THERMATTACH® T-411
Thermal Tapes

Reliability Test Report

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Chomerics Approved Signatory:

The user, through its own analysis and testing, is solely responsible for making the final selection of the system and components and assuring that all performance, endurance, maintenance, safety and warning requirements of the application are met. The user must analyze all aspects of the application, follow applicable industry standards, and follow the information concerning the product in the current product catalog and in any other materials provided from Parker or its subsidiaries or authorized distributors.

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SUMMARY OF PHYSICAL PROPERTIES

Property	**T411**	**Test Method**
Carrier	Aluminum Mesh	
Thickness, in (mm)	0.011 (0.28)	ASTM D374
Tensile Strength, psi (MPa)	390 (2.7)	ASTM D412
Tear Strength, lb/in (KN/m)	69 (12)	ASTM D624
Dielectric Strength, KV ac/mm	N/A	ASTM D149
Breakdown Voltage, V ac	N/A	ASTM D149
Volume Resistivity, Ohm-cm	N/A	ASTM D257
Tested at 10 PSI		
Thermal Impedance, °C-in²/W	1.1	ASTM D5470
Thermal Conductivity, W/m-K	0.45	ASTM D5470
Flammability	Not Rated	U.L.
Aluminum Lap Shear Adhesion, psi (Mpa)		
2 lbs. application force	24 (0.17)	ASTM D1002
25 lbs. application force	32 (0.22)	
Die Shear Adhesion, psi (MPa)		Chomerics Test
Steel/PQFP		Procedure #54
@ 25°C	100 (0.69)	
@ 125°C	25 (0.17)	
Peel Adhesion, lb/in (kN/m)		ASTM D1000
(FR4 Substrate)	3.3 (0.57)	

Summary: Random production samples of Thermattach 411 thermal tapes were subjected to various environmental conditions and tested for shear and adhesion performance.

These tests include visual inspection, die shear strength, lap shear strength and 90° peel adhesion.

Exposure Methods

(1.0) Control Study of initial performance at room temperature environment (25° C).

(1.1) Heat Aging exposure of one thousand (1,000) hours at 125°C (250°F).

Apparatus: A forced convection Blue M oven was set at 125°C. Temperature uniformity was +/- 5°C within oven.

Procedure: Fixtures were placed in a forced convection hot air oven maintained at 125° C +/- 5°C for 1000 hours. Fixtures were then removed from oven and allowed to cool to room temperature (acclimate) for two hours minimum before evaluation.

(1.2) Temperature cycling of one thousand (1,000) cycles from 25°C to 125°C. A cycle consists of a 20 minute dwell at 25°C, heating to 125°C at 10°C/minute, a 20 minute dwell at 125°C and cooling at 25°C temperature at 10°C/minute.

Apparatus: Tenney environmental chamber #942 set to cycle from 25°C to 125°C. Temperature uniformity was ± 2°C of set point.

Procedure: Fixtures were placed in Tenney environmental chamber for a period of 1000 cycles. Fixtures were then removed from environmental chamber and allowed to acclimate to room temperature for two hours minimum before testing.

(1.3) Thermal shock exposure of 25 cycles from –50° to 100°C.

Apparatus: Low temperature bath: The low temperature bath consisted of a one gallon capacity insulated glass container. Excess dry ice was added to 0.75 gallon of isopropanol to cool bath to –50°C +0/-5°C. Temperature was measured with a Type K thermocouple located approximately one inch below the liquid surface. The bath was stirred before a temperature measurement was taken. Temperature was consistently maintained by the addition of dry ice.
High temperature bath: The high temperature bath consisted of a one gallon capacity Pyrex beaker filled with water. The temperature was measured with a type K thermocouple located approximately one inch below the liquid surface. Filled beaker was placed on electrical hot plate and maintained at a constant boil. Temperature was measured at 100°C (+0/-2°C).

