THERM-A-GAP™ GEL 75 Reliability Report

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Executive Summary

THERM-A-GAP™ GEL 75 is a high-performance, one-component, dispensable thermally conductive gel. The paste-like consistency enables superior performance and long-term thermal stability. This material is designed to be dispensed in applications requiring low compressive forces and minimal thermal resistance for maximal thermal performance. This document outlines the examination of the thermal reliability of this high-performance gap filler after being subjected to long-term environmental aging under dry heat, heat & humidity conditions, and temperature cycling from -40°C to 125°C.

The thermal performance of THERM-A-GAP™ GEL 75 was examined after being subjected to multiple environmental stress tests. The thermal impedance of the aged samples did not experience a significant increase after any of the treatments studied. After 1000-hour dwell at 125°C, 1000 hours at 85°C/85% relative humidity, and 1000 temperature cycles from -40°C to 125°C, there was no statistically significant increase in impedance according to one-way ANOVA with the Tukey method for multiple comparisons. The mean value for thermal impedance decreased for each aging treatment, indicating an improvement in thermal performance. This improvement can likely be attributed to enhanced wetting at the interface between the gel and the reliability fixture.

Based on these results, THERM-A-GAP™ GEL 75 demonstrates the ability to withstand long-term aging without a reduction in thermal performance.

1.0 Introduction

The purpose of this document is to examine the thermal reliability of this high-performance thermal gel. Samples of production-scale batches were subjected to long-term aging conditions, and the thermal performance was measured over time.

Successful survival of long-term aging is demonstrated by a lack of statistically significant increase in thermal impedance of the reliability fixtures after the full aging duration. The reliability fixtures comprise GEL 75 sandwiched between two stainless-steel coupons, with thickness set by PTFE spacers. It is worth noting that the exact impedance value of the reliability fixture is not representative of the impedance value of the thermal interface material itself, but it can be used to measure changes to thermal performance over time.

2.0 Long-Term Aging

2.1. Purpose

Long-term aging was performed on GEL 75 between stainless-steel substrates to evaluate the reliability of thermal performance over time. The material was subjected to an extended dwell time of 1000 hours at 125°C, 1000 cycles of temperature cycling from -40°C to 125°C, and long-term heat and humidity aging at 85°C and 85% relative humidity.

2.2. Materials

2.2.1. Twenty-four 1” x 1” x 0.040” 316 stainless-steel coupons.
2.2.2. PTFE shims, 0.040” thick.
2.2.3. Twenty-four clamps.
2.2.4. Russells Humidity Chamber GD-16-3-3-AC.
2.2.5. Sun Electronics Systems PTL-001 Temperature Cycling System.

2.3. Sample Preparation

2.3.1. 3.0 g samples of GEL 75 were dispensed onto the center of each stainless-steel coupon.
2.3.2. The 0.040” PTFE shims were placed at each corner of the coupon.
2.3.3. A second stainless-steel coupon was placed on top of the dispensed material.
2.3.4. Two clamps were placed onto the assembly to hold the substrates at a constant thickness of 0.040”.
2.3.5. The above procedure was performed for all 12 sample assemblies.

2.4. Test Procedure

2.4.1. The assemblies were removed from their clamps and one drop of 500 cSt silicone oil was applied by pipette to the outside of each stainless-steel substrate.
2.4.2. The samples were tested initially for thermal impedance at 50°C and 100 psi per ASTM D5470.

2.4.3. After testing each assembly, the silicone oil was gently removed from the surfaces and the clamps were placed back onto the assemblies.

2.4.4. Four assemblies were subjected to each aging condition:

2.4.4.1. Dry heat aging: oven at 125°C.

2.4.4.2. Heat/humidity aging: humidity chamber at 85°C, 85% relative humidity.

2.4.4.3. Temperature cycling: thermal cycling chamber from -40°C to 125°C; 10°C/min ramp; 15-minute dwell.

2.4.5. After 250 hours of dry heat or heat/humidity aging, or 250 temperature cycles, the samples were removed from their respective environments, allowed to equilibrate at room temperature for at least two hours, and re-tested for thermal impedance.

2.4.6. Once tested, the samples were returned to their respective aging environments and the aging intervals were repeated until the samples had been subjected to a total of 1000 hours of dry heat or heat/humidity aging, or 1000 temperature cycles.

