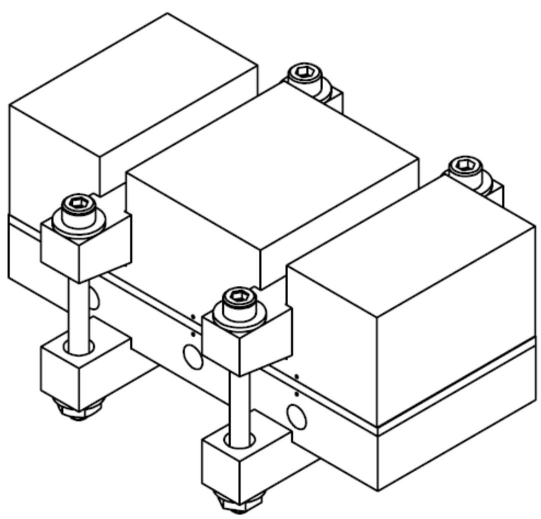
# Tflex SF800 Thermal Reliability Report


## Summary

The Laird Technologies' gap filler reliability test procedure has been designed to characterize the long-term performance of a gap pad while being subjected to isothermal conditions, repeated extremes in temperature, and moderate heat - high humidity environments. Specimens are placed within application-related fixtures under set conditions and at regular intervals the thermal properties of the specimens are measured.


## Fixture Setup

The test fixture is rectangular with dimensions of 2" x 5" (surface area of 10 $in^2$). It consists of an aluminum heater plate and an extruded aluminum heat sink "cooler plate". The heater plate contains 3 holes for insertion of cartridge heaters. Both plates contain 3 sets of thermocouple holes drilled for measurement of the temperature very near the surfaces mated by the gap pad. Each test fixture accommodates 3 test positions. The heater and cooler plates are held together by metal straps which span the width of the plates (2 sets per test fixture) and are bolted to each other. Cartridge heaters are inserted into the heater plate holes. A specified power from a power supply is input to the heaters to obtain a constant $70^0$C across the heater plate. This will ensure a constant heat flow is maintained through the gap filler during data acquisition. A cooling fan (not pictured) is centered on top of the heat sink during testing to facilitate realistic air flow and cooling. Test values are measured in an ambient laboratory environment.



## Theory

Throughout the test period, the measured variable is the temperature difference of the surfaces of the heater and cooler plates. Thermal resistance ($R_{th}$) is defined as the temperature difference ($\Delta T$) between two surfaces for a given heat flow ($\Delta P$). That is: $R_{th} = \Delta T / \Delta P$. In this testing, heat flow is controlled and constant, therefore, $R_{th} \alpha \Delta T$. This relationship indicates that a constant value of $\Delta T$ throughout the test program requires $R_{th}$ to also remain constant, which indicates a highly reliable system and thus a gap pad that is not influenced by the exposure conditions.

## Types of Reliability Testing

### Thermal Shock

In thermal shock testing, test fixtures containing the specimens are transitioned between -40$^0$C and 110$^0$C with a 1 hour hold to reach thermal equilibrium at each temperature extreme. The transfer time between the oven temperatures is quick, typically less than 20 seconds. 1000 cycles or “Shocks” are performed on each fixture.

### Isothermal Bake

In isothermal bake testing, fixtures are maintained at 120$^0$C for 1000 hours.