Procedure: A cycle consists of placing a specimen into a 100°C boiling water bath for 10 minutes and after removal, rapidly plunging specimen into the low temperature bath of dry ice/isopropanol for 10 minutes. The specimen was then removed from the cold bath, and the next cycle started immediately.

Sample fixtures: Sample specimens were placed in a solvent resistant plastic bag, the excess air removed from the bag, and the bag hermetically sealed to ensure exposure of samples to only temperature extremes and not liquid medium.

(1.4) High temperature/Humidity Resistance 1000 hours, 85° C @ 85% RH.

Apparatus: A Tenney Versa Tenn II humidity cabinet chamber maintained at 85°C (+/-2°C) at a relative humidity of 85%.

Procedure: Fixtures were placed in a chamber and fully exposed with no attempt made to protect metal surfaces or leads. After constant exposure for 1000 hours samples were removed and allowed to acclimate to room temperature for two hours minimum before testing.

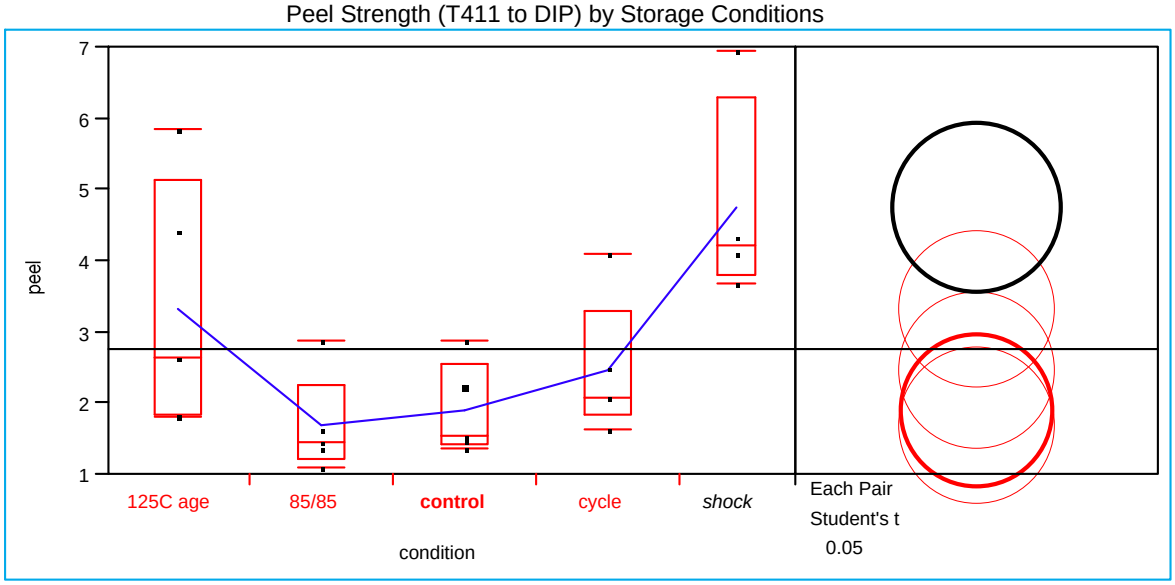
Peel Value Test

Peel adhesion at a 90°-angle measuring bond strength of adhesive tape to plastic package surface. Sample tape size 0.50 inch wide x 5.0 inch long attached to a 40 pin 2.0 inch x 0.55 inch DIP package (Zilog Z0842006 PSC) with 5 lbs. applied lamination pressure. To initiate the test the 3.0 inch free end of sample is gripped into the fixture of a standard Instron upper grip. The DIP package is securely clamped to mounting table with the tape maintained at a constant angle of 90° during testing as the crosshead is driven down in tension at a rate of 2 inches per minute. The force required to peel the tape laminate is monitored by the load weighing system providing a direct measurement of bond strength. The peel value is the mean of five samples tested and recorded in PPI (lbs. per inch value).

