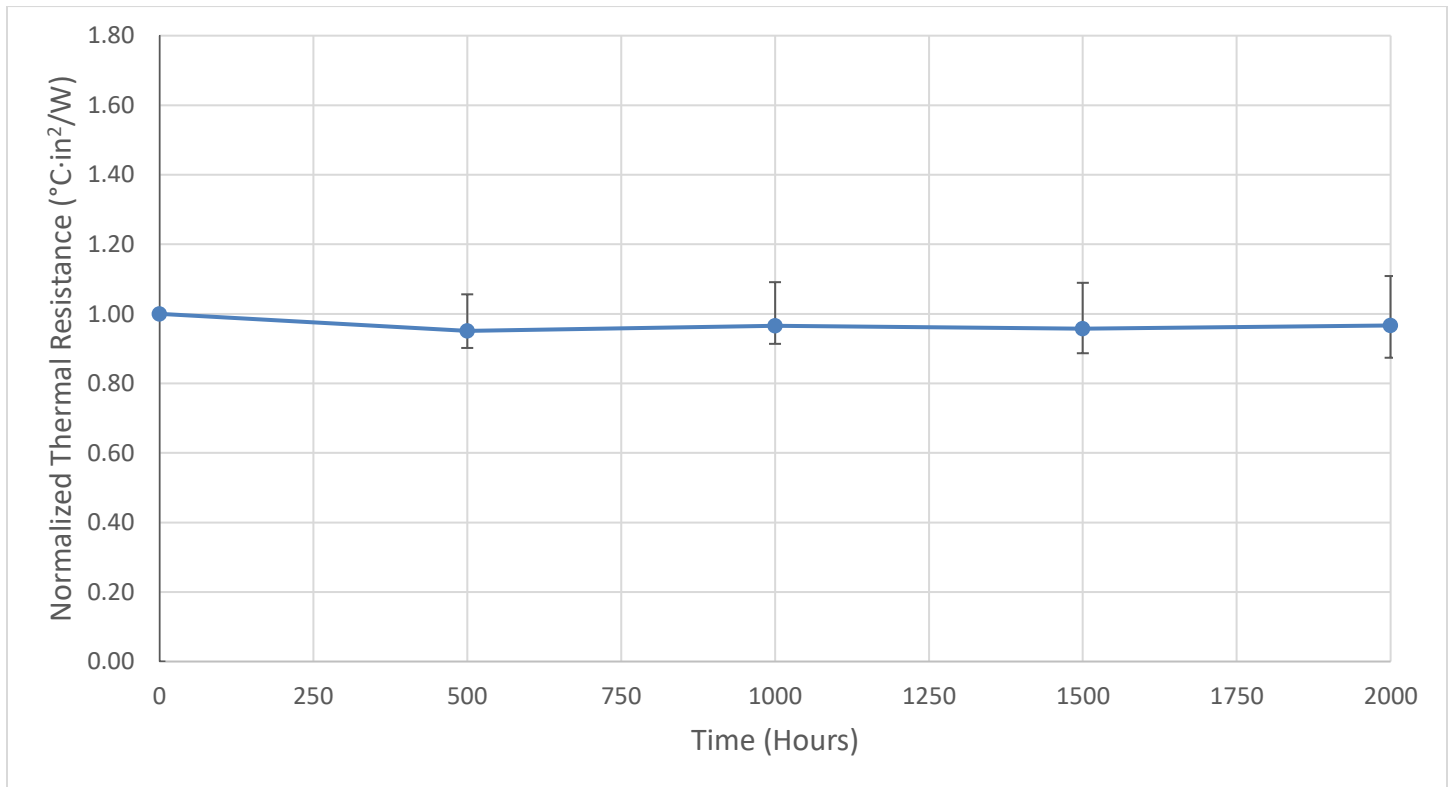
TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 8 of 10

Thermal Shock

Thermal shock was performed for 2,000 cycles from -40°C to 125°C and -40°C to 150°C. Each cycle is one hour, with the assembly spending thirty minutes at each condition. The sample transition time between the two temperature extremes is approximately 10 seconds. The samples were tested for thermal resistance on a modified ASTM D5470 thermal resistance tester. During testing, the samples were maintained between two round aluminum disks measuring one square inch in surface area. Clamps were used to hold a constant pressure on the samples while in the environmental chamber. See Figure 4 & 5 for thermal shock results.

