TEST REPORT

THERM-A-GAP Pad80 Reliability Report
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1. Steady Temperature Test

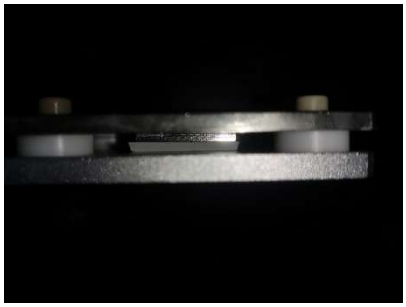
1.1 Sample Preparation

1.1.1 Thermal conductivity test
Samples were cut to 1.3inch diameter discs before aging. As figure1(a)

1.1.2 Thermal impedance test
Samples were cut to 1inch×1inch and installed in a simulated application fixture. The gap thickness is 0.039inch(1.0mm). As figure1(b)

1.1.3Compression deflection test
Samples were cut to 0.5inch diameter discs before aging. As figure1(a)

(a) Sample prepared in tray



(b) Thermal impedance fixture

Fig.1 Sample prepared before aging

1.2 Aging Procedure

The samples were placed into the test chambers at 125°C, and 85°C/85%R.H. and held for 1000 hours. After the 500 hours, the first set of samples were taken out and left at room temperature. Measurements were taken after a minimum of 2 hours. The process was repeated after 1000 hours.

1.3 Test Procedure

1.3.1 Thermal Conductivity Test
Samples were tested at 50°C and 20psi of pressure for each aging condition per ASTM D5470.

Fig.2 TIM Tester

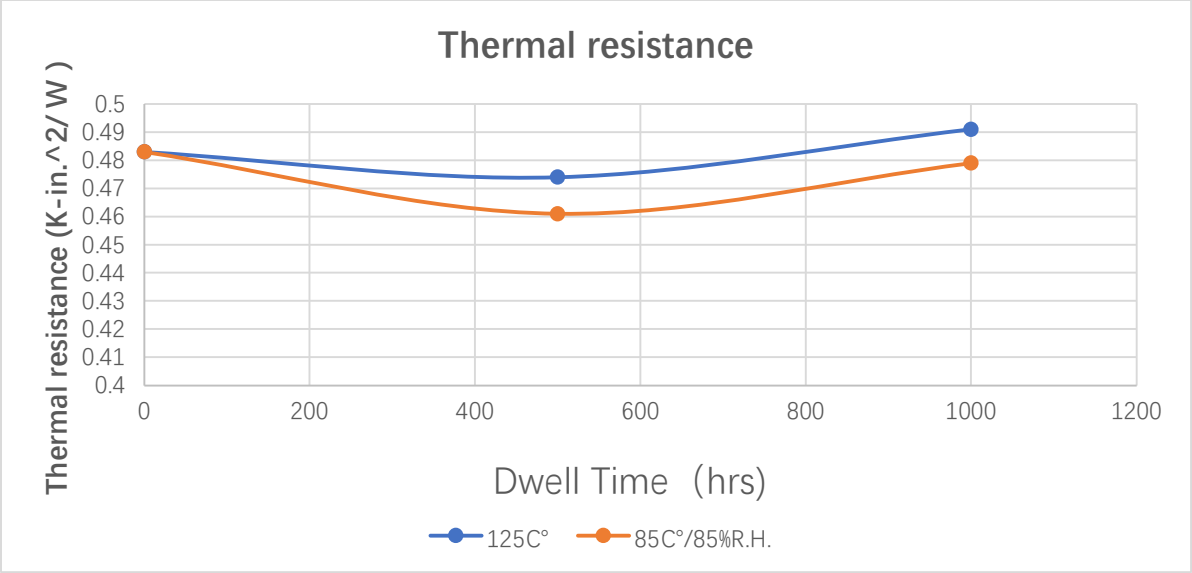
1.3.2 Compression Deflection Test
Samples were tested in a laboratory environment on a Texture Analyzer (from Texture Technologies). Samples were tested at 0.025 in/min up to 70% deflection rate or the deflection limit of the load cell(500N).