Results

Visual: There was no evidence of delamination, tape lifting or any other signs of adhesive failure after exposure to all listed environmental test conditions.

Peel Strength: Analysis of the data shows that there is no degradation of the peel strength under any of the aging conditions. There is no statistically significant change in the peel strength for the samples exposed to heat aging, temperature cycling, or high temperature/high humidity storage, and a slight increase in peel strength for the samples exposed to temperature shock. Based on the standard deviation in the data, this increase is not technically significant.



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
125ºC age	5	3.32400	1.77448	0.79357
85C/85RH	5	1.69200	0.69880	0.31251
control	5	1.90600	0.64174	0.28699

temp cycle	5	2.48000	0.95116	0.42537
temp shock	4	4.77000	1.47700	0.73850

Comparisons for each pair using Student's t

Alpha= 0.05

t =2.09301

Abs(Dif)-LSD	shock	125C age	cycle	control	85/85
shock	-1.74319	-0.20774	0.63626	1.21026	1.42426
125C age	-0.20774	-1.55916	-0.71516	-0.14116	0.07284
cycle	0.63626	-0.71516	-1.55916	-0.98516	-0.77116
control	1.21026	-0.14116	-0.98516	-1.55916	-1.34516
85/85	1.42426	0.07284	-0.77116	-1.34516	-1.55916

Positive values show pairs of means that are significantly different.

Raw Data

Table 1 Peel test 90°. Control samples in accordance with 1.0 method.

Mean Average PPI

1.55	
2.88	
1.37	Mean = 1.9 PPI
1.49	σ = 0.6
2.24	

Table 2 Peel test 90°. Heat Age in accordance with 1.1 method.

Mean Average PPI

1.81	
5.87	
2.65	Mean = 3.3 PPI
1.86	σ = 1.8
4.43	

Table 3 Peel test 90°. Temperature Cycling in accordance with 1.2 methods.

Mean Average PPI

2.51	
2.09	
1.64	Mean = 2.5 PPI
2.07	σ = 1.0
4.09	

Table 4 Peel test 90°. Thermal Shock in accordance with 1.3 method.

Mean Average PPI

4.34	
3.70	Mean = 4.8 PPI
6.95	σ = 1.5
4.09	

Table 5 Peel test 90°. High Temperature/Humidity resistance in accordance with 1.4 method.

Mean Average PPI (lbs. per inch)

1.47	
2.89	
1.09	Mean = 1.7 PPI
1.64	σ = 0.7
1.37	

Lap Shear

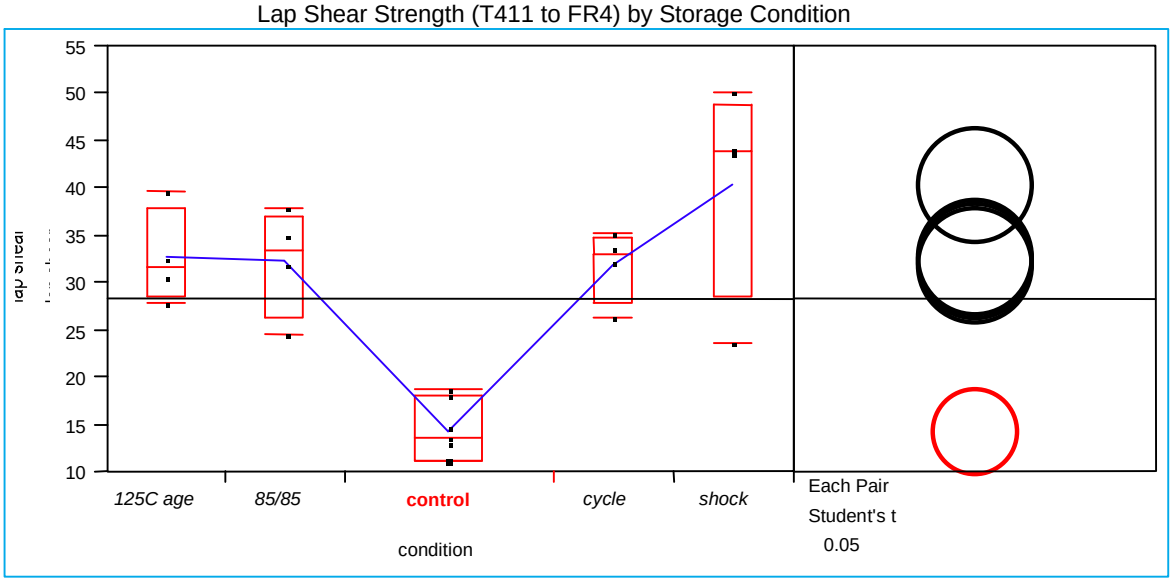
Lap shear panels consisted of 1 inch wide x 5 inch long class 2024 aluminum strip panels attached to a FR4 plastic composite of the same dimensions. The lap shear adhesive area tested was one inch.