2.5. Results

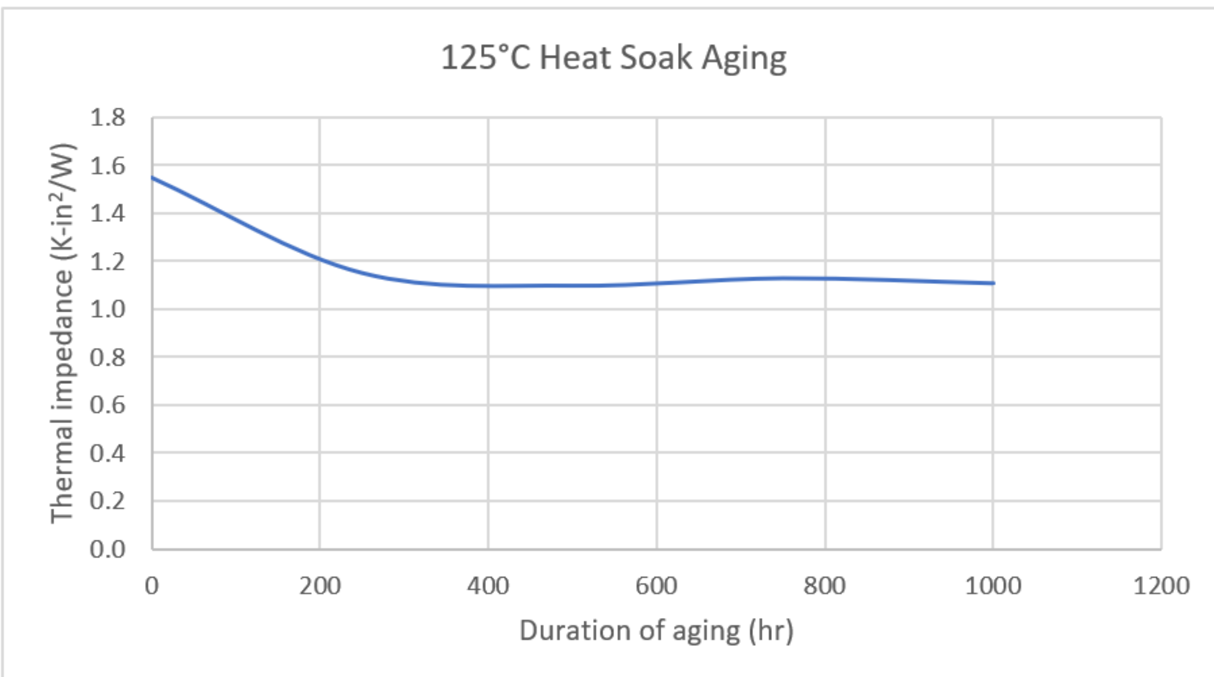

Figure 1: Dry heat aged thermal impedance versus time

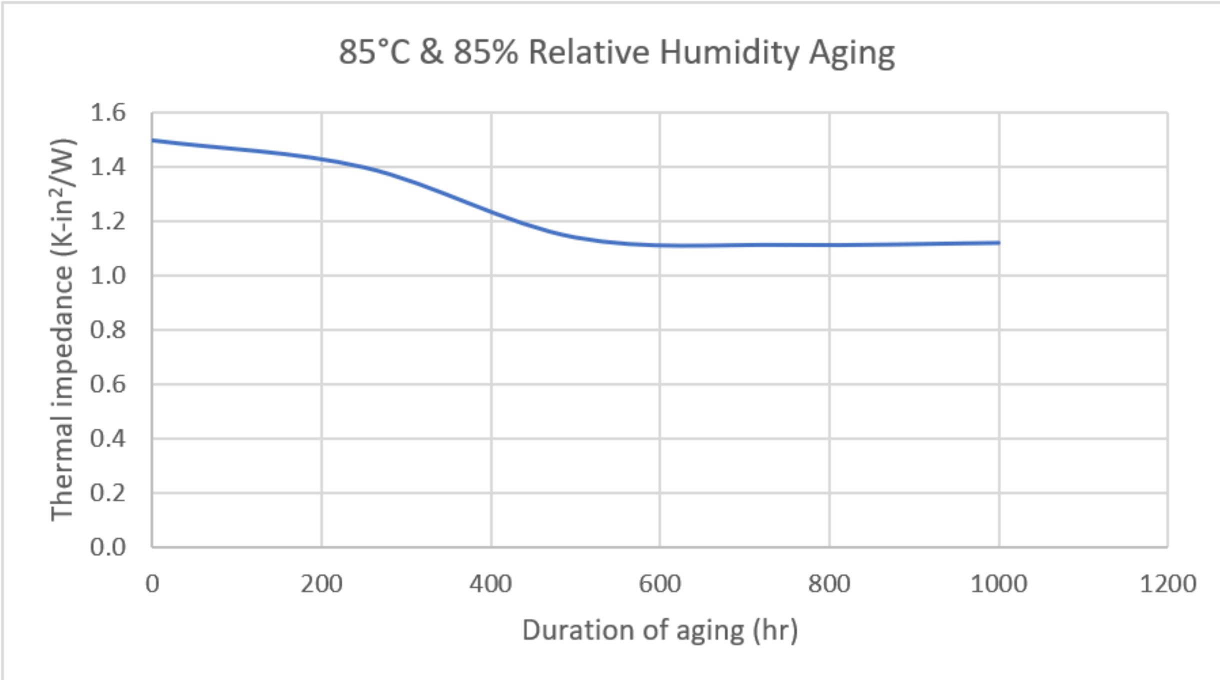

Figure 2: Heat & humidity aged thermal impedance versus time

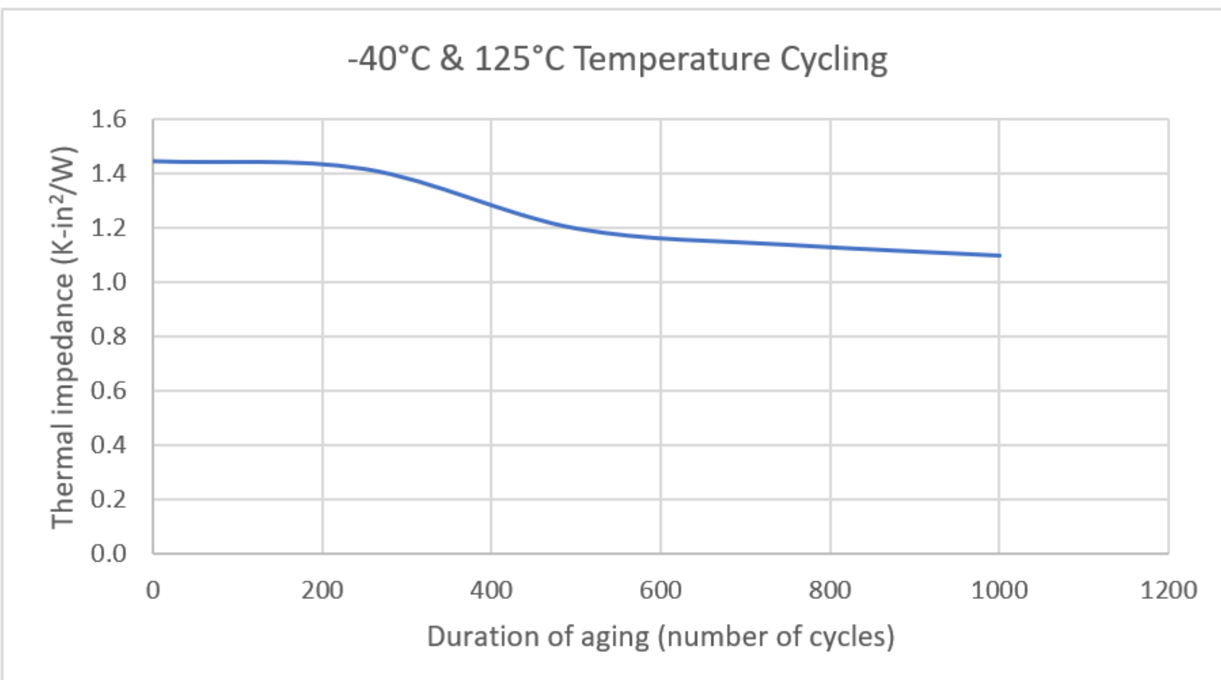

Figure 3: Temperature cycling thermal impedance versus elapsed cycles

3.0 Total Mass Loss

3.1. Purpose

This test is intended to provide data on the volatile silicone content of THERM-A-GAP™ GEL 75. Volatile silicone is of concern due to its ability to migrate and cause problems in electronics applications. The material was tested by thermogravimetric analysis (TGA) and by an independent outside laboratory.

3.2. Materials

3.2.1. TA Instruments Thermogravimetric Analyzer.
3.2.2. Small sample of GEL 75.

3.3. Test Procedure

3.3.1. A small amount of GEL 75 was dispensed onto a TGA test aluminum dish.
3.3.2. The sample was subjected to 125° C for three hours in a nitrogen environment and the sample weight loss was recorded.

3.4. Results

GEL 75 experienced a total mass loss of 0.042 % after a 3-hour dwell at 125°C.

