



TEST REPORT
THERMATTACH THERMAL TAPES

T411

TABLE OF CONTENTS

Physical Properties.....1

Detailed Research Reports

Exposure Methods

Method (1.0) Control.....2

Method (1.2) Heat Aging.....2

Method (1.3) Thermal Shock.....2

Method (1.4) Heat/Humidity.....3

Tests and Results

Peel Value...Tables 1-5.....4 & 5

Lap Shear...Tables 6-10.....6 & 7

PQFP Die Shear...Tables 11-16.....8 & 9

FR4 Die Shear...Tables 17-21.....10 & 11

SUMMARY OF PHYSICAL PROPERTIES

Property	T411	Test Method
Carrier	Aluminum Mesh	
Thickness, in (mm)	0.011 (0.28)	ASTM D374
Tensile Strength, psi (MPa)	??	ASTM D412
Tear Strength, lb/in (KN/m)	??	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-in ² /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)	???	
Creep Adhesion, days		P.S.T.C. #7
(PQFP)	???	

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, thermal performance, 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 +/- 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 and 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 average 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.

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

Mean Average PPI

1.55	
2.88	
1.37	Average = 1.9 PPI
1.49	
2.24	

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

Mean Average PPI

1.81	
5.87	
2.65	Average = 3.3 PPI
1.86	
4.43	

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

Mean Average PPI

2.51	
2.09	
1.64	Average = 2.5 PPI
2.07	
4.09	

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

Mean Average PPI

4.34	
3.70	Average = 4.8 PPI
6.95	
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	Average = 1.7 PPI
1.64	
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 an average 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: Shear strength results improved in humidity and elevated temperatures. This is most likely due to increase in the modulus of the adhesive under these conditions.

Table 6 Control Study in accordance with 1.0 method

Peak Load (PSI)

13.1	
14.8	
13.7	
11.2	Average = 14.4 PSI
18.7	
18.2	
11.2	

Table 7 Heat Aging in accordance with 1.1 method.

Peak Load (PSI)

30.7	
32.7	Average = 32.8 PSI
39.8	
28.0	

Table 8 Temperature Cycling in accordance with 1.2 method.

Peak Load (PSI)

33.8	
26.4	Average = 31.9 PSI
32.2	
35.3	

Table 9 Thermal Shock in accordance with 1.3 method.

Peak Load (PSI)

44.2	
50.3	Average = 40.5 PSI
23.7	
43.7	

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

Peak Load (PSI)

35.0	
31.9	Average = 32.4 PSI
37.9	
24.6	

Die Shear Adhesion to Topline 80386 PQFP

Die Shear: 0.50 x 0.50 inch 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). 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 possible due to the increased adhesive modulus under these conditions.

Table 11 Control Samples in accordance with 1.0 method

Peak Load	
10.6 lbs	
12.8	
15.8	Average = 56 psi
20.8	
12.0	
11.4	

Table 12 Heat Aging in accordance with 1.1 method.

Peak Load	
34.2 lbs	
31.4	
22.6	Average = 108 psi
23.2	
24.2	

Table 13 Temperature Cycling in accordance with 1.2 method.

Peak Load	
18.0 lbs	
17.8	
12.8	Average = 65 psi
15.2	
17.2	

Table 14 Thermal Shock in accordance with 1.3 method.

Peak Load	
26.0	
20.6	
16.6	Average = 86 psi
21.8	
22.2	

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

Peak Load	
15.0	
13.2	
17.6	Average = 66. psi
19.8	
17.4	

Die Shear Adhesion FR4 Plastic Composite

0.50 x 0.50 inch 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).

NOTE: Before taping, steel chips were cleaned with MEK (Methylethylketone) solvent and dried with a lint free cloth. FR4 plastic composite was cleaned with alcohol wipe to remove any handling contamination. 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 possible due to the increased adhesive modulus under these conditions.

Table 16 Control Samples in accordance with 1.0 method.

Peak Load	
13.2 lbs	
12.2	Average = 57 psi
17.8	
13.8	

Table 17 Heat Aging in accordance with 1.1 method.

Peak Load	
37.8 lbs	
32.2	Average = 128 psi
24.8	
29.0	
34.6	

Table 18 Temperature Cycling in accordance with 1.2 method.

Peak Load	
38.8 lbs	
24.6	
24.8	Average = 109 psi
26.6	
21.4	

Table 19 Thermal Shock in accordance with 1.3 method.

Peak Load	
22.0 lbs	
32.2	Average = 93 psi
23.6	
19.2	

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

Peak Load	
31.2 lbs	
27.6	Average = 109 psi
19.6	
30.4	

	Control Samples Initial Performance (25°C)	Heat Age 1000 hrs (125°C)	Temp. Cycling 1000 cycles (25°C to 125°C)	Thermal Shock 25 cycles (-50°C to +100°C)	High Temperature/ Humidity Resist. (85°C/85% RH) 1000hrs
Peel Adhesion Bonded to 40 pin 2.0" x .55" DIP Peels Peel value at ambient after exposure (PPI)	1.9	3.3	2.5	4.8	1.7
Lap Shear FR4 Composite bonded to 2024 Aluminum Lap shear at ambient after exposure Applied @ 2 to 5 lbs (PSI)	14	33	32	41	32
Die Shear Adhesion (Chomerics Test Procedure #54) Die shear adhesion at ambient of steel to plastic x386 PQFP after exposure (PSI)	56	108	65	86	66
Die Shear Adhesion (Chomerics Test Procedure #54) Die shear adhesion at ambient of steel to FR4 plastic composite after exposure (PSI)	57	128	109	93	109
Creep Adhesion (per PSTC #7 test procedure) at 25° C 500 G/¼ in² (DAYS) at 125° C 500 G/1. in². (DAYS)					