The thermal tape was applied to a 2024 aluminum panel first using light pressure (2-5 lbs). The other side of thermal tape was then attached to FR4 composite using light pressure of 2-5 lbs. for a dwell time of 20 seconds. Panel samples were applied one after the other. Samples were allowed to dwell for period of one hour at 25°C to wet out adhesive to substrate. Samples were then placed into environmental conditions and no attempt was made to protect metal surfaces.

Testing of lap shear panels was per ASTM D1002 with tension cross head speed run at 0.05 inch per minute. Results are a mean of 4-5 samples tested and recorded in PSI (pounds per square inch).

Visual: There was no visual evidence of adhesive failure or delamination after any environmental test conditions.

Shear Strength: Analysis of the data showed that the shear strength increased after exposure to elevated temperatures. This is consistent with the conclusion that increased adhesion results from improved flow and surface wetting by the adhesive under elevated temperatures.



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
125ºC age	4	32.8000	5.0484	2.5242
85C/85RH	4	32.3500	5.7181	2.8590
control	7	14.4143	3.0482	1.1521
temp cycle	4	31.9250	3.8948	1.9474
temp shock	4	40.4750	11.5788	5.7894

Comparisons for each pair using Student's t

Alpha= 0.05

t =2.10091

Abs(Dif)-LSD	shock	125C age	85/85	cycle	control
shock	-9.1175	-1.4425	-0.9925	-0.5675	17.9789
125C age	-1.4425	-9.1175	-8.6675	-8.2425	10.3039
85/85	-0.9925	-8.6675	-9.1175	-8.6925	9.8539
cycle	-0.5675	-8.2425	-8.6925	-9.1175	9.4289
control	17.9789	10.3039	9.8539	9.4289	-6.8922

Positive values show pairs of means that are significantly different.

Raw Data

Table 6 Control Study in accordance with 1.0 method

Peak Load (PSI)

13.1	
14.8	
13.7	
11.2	Mean = 14.4 PSI
18.7	σ = 3.0
18.2	
11.2	

Table 7 Heat Aging in accordance with 1.1 method.

Peak Load (PSI)

30.7	
32.7	Mean = 32.8 PSI
39.8	σ = 5.0
28.0	

Table 8 Temperature Cycling in accordance with 1.2 method.

Peak Load (PSI)

33.8	
26.4	Mean = 31.9 PSI
32.2	σ = 3.9
35.3	

Table 9 Thermal Shock in accordance with 1.3 method.

Peak Load (PSI)

44.2	
50.3	Mean = 40.5 PSI
23.7	σ = 11.6
43.7	

Table 10 High Temperature/Humidity Resistance in accordance with 1.4 method.

Peak Load (PSI)

35.0	
31.9	Mean = 32.4 PSI
37.9	σ = 5.7
24.6	

Die Shear Adhesion to Topline 80386 PQFP

A 0.50 x 0.50 inch sample of thermal tape was applied using light pressure (2-5 lbs.) to uncleaned, as supplied, Topline 80386 PQFP packages.