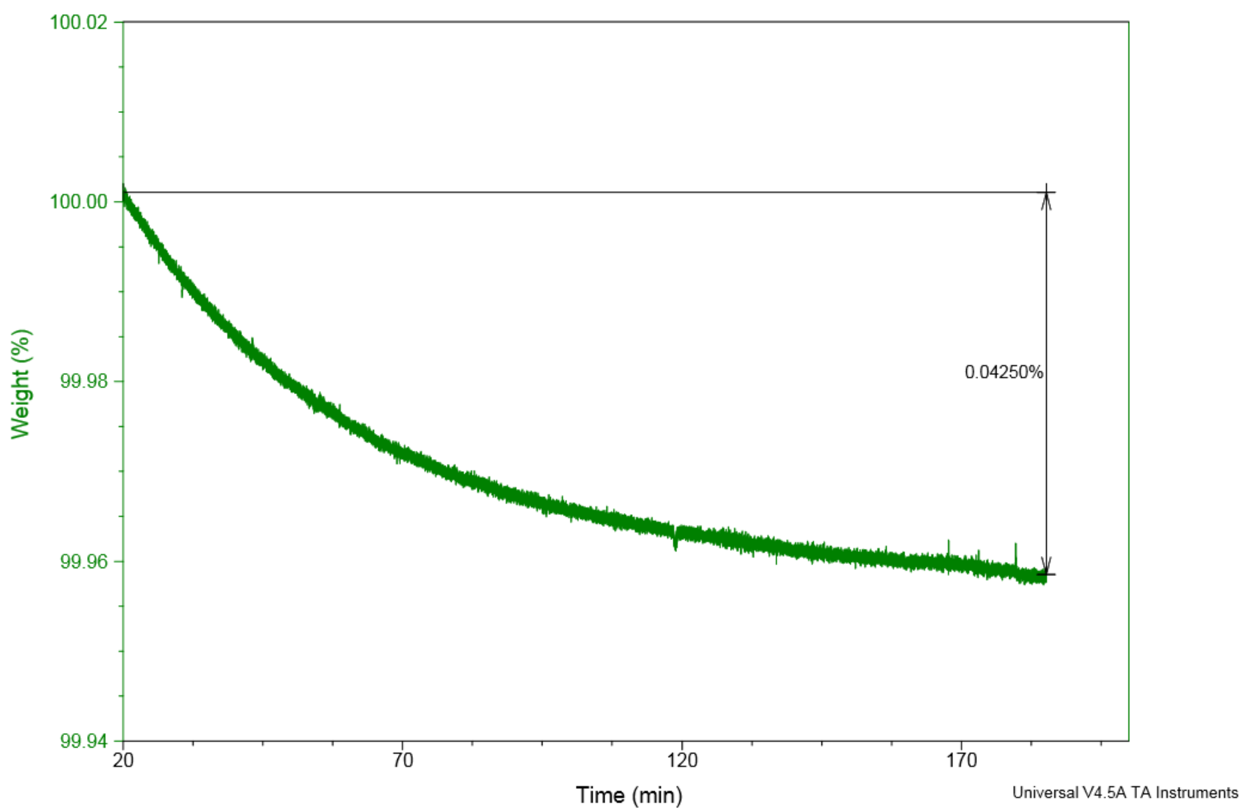

Figure 4: Thermogravimetric Analysis of GEL 75 at 125°C for 3 hours

The National Aeronautics & Space Administration (NASA) criteria for low-volatility materials limits the total mass loss (TML) to 1.0% and collected volatile condensable material (CVCM) to 0.10%.

Outgassing Results	
% Total mass loss	0.18
% CVCM	0.05

Table 1: Independent laboratory outgassing test results

Based on the independent laboratory results, GEL 75 passes the NASA outgassing criteria for low-volatility material.

4.0 Results

THERM-A-GAP™ GEL 75 is a one-component, dispensable thermal compound. The thermal performance of GEL 75 was measured after exposure to multiple accelerated aging conditions. The aging treatments featured in this study include 1000 hours of dry heat aging at 125°C, 1000 hours of heat and humidity aging at 85°C and 85% relative humidity, and 1000 temperature cycles from -40°C to 125°C. There was no statistically significant increase in the thermal impedance of the sample assemblies for any of the aging treatments according to one-way ANOVA with the Tukey method for multiple comparisons.

The mean decrease in impedance represents improved thermal performance, and this phenomenon may be attributed to enhanced wetting at the interface between the thermal compound and the substrate.

5.0 Conclusion

The results of this study provide evidence that GEL 75 maintains reliability after long-term aging.