### HAST

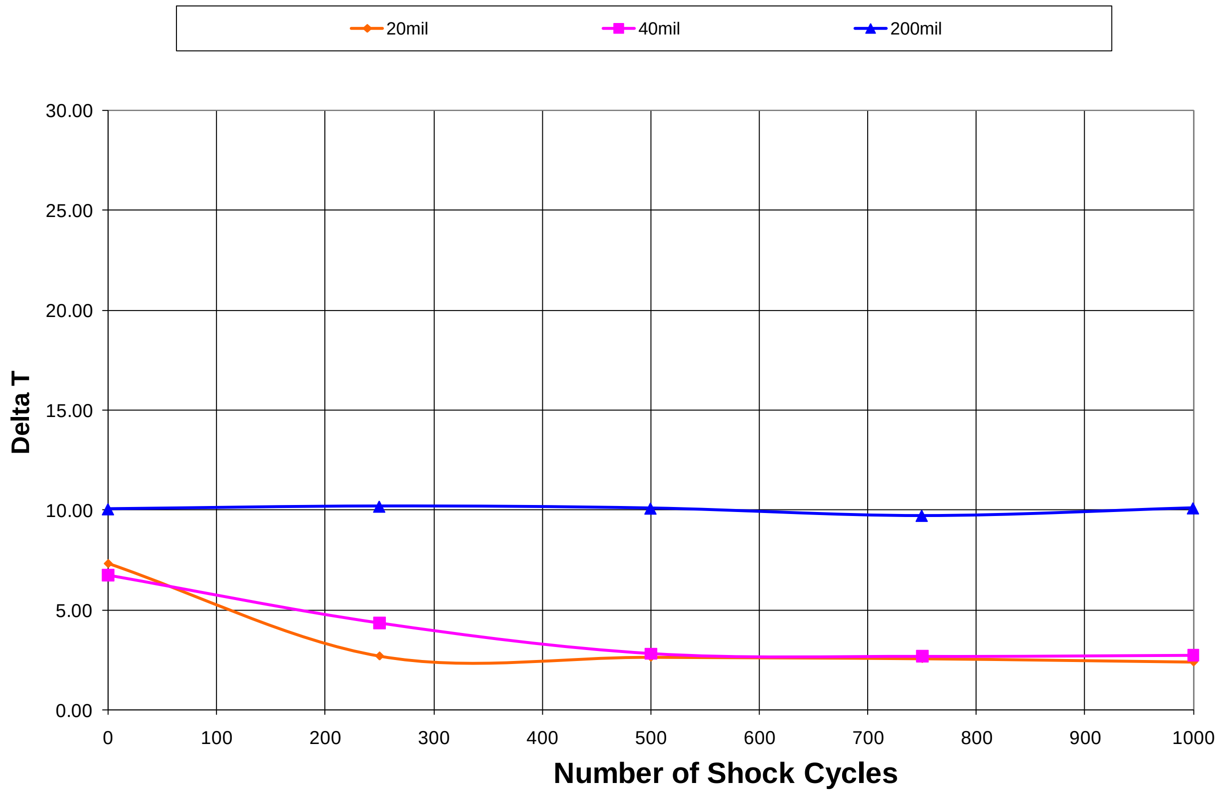
In HAST testing, the fixtures are maintained in conditions of moderate temperature (85$^0$C) and high humidity (85%) for the duration of the test.

## Results

The thicknesses of Tflex SF800 tested were 20mil (0.51mm), 40mil (1.02mm), and 200mil (5.08mm). Two fixtures for each thickness were assembled and tested for all three reliability testing types (3 test positions for each unit). The data reported is the average of each value for the two fixtures.