Figure 4: Thermal Shock Results: -40°C to 125°C

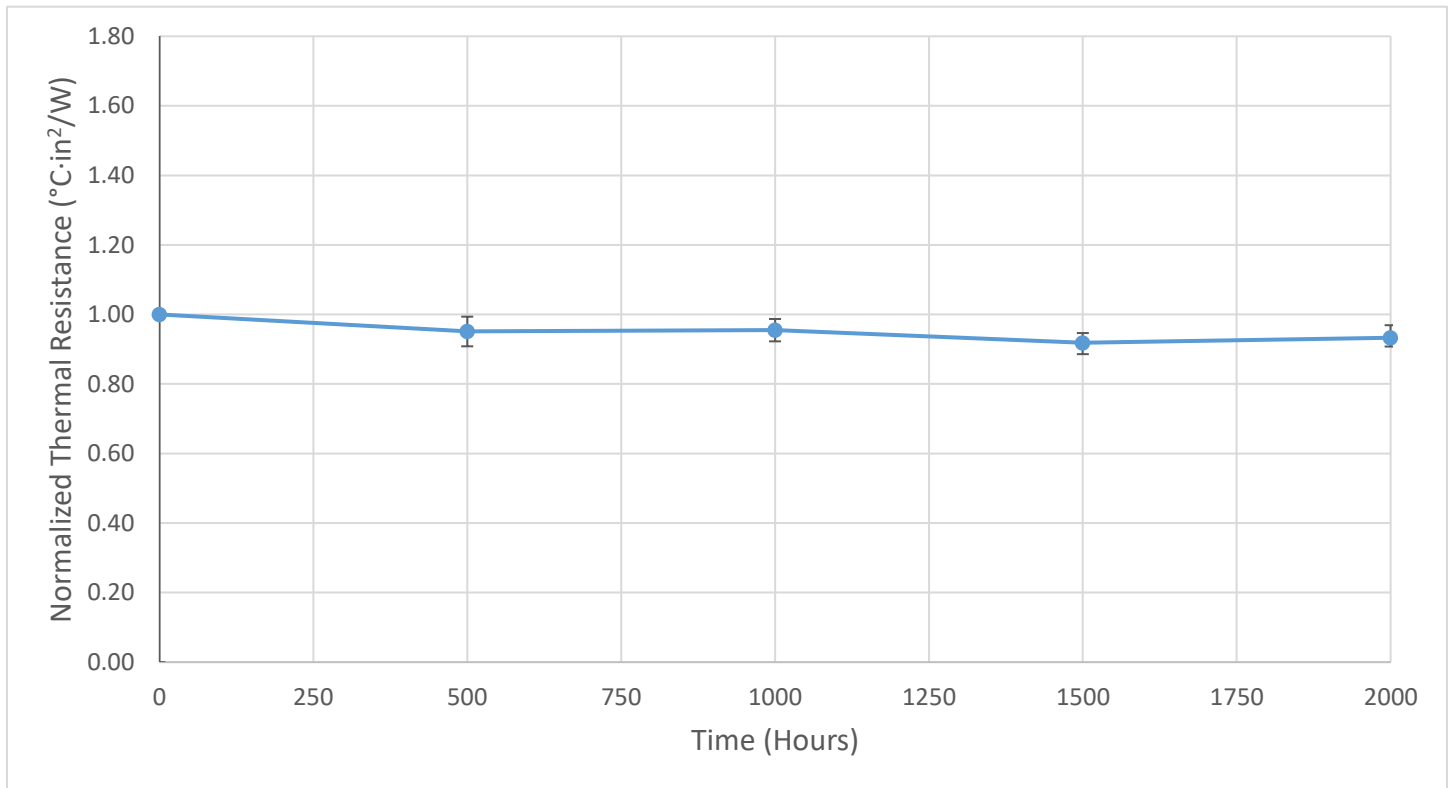


TEST REPORT

TpcmTM 5000 Thermal Reliability

No. : A18454-00
Date : 2021.10.18
Page : 9 of 10

Figure 5: Thermal Shock Results: -40°C to 150°C



TEST REPORT

Tpcm[™] 5000 Thermal Reliability

No. : **A18454-00**
Date : **2021.10.18**
Page : **10 of 10**

Discussion

When analyzing the results to determine the thermal reliability of the material in the accelerated and stressed conditions, it is essential to observe the general long-term trend over the duration of the study. Variations from interval test point to interval test point will occur. Variability also exists in the test setup. Thus, 2 samples are used for each condition. Long term negative, or increase of thermal resistance, indicates a failing study and may indicate the poor thermal performance over stressed conditions. As the material may crack or degrade, less substrate contact may result which would lead to less heat transfer. Poor thermal performance from degradation was not observed.

The data from the testing completed demonstrates that Tpcm[™] 5000 continues to perform well at each condition; high temperature bake, thermal shock, and HAST. Initial decrease in thermal resistance is most likely due to the material's natural ability to wet-out the surfaces further filling the microscopic voids on the surfaces of the mated components and reducing to bondline after the initial testing.

In conclusion, all conditions show optimal thermal performance at the end of the stated hours. Tpcm[™] 5000 passes all of the stressed conditions and can be considered a reliable thermal interface material that will continue to perform well under the most rigorous conditions.