Fig.3 TA Tester

1.4. Test Result
1.4.1 Thermal Conductivity Test

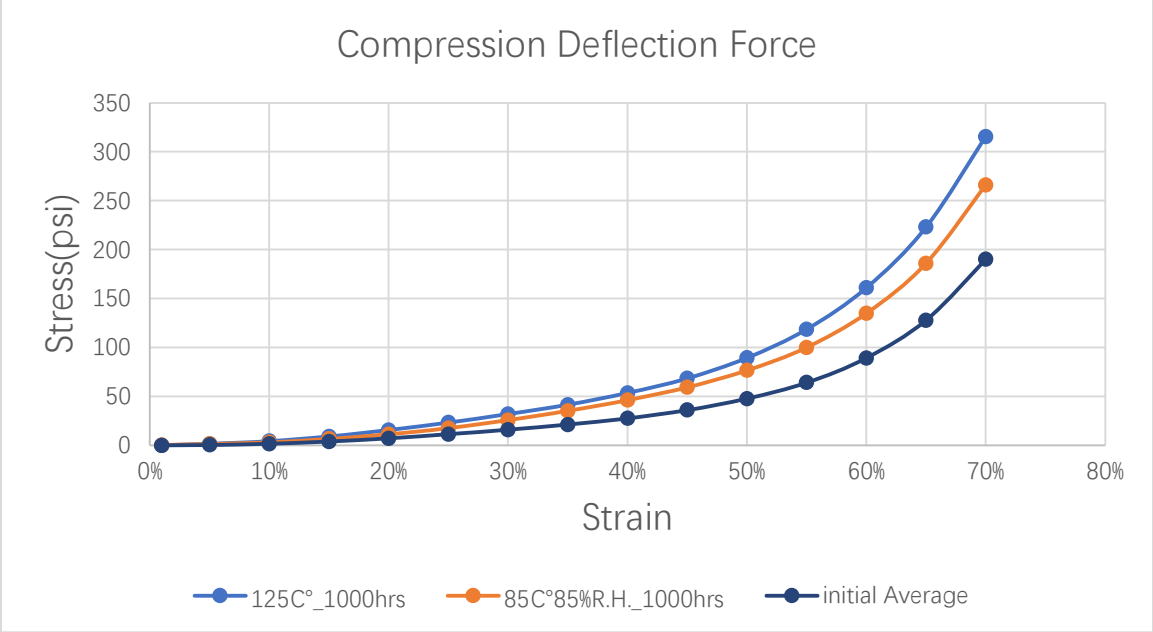
Item / Aging Process	Thermal resistance RA (K-in.^2/ W)				
	Initial	**500hrs**	**500hrs Change %**	**1000hrs**	**1000hrs Change %**
125℃	0.483	0.474	-1.86	0.491	1.66
85℃/85%R.H.	0.483	0.461	-4.55	0.479	-0.83

Table.1 The thermal conductivity test result



Graph.1 The thermal resistance curve

1.4.2 Compression Deflection Test



Graph.2 Compression Deflection Test Result of Pad80

2. Automotive Test

2.1 Sample Preparation

Pad80 was installed in a simulated application fixture and the gap thickness is 0.039inch(1.0mm). Thermal impedance tester is LongWin9389. The fixture and thermal tester as figure3.

Fig.3 The fixture and thermal tester

2.2 Aging Procedure

The automotive reliability tests include Thermal Shock Air-To-Air(TS)、Power Temperature Cycle (PTC) and Random Vibration. The test methods according to GMW3172. This standard applies to Electrical/Electronic (E/E) components for passenger or commercial vehicles and trucks. The standard describes the environmental and durability tests for E/E components based on mounting location.

2.2.1 Thermal Shock Air-To-Air (TS)

Specimens tested from -40 ºC to 85 ºC, and the dwell time at high temperature and low temperature is 15min. The Espec thermal shock chamber and temperature curve as figure4.