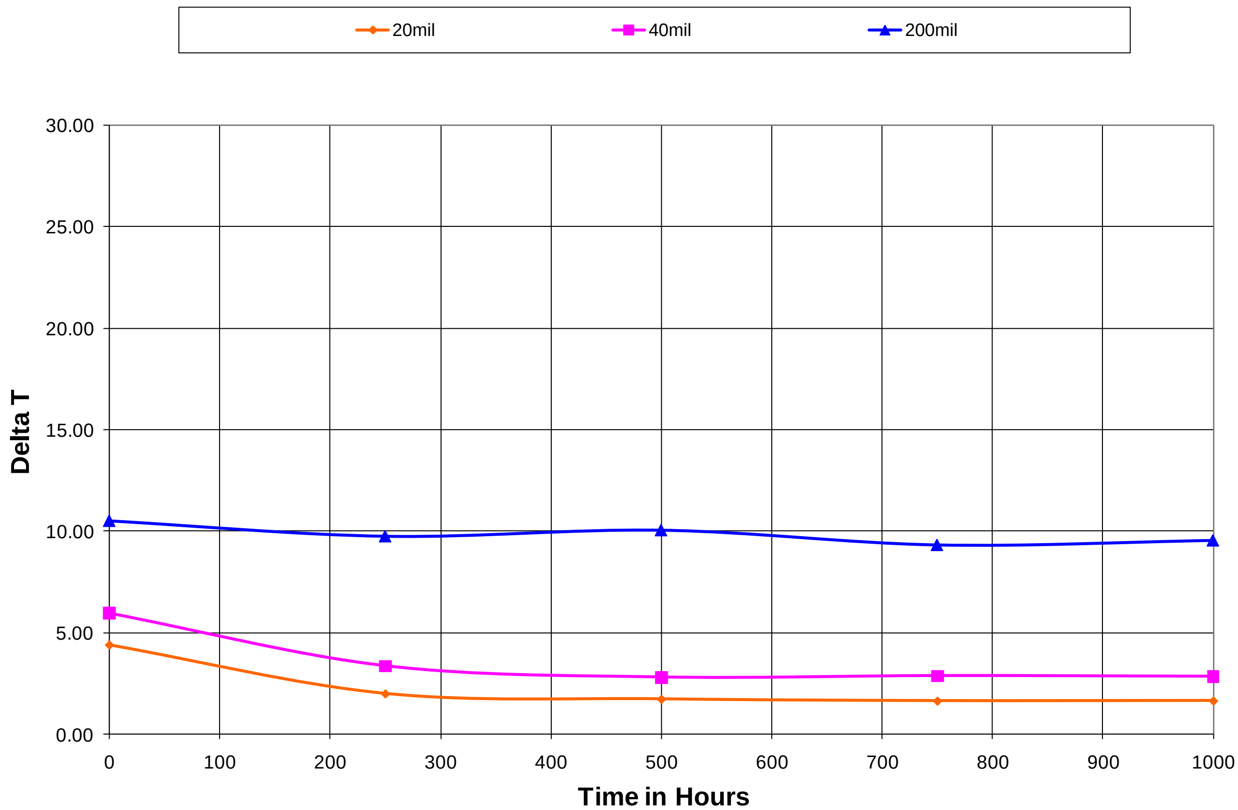
The change in temperature ($\Delta T$) vs. time / # of cycles tested is reported below:

## Thermal Shock



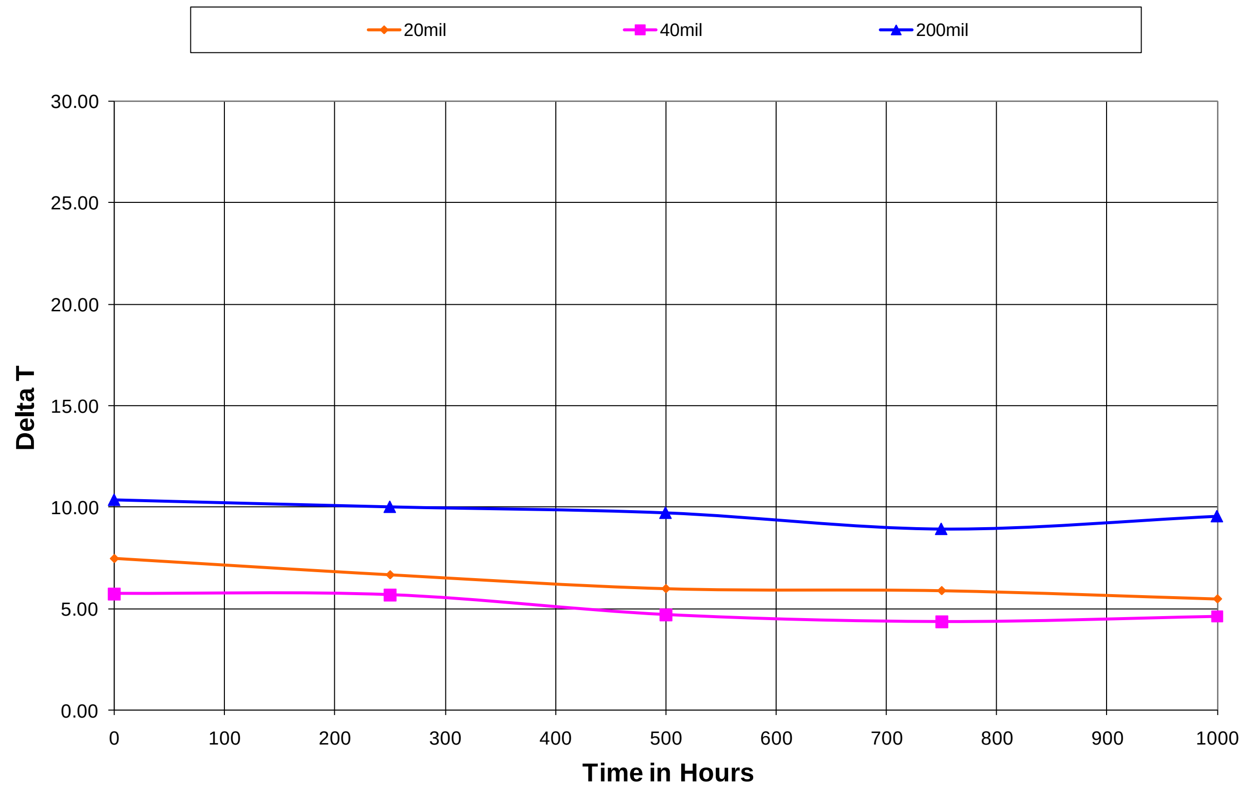

| Material | Cycles | Avg ΔT |
|---|---|---|
| Tflex SF820 | 0 | 7.34 |
| | 250 | 2.68 |
| | 500 | 2.62 |
| | 750 | 2.55 |
| | 1000 | 2.38 |
| | | |
| Tflex SF840 | 0 | 6.73 |
| | 250 | 4.34 |
| | 500 | 2.81 |
| | 750 | 2.67 |
| | 1000 | 2.72 |
| | | |
| Tflex SF8200 | 0 | 10.04 |
| | 250 | 10.18 |
| | 500 | 10.08 |
| | 750 | 9.72 |
| | 1000 | 10.09 |

# Isothermal Bake




| Material | Hours | Avg ΔT |
|---|---|---|
| Tflex SF820 | 0 | 4.40 |
| | 250 | 1.99 |
| | 500 | 1.72 |
| | 750 | 1.64 |
| | 1000 | 1.64 |
| | | |
| Tflex SF840 | 0 | 5.95 |
| | 250 | 3.34 |
| | 500 | 2.79 |
| | 750 | 2.86 |
| | 1000 | 2.82 |
| | | |
| Tflex SF8200 | 0 | 10.49 |
| | 250 | 9.72 |
| | 500 | 10.02 |
| | 750 | 9.30 |
| | 1000 | 9.52 |

# HAST




| Material | Hours | Avg ΔT |
|---|---|---|
| Tflex SF820 | 0 | 7.45 |
| | 250 | 6.65 |
| | 500 | 5.97 |
| | 750 | 5.87 |
| | 1000 | 5.47 |
| | | |
| Tflex SF840 | 0 | 5.73 |
| | 250 | 5.66 |
| | 500 | 4.69 |
| | 750 | 4.35 |
| | 1000 | 4.60 |
| | | |
| Tflex SF8200 | 0 | 10.35 |
| | 250 | 10.00 |
| | 500 | 9.71 |
| | 750 | 8.92 |
| | 1000 | 9.54 |

## Conclusion:

The graphs and data show that Tflex SF800 performed better (lower thermal resistance) at the end point for Thermal Shock, Isothermal Bake, and HAST testing than at Time $T_0$. In general, the decrease in ΔT primarily occurs between the $T_0$ point and the first data point after the exposure begins. Also, the decrease in ΔT is more pronounced for the thinner pads. Both of these observances are explained by the increased level of interfacial wetting that occurs when the Tflex SF800 is heated (which simulates application conditions). In the thinner pads, the interfacial resistance contributes a large percentage of the overall ΔT of the system. Therefore as interfacial resistance is decreased due to improved wetting, the ΔT is significantly reduced. In thicker pads, ΔT is dominated by the thermal conductivity of the gap pad.

Based upon this data, no thermal degradation was evidenced and therefore, it is shown that Tflex SF800 will continue to perform as designed in applications under harsh environmental conditions similar to those tested.

Karen Bruzda
Technology Leader: Gap Pads
5-9-12