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Tflex CR607 Thermal Reliability

This report summarizes the thermal reliability testing of Tflex CR607. This reliability test procedure is designed to characterize the long term performance of the dispensable thermal gap filler by subjecting the material in the test fixtures to isothermal conditions, repeated thermal shock conditions, and high heat and high humidity conditions. The test fixtures feature three isolated sample platforms with an area of 12mm x 14mm.

Test Equipment

- Tflex CR607 with a fixed gap of 1.6mm
- 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 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

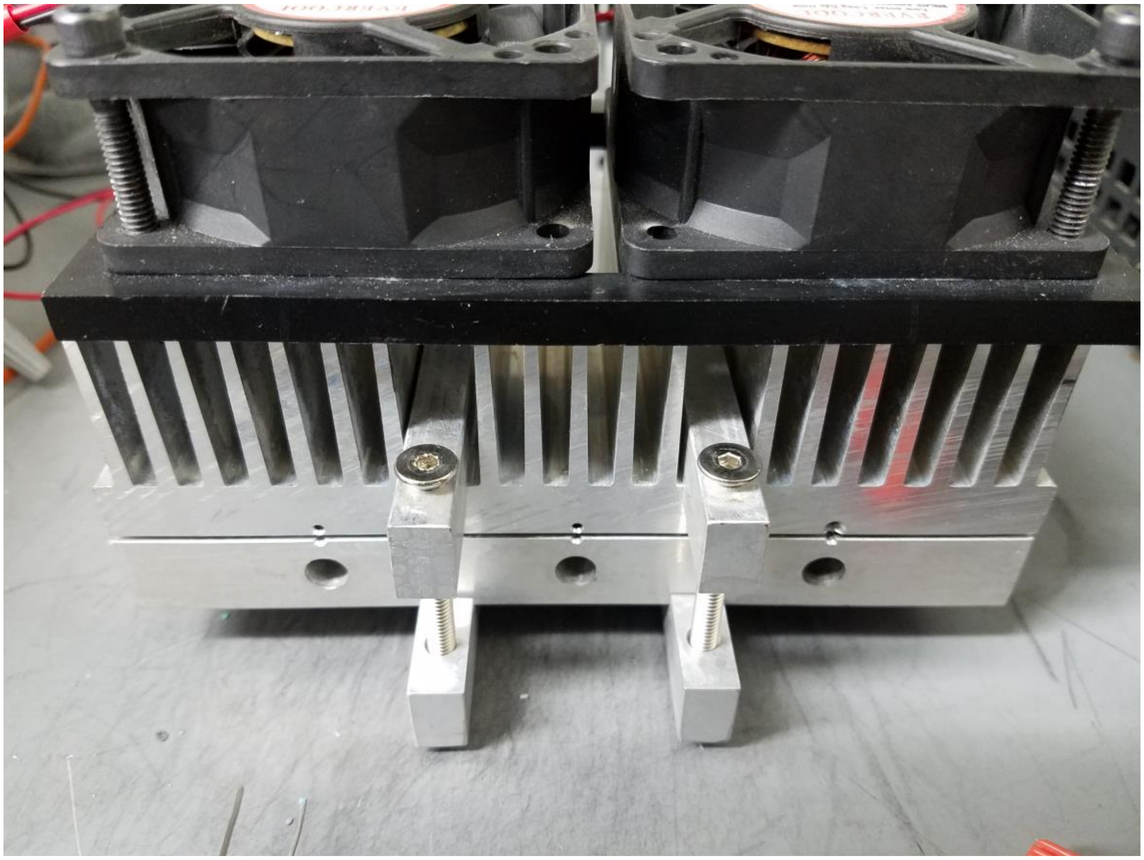
Test Fixture and Sample Preparation

The test fixture is a rectangular fixture with dimensions of approximately 2 inches x 5 inches, or 10 square inches. It consists of an aluminum hot plate and an extruded aluminum heat sink. The hot plate has three machined holes at even intervals for insertion of cartridge heaters. Both hot plate and heat sink have three precision machined holes for thermocouples. The thermocouples can be inserted in very close proximity to the surface of the plates and precisely in alignment for each set of “hot” and “cold” thermocouples. The sample is placed on the 12mmx14mm raised pedestals (0.1mm height) on the hot plate surface and the fixture is assembled by two brackets and 4 screws. Each test fixture accommodates 3 samples of 12mmx14mm. Final gap was set by using metal shims of appropriate height to achieve a sample gap of 1.6mm. During thermal testing of the exposed test fixture, a dual fan unit is placed on top of the aluminum heat sink and air flow is directed from the heat sink to the atmosphere. The thermal test is performed in an ambient laboratory environment. Once fully assembled, the cartridge heaters are connected to a power supply and power is applied to maintain a hot plate sample temperature of approximately 70°C across the hot plate surface. This is monitored by the data acquisition system. Steady state condition is achieved in approximately forty five minutes to one hour.