The tape was then placed in contact with a 0.25 x 0.25 inch chip of cleaned cold rolled steel (Feeler stock). Before taping, steel chips were cleaned with MEK (Methylethylketone) solvent and dried with a lint free cloth. All cleaning of test surfaces was done in accordance with PSTC appendage C. (Pressure Sensitive Tape Council - cleaning of test surfaces procedure). Pressure of 5 lbs. was applied to steel chip for 20 seconds dwell time. Excess tape around perimeter of chip was removed, leaving only adhesive film under chip for testing. Samples were allowed to dwell at 25°C for a minimum of one hour before testing.

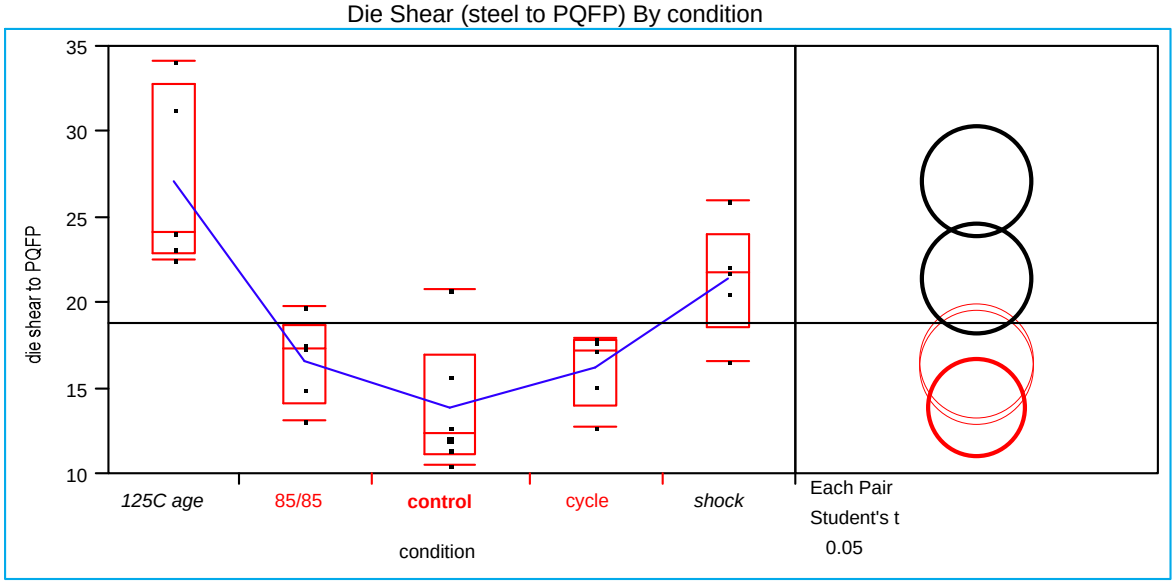
Apparatus: A Hybrid machine model #1760 heavy-duty shear tester was used to determine shear strength values. The heater plate was turned OFF and the shear speed was one inch per minute in all tests.

Die Shear Results

Visual: There was no evidence of adhesive failure, lifting, drooping or flagging on any samples after environmental exposures.

Die Shear Strength: The results of the shear strength tests show performance improvements in samples that were heat aged or temperature shocked. No significant change in performance is seen from the control to the temperature cycling or high temperature/high humidity samples.

Die Shear (steel to PQFP) By condition



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
125ºC age	5	27.1200	5.30961	2.3745
85C/85RH	5	16.6000	2.54951	1.1402
control	6	13.9000	3.82570	1.5618
temp cycle	5	16.2000	2.20000	0.9839
temp shock	5	21.4400	3.37757	1.5105

Alpha= 0.05

Comparisons for each pair using Student's t

t =2.07960

Abs(Dif)-LSD	125C age	shock	85/85	cycle	control
125C age	-4.77631	0.90369	5.74369	6.14369	8.64703
shock	0.90369	-4.77631	0.06369	0.46369	2.96703
85/85	5.74369	0.06369	-4.77631	-4.37631	-1.87297
cycle	6.14369	0.46369	-4.37631	-4.77631	-2.27297
control	8.64703	2.96703	-1.87297	-2.27297	-4.36015

Positive values show pairs of means that are significantly different.

