Tflex CR350 Thermal Reliability

Purpose

This report summarizes the thermal reliability testing of Tflex CR350 utilizing reliability test fixtures designed to simulate the material in application. The reliability test conditions are designed to characterize the long-term performance of the thermal material by subjecting the material in the test fixtures to high isothermal conditions, repeated thermal shock conditions, and moderate heat and high humidity conditions. Specimens are placed within application-related fixtures under set conditions and at regular intervals the thermal properties of the specimens are measured.

Test Equipment

- Tflex CR350, 0.25 mm, 1.0 mm and 2.5 mm thickness
- Thermal Shock and Environmental Chambers
- Reliability Test Fixtures
- Power Supply with cartridge heaters
- Data acquisition system for temperature monitoring

Theory

Thermal resistance of the material is directly proportional to the temperature differential of the surface of the hot plate and the surface of the cold plate (approximating the sample surface temperatures at the substrate interface). The thermal resistance (R_{th}) can be represented as the temperature differential (ΔT) between the two surfaces for a given heat flow (ΔQ).

$$R_{th} = {}^{\Delta T}/_{\Delta Q}$$

For this procedure, actual thermal resistance is not required as the same sample with test fixture is $R_{th} = \Delta T/\Delta Q$ tested repeatedly. It is sufficient to record the temperature differential and compare the increase or decrease over time to the original performance prior to aging. Thus, the thermal resistance and thermal performance can be inferred from the temperature differential. In essence, an increase in ΔT over the reliability testing can be attributed to an increase in thermal resistance of the thermal interface material.

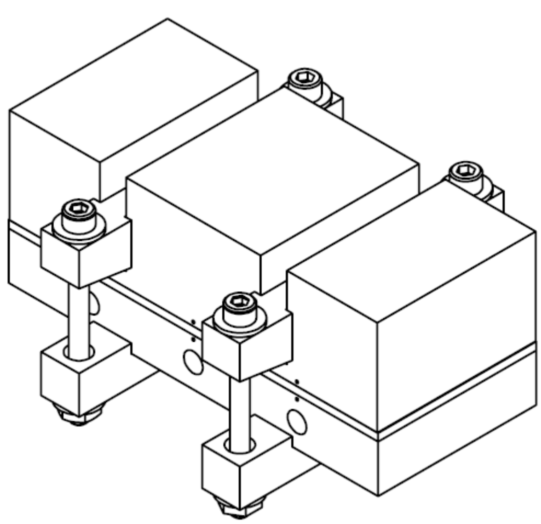
Test Procedure

Test Fixture and Sample Preparation

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 70^0C 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.

Each assembly, with sample, is tested at time zero and then placed into the conditioning chambers for the specified period of time or number of cycles. Every 250 hours the assemblies are removed, tested and then placed back into the chamber. Figure 1 shows the assembly effect of the test fixture.