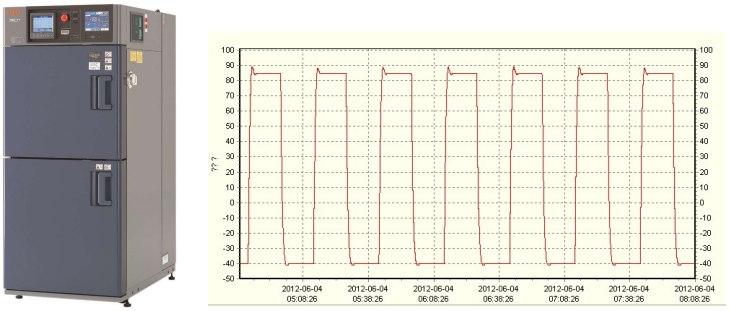


Fig.4. Espec thermal shock chamber and temperature curve

The number of thermal cycles according to GMW 3172 9.4.2 Table 33, Position ABCD as table5.

Code Letter For Temperature	Location In The Vehicle	Combined Number of TS + PTC Cycles	Number Of TS Cycles	Number Of PTC Cycles
A, B, C, and D	Inside the passenger compartment, luggage compartment, or attached to the exterior of the vehicle but not under the hood or above the exhaust system	843	632	211
E and F	Under the hood of the vehicle	1236	927	309
G, H, and I	Attached to or inside the engine (total cycles = 2248)	1248	1000	248
		Cyclic Humidity and Constant Humidity		
		1000	1000	0

Table2. Number of thermal cycles

2.2.2 Power Temperature Cycle (PTC)

Specimens test from -40 °C to 85 °C at a 10 °C /min speed and 15min dwell time at -40℃ and 85℃.

The number of thermal cycles according to GMW 3172 9.4.2 Table 33, Position ABCD as table5.

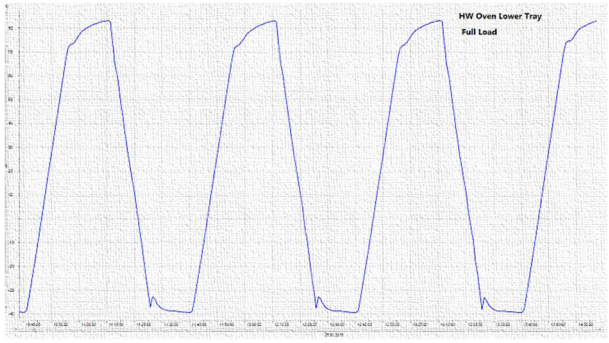
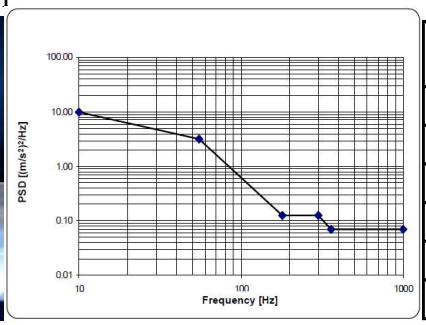


Fig.5 Espec temperature cycling chamber and Temperature curve

2.2.3 Random Vibration

Sample preparation and test procedure according to IEC 60068-2-64, the test parameters and profile as figure6. Effective Acceleration=19.6m/s2=2.0GRMS

3 directions. 8 hours per direction



Fre-quency	Power Spectral Density
10 Hz	9.9069 $(m/s^2)^2$/Hz = 0.1032 G^2/Hz
55 Hz	3.2245 $(m/s^2)^2$/Hz = 0.0336 G^2/Hz
180 Hz	0.1238 $(m/s^2)^2$/Hz = 0.0013 G^2/Hz
300 Hz	0.1238 $(m/s^2)^2$/Hz = 0.0013 G^2/Hz
360 Hz	0.0695 $(m/s^2)^2$/Hz = 0.0007 G^2/Hz
1000 Hz	0.0695 $(m/s^2)^2$/Hz = 0.0007 G^2/Hz

Fig.6 Vibration Stand , Test parameters and profile

2.3 Test Procedure

2.3.1 Test initial thermal Impedance and make record-R_0 (K-in.^2/W);

2.3.2 Put fixtures into Thermal shock chamber for 632cycles;

2.3.3 After 632cycles remove specimens from thermal shock chamber and test thermal impedance and make record-R_1 (K-in.^2/W).

2.3.4 After measured the thermal impedance R_1, then put the specimens into thermal cycling chamber.

2.3.5 After 211 cycles, test thermal impedance and make record-R_2 (K-in.^2/W)

2.3.6 After measured the thermal impedance R_2, then fixed specimens onto vibrator. Set up the parameters and do the Random Vibration test. Then test thermal impedance and make record-R_3 (K-in.^2/W)

The automotive test procedure as figure7.