Raw Data

Table 11 Control Samples in accordance with 1.0 method

Peak Load	
10.6 lbs	
12.8	
15.8	Mean = 56 psi
20.8	σ = 15.3
12.0	
11.4	

Table 12 Heat Aging in accordance with 1.1 method.

Peak Load	
34.2 lbs	
31.4	Mean = 108 psi
22.6	σ = 21.2
23.2	
24.2	

Table 13 Temperature Cycling in accordance with 1.2 method.

Peak Load	
18.0 lbs	
17.8	Mean = 65 psi
12.8	σ = 8.8
15.2	
17.2	

Table 14 Thermal Shock in accordance with 1.3 method.

Peak Load	
26.0	
20.6	Mean = 86 psi
16.6	σ = 13.5
21.8	

22.2	

Table 15 High Temperature/Humidity resistance in accordance with 1.4 method.

Peak Load	
15.0	
13.2	Mean = 66 psi
17.6	σ = 10.2
19.8	
17.4	

Die Shear Adhesion FR4 Plastic Composite

A 0.50 x 0.50 inch sample of thermal tape was applied using light pressure (2-5 lbs.) to a clean surface of FR4 plastic composite strip (0.50 inch wide). The tape was then placed in contact with a 0.25 x 0.25 inch chip of cleaned cold rolled steel (Feeler stock).

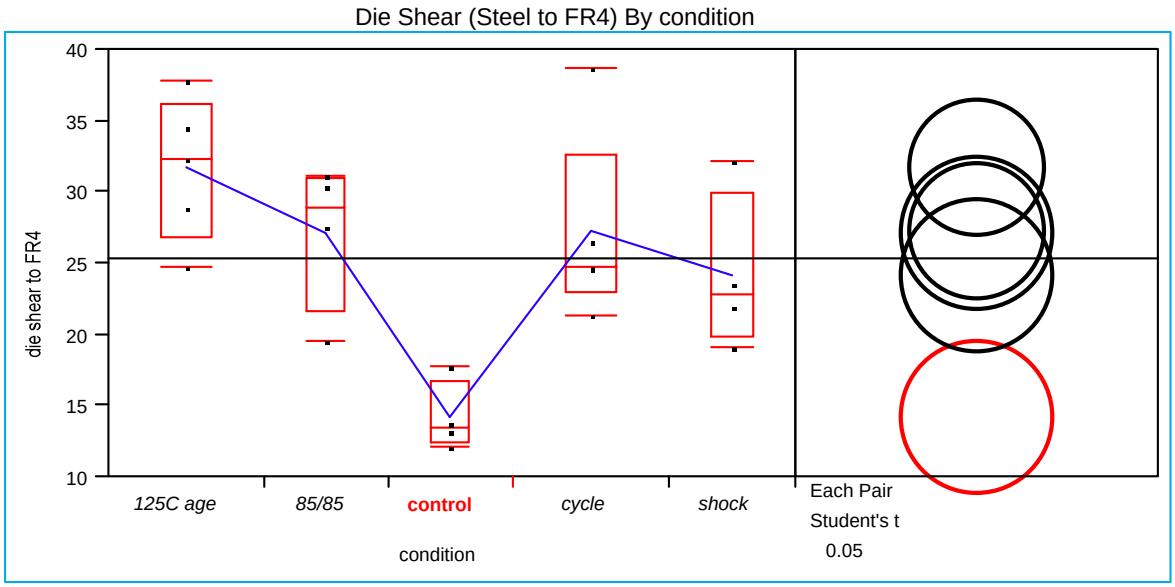
Before taping, steel chips were cleaned with MEK (Methylethylketone) solvent and dried with a lint free cloth. All cleaning of test surfaces was done in accordance with PSTC appendage C. (Pressure Sensitive Tape Council-cleaning of test surfaces procedure). Pressure of 5 lbs. was applied to steel chip for 20 second dwell time. Excess tape around perimeter of steel chip was trimmed and removed. Samples were allowed to dwell at 25° C for a minimum of one hour before conditioning.