Figure 1: Test Fixture



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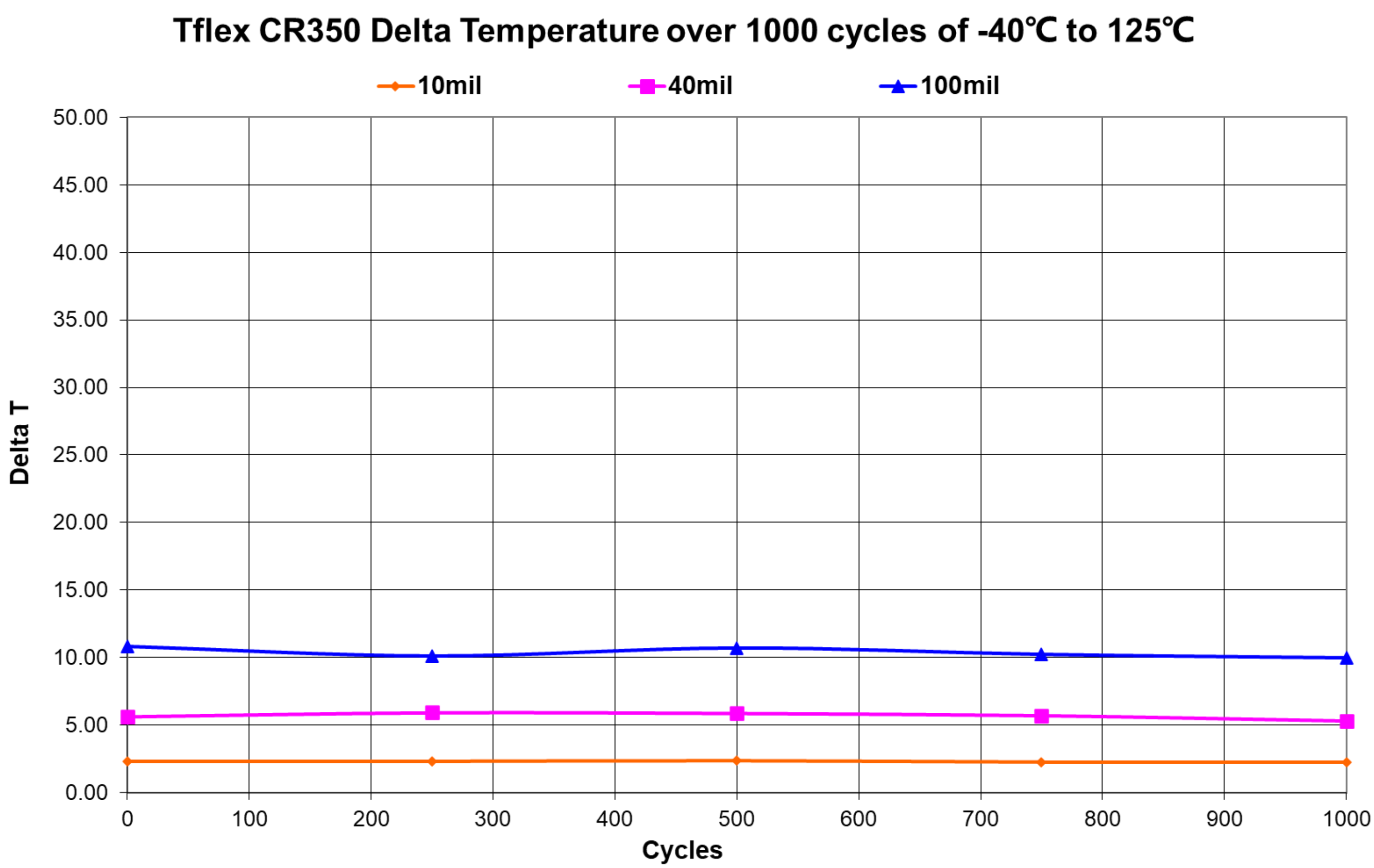
Test Conditions

- Thermal shock from -50 to 125°C (1 cycle is 30 minutes per condition, 10 second transfer)
- Isothermal bake @ 150°C
- HAST @ 85°C and 85% Relative Humidity

Results Thermal Shock

Thermal shock was performed for 1000 cycles from -50°C to 125°C. Each cycle is one hour, with the assembly spending thirty minutes at each condition. The sample transition time between the two temperature extremes is approximately 10 seconds. The thermal shock condition held the sample using 2 test fixtures. See Figure 2 for thermal shock results.