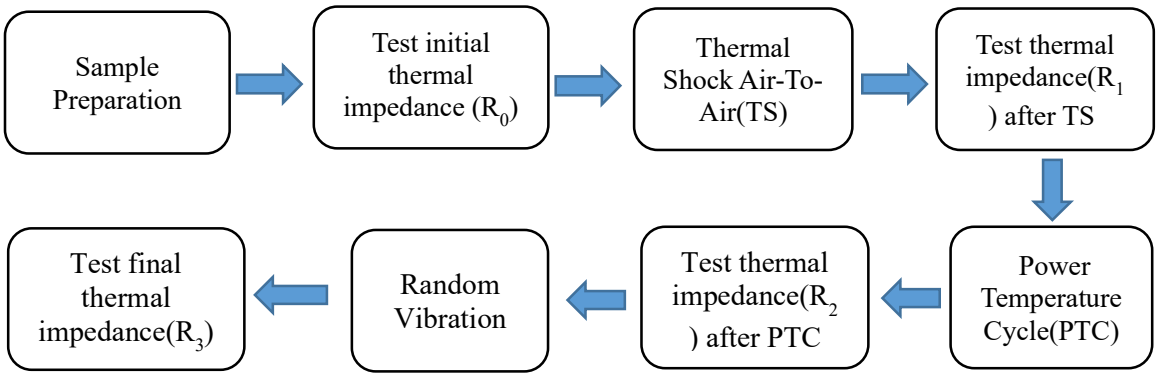


Fig.7 The Automotive Test Procedure

2.4 Automotive Test Result

Specimen No	R_0	R_1	R_2	R_3	Change%
1	0.573	0.562	0.605	0.597	4.2
2	0.586	0.592	0.646	0.615	5.0

Table3. Result Summary Table

3. Oil Bleeding Test（Weight Loss Test）

3.1 Test Procedure

3.1.1 Cut three circles with 1.3inch square, measure the initial sample thickness T_0 and weight W_0.

3.1.2 Measure the filter paper thickness T_1.

3.1.3 Calculate the shim thickness. The compression rate should be 50%, use any combination of shim stock to obtain this thickness.

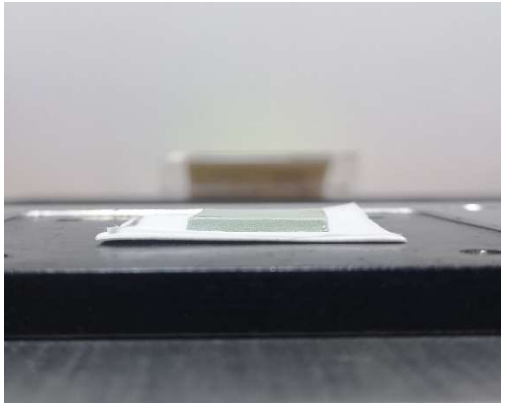
$$\text{Shim thickness}=50\%*T_0+2*T_1$$

3.1.4 Assemble the fixture and place the fixture at room temperature environment for 24-hrs.

3.1.5 After 24 hours, open the fixture and remove the filter paper from the sample

3.1.6 Measure the sample final weight(W_1) and calculate the weight loss% (W_L).

$$W_L = 100 * (W_0 – W_1) / W_0$$



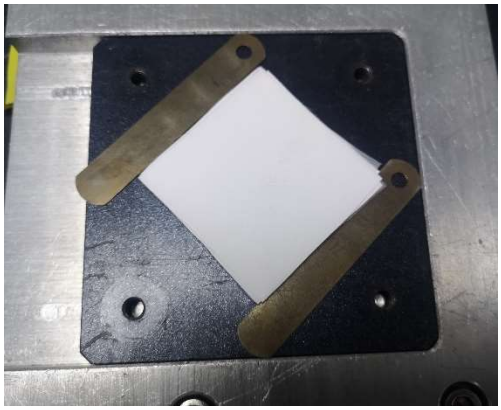


Fig.8 Oil Bleeding Test（Weight Loss Test）

3.2 Test Result

Oil Bleeding (weight loss) %=0.37%

Footnote:

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