Apparatus: A Hybrid machine model #1760 was used to determine shear strength values. Heater plate was used in noted tests to determine high temperature shear performance. In all tests shear speed was at one inch per minute.

Die Shear Results

Visual: There was no evidence of adhesive failure, lifting, drooping or flagging on any samples after environmental exposures.

Die Shear Strength: The results of the shear strength tests show performance improvements after conditioning. This is consistent with the conclusion that increased adhesion results from improved flow and surface wetting by the adhesive under elevated temperatures.



Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean
125ºC age	5	31.7200	5.02514	2.2473
85C/85RH	4	27.2000	5.29654	2.6483
control	4	14.2500	2.45696	1.2285
temp cycle	5	27.2400	6.72815	3.0089
temp shock	4	24.2500	5.60327	2.8016

Alpha= 0.05

Comparisons for each pair using Student's t

t =2.10980

Abs(Dif)-LSD	125C age	cycle	85/85	shock	control
125C age	-7.07957	-2.59957	-2.98901	-0.03901	9.96099
cycle	-2.59957	-7.07957	-7.46901	-4.51901	5.48099
85/85	-2.98901	-7.46901	-7.91519	-4.96519	5.03481
shock	-0.03901	-4.51901	-4.96519	-7.91519	2.08481
control	9.96099	5.48099	5.03481	2.08481	-7.91519

Positive values show pairs of means that are significantly different.

Raw Data

Table 16 Control Samples in accordance with 1.0 method.

Peak Load	
13.2 lbs	
12.2	Mean = 57 psi
17.8	σ = 9.8
13.8	

Table 17 Heat Aging in accordance with 1.1 method.

Peak Load	
37.8 lbs	
32.2	Mean = 128 psi
24.8	σ = 20.1
29.0	
34.6	

Table 18 Temperature Cycling in accordance with 1.2 method.

Peak Load	
38.8 lbs	
24.6	Mean = 109 psi
24.8	σ = 26.9
26.6	
21.4	

Table 19 Thermal Shock in accordance with 1.3 method.

Peak Load	
22.0 lbs	
32.2	Mean = 93 psi
23.6	σ = 22.4
19.2	

Table 20 High Temperature/Humidity resistance in accordance with 1.4 method.

Peak Load	
31.2 lbs	
27.6	Mean = 109 psi
19.6	σ = 21.2
30.4	

Physical Properties

Property	T410	T411	T413	Test method
Adhesive type	**silicone / acrylic**	**silicone**	**acrylic**	**FTIR**
Adhesive color	**clear/white**	**clear**	**white**	**visual**
Substrate type	**Aluminum**	**Aluminum mesh**	**Fiberglass cloth**	**Visual/data sheets**
Substrate thickness, mils	**2**	**7**	3	ASTM D374
Total thickness [mils]	**7**	**11**	7	ASTM D374
Thermal impedance [°C-in^2/W] **<1 psi** **50 psi**	**1.1**	**1.0** **0.85**	**0.65**	**ASTM D5470 modified**
Apparent thermal conductivity [W/m-K]	**0.25**	**0.30**	**0.35**	**ASTM D5470 modified**
Adhesive Specific Gravity	**1.4 / 1.7**	**1.4**	**1.7**	**ADTM D792**