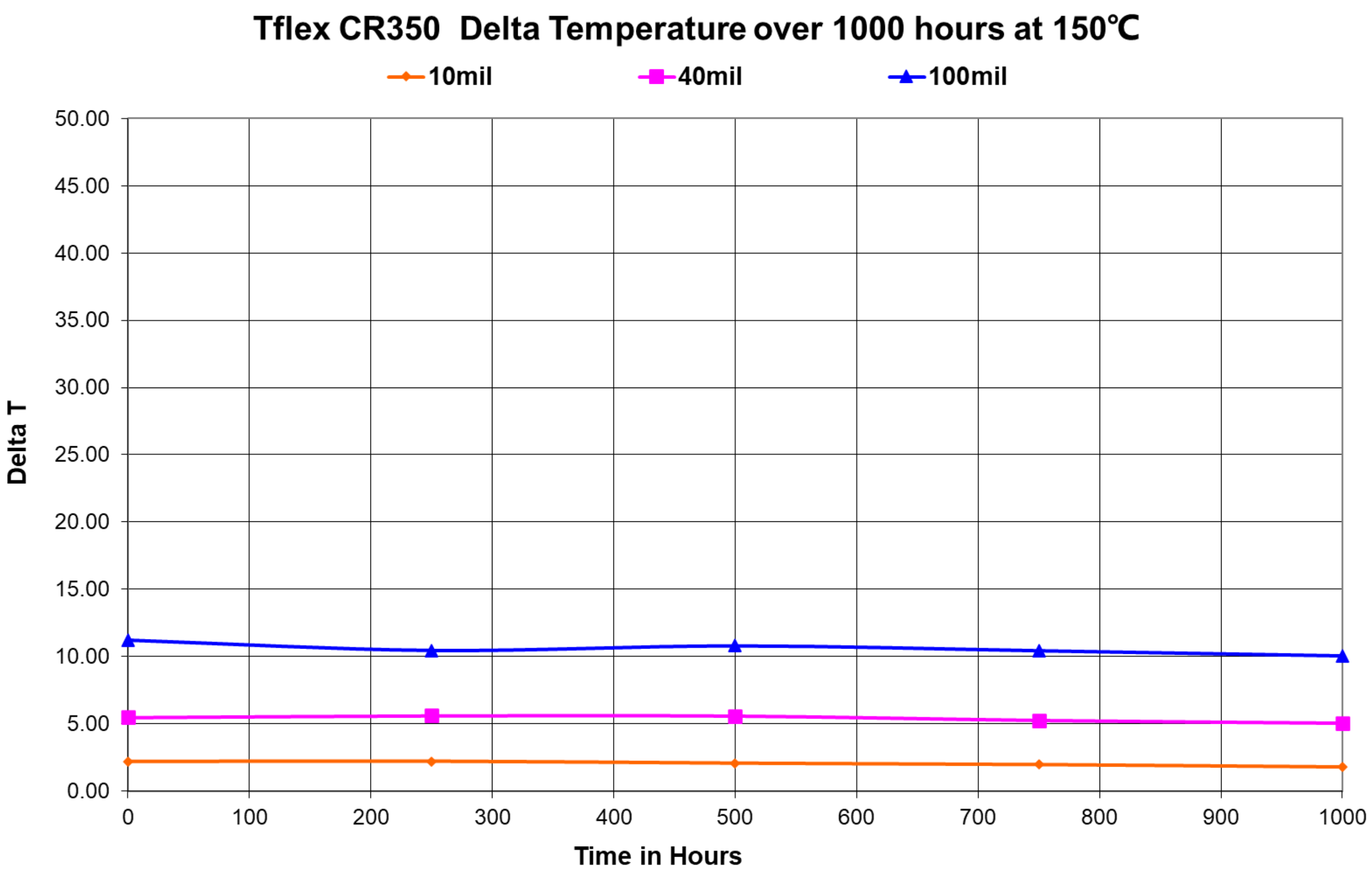
Figure 2: Thermal Shock Results – -50°C to 125°C



Isothermal Bake

Isothermal bake was performed for 1,000 hours at 150°C. The isothermal bake condition held the sample using 2 test fixtures. See Figure 3 for isothermal bake results.

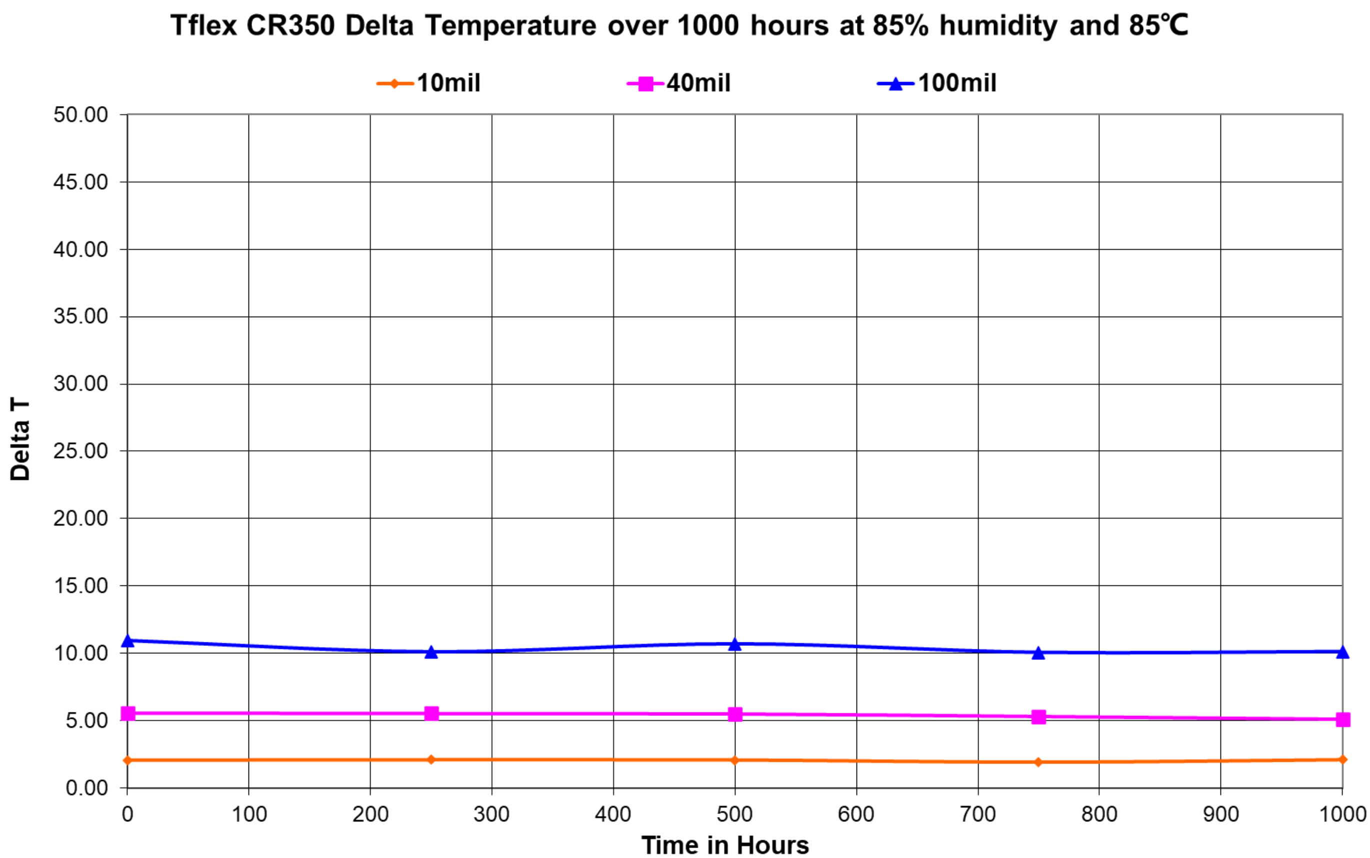
Figure 3: Isothermal Bake Results – 125°C



HAST

HAST exposure testing was performed for 1,000 hours at 85°C and 85% relative humidity. The HAST condition held the sample using 2 test fixtures. See Figure 5 HAST results.

Figure 5: HAST Results - 85°C/85% Relative Humidity



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Discussion

When analyzing the results to determine the thermal reliability of the material in the accelerated and stressed conditions, it is essential to observe the general long-term trend over the duration of the study. Variations from interval test point to interval test point will occur. Long term increase in temperature differential, or increase of thermal resistance, indicates a failing study and may indicate the poor thermal performance over stressed conditions. As the material may crack or degrade, less substrate contact may result which would lead to less heat transfer. Poor thermal performance from degradation was not observed.

The data from the testing completed demonstrates that Tflex CR350 continues to perform well at each condition; high temperature bake, thermal shock, and HAST exposure. Tflex CR350 passes all of the stressed conditions and can be considered a reliable thermal interface material that will continue to perform well under the most rigorous conditions.