Adhesive Properties

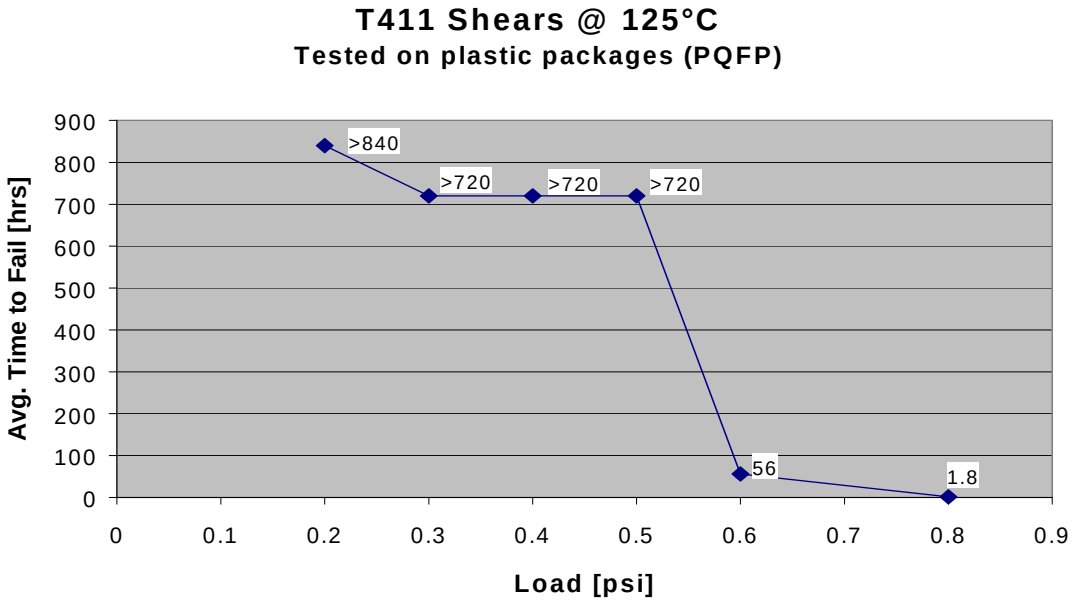
	T410	T411	T413	Test method
90° Peel Adhesion peel from plastic DIP [ppi]	3.3	3.3	0.9	ASTM D1000
Lap Shear [psi] Aluminum to FR4 25 lbs application pressure	36.4 Adh fail from FR4	38.7 Adh fail from mesh	36.6 Adh fail from Al	ASTM D1002
Holding power [days] PQFP 4.4 psi 25°C (Creep) ½" x ½" x 500grams	>50 No failure (~1/50" slip)	12.3 Adhesive failure from mesh substrate	0.4 Adhesive failure from PQFP	PSTC-7A
Die Shear [psi] 25°C 125°C	Steel/FR4 170 40	Steel/FR4 80 20	Aluminum 180 20 (150°C)	Chomerics TP-54
Torque [in-lbs] 24 hr dwell, from plastic BGA	6.5 Adh fail from pkg	9.3 Adh fail from mesh	4.2 Adh fail from pkg	
Operating Range [°C]	-50 to 150	-50 to 150	-50 to 150	

Summary

Shear adhesion (Creep) testing at 125°C was performed with Chomerics T411 tape on plastic flat packages. Various loads were used during the testing in order to generate a curve of load versus failure time. Any load of 0.5 psi or lower appears to hold indefinitely under these conditions.

Results

The data from several tests were compiled and averaged to generate the load versus failure **time**



curve. All tests were repeated a least three times. Several of the samples did not fail or show signs of slippage within 30 days, so testing was stopped in order to make room for other tests. Due to the size of the PQFP, the tapes were tested with 1/2 x 1/2 inch sample areas. All tests were applied to the PQFP with 25 pounds of application pressure for 20 seconds, and were allowed to dwell for 24 hours at room temperature before going into the 125°C oven. Test method was similar to PSTC-7C, Pressure Sensitive Tape Council's Holding Power of Pressure Sensitive Tapes.