Each assembly, with sample, is tested at time zero and then placed into the conditioned chambers for the specified period of time. Generally, every 250 hours the assembly is removed, tested and then placed back into the chamber. Figure 1 shows a detail of the hot plate surface, providing a visual of the raised sample platform. See figure 2 for an image of the test fixture with dual fan in place for testing.

Figure 1: Test Fixture Hot Plate Sample Surface

Figure 2: Test Fixture Assembly with Fan



Results

Thermal Shock

Thermal shock was performed for 1000 cycles at two different conditions, -40°C to 85°C and -40°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. Two assemblies were used in each condition and assemblies were kept in horizontal orientation. See figures 3 and 4 thermal shock results.

Figure 3: Thermal Shock Results / -40°C to 85°C

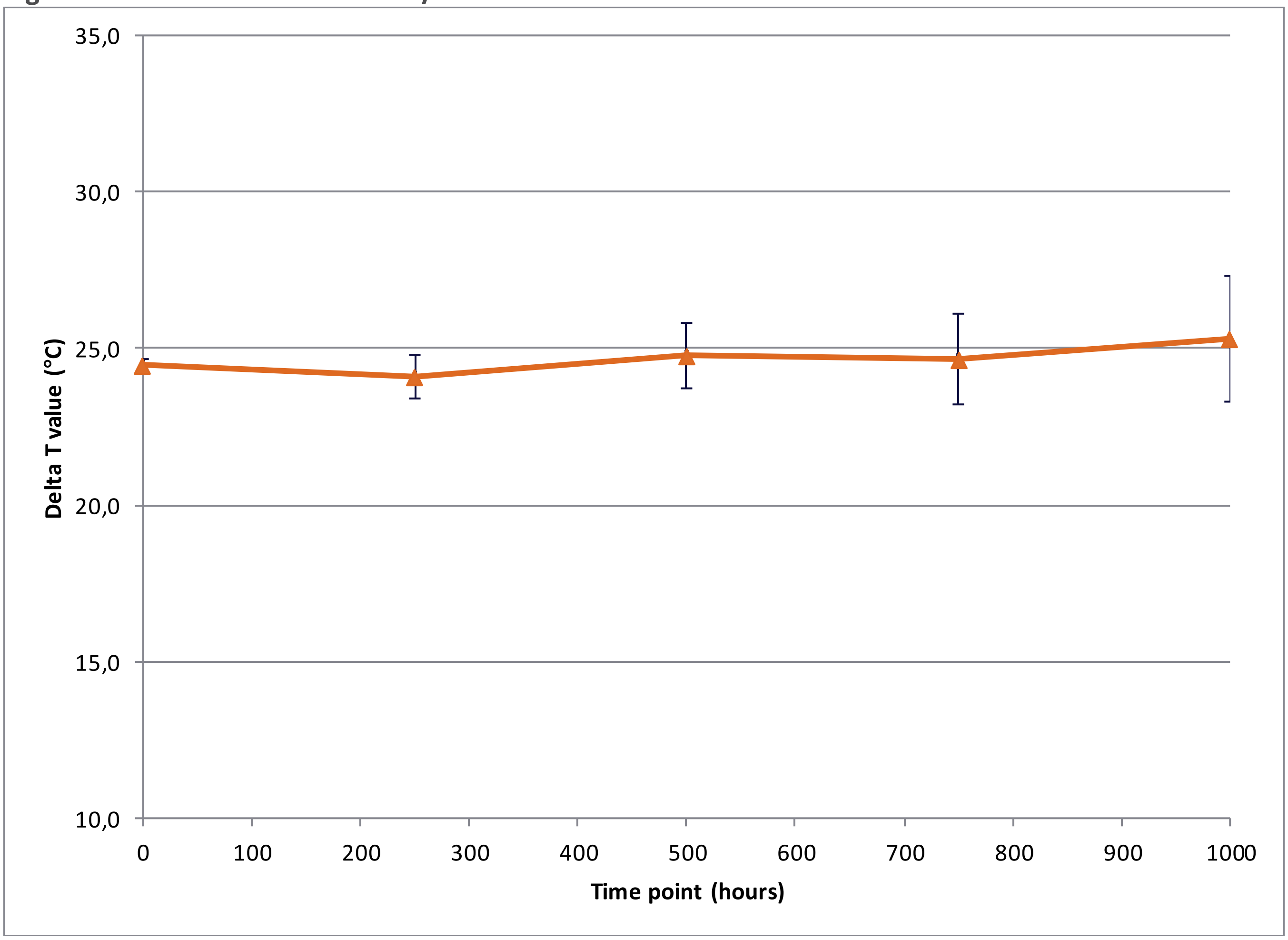
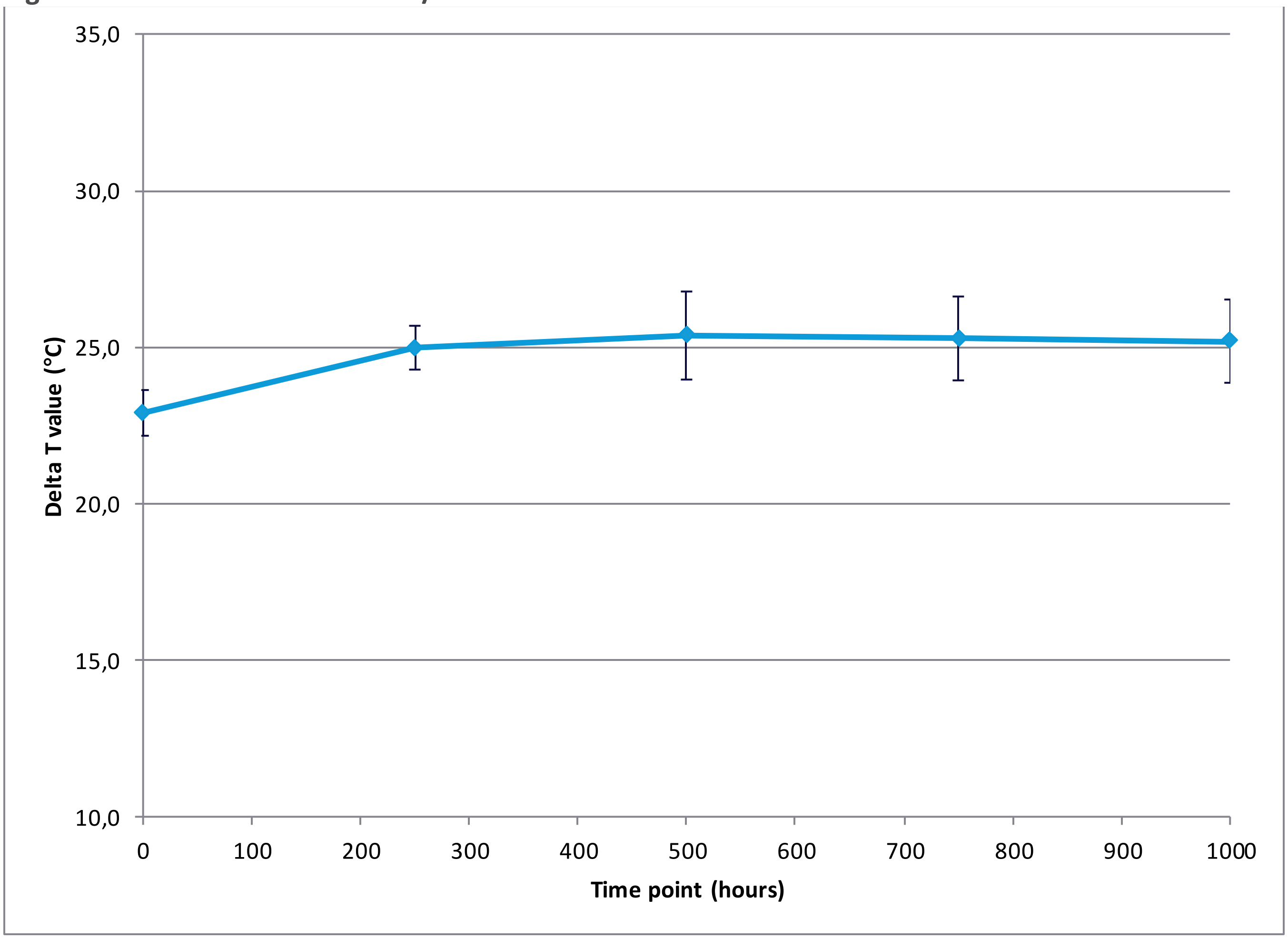


Figure 4: Thermal Shock Results / -40°C to 125°C



Isothermal Bake

Isothermal bake was performed for 1000 hours at 125°C and at 150°C. Two test fixtures were used in each condition and assemblies were kept in horizontal orientation. See figures 5 and 6 for isothermal bake results.

Figure 5: Isothermal Bake Results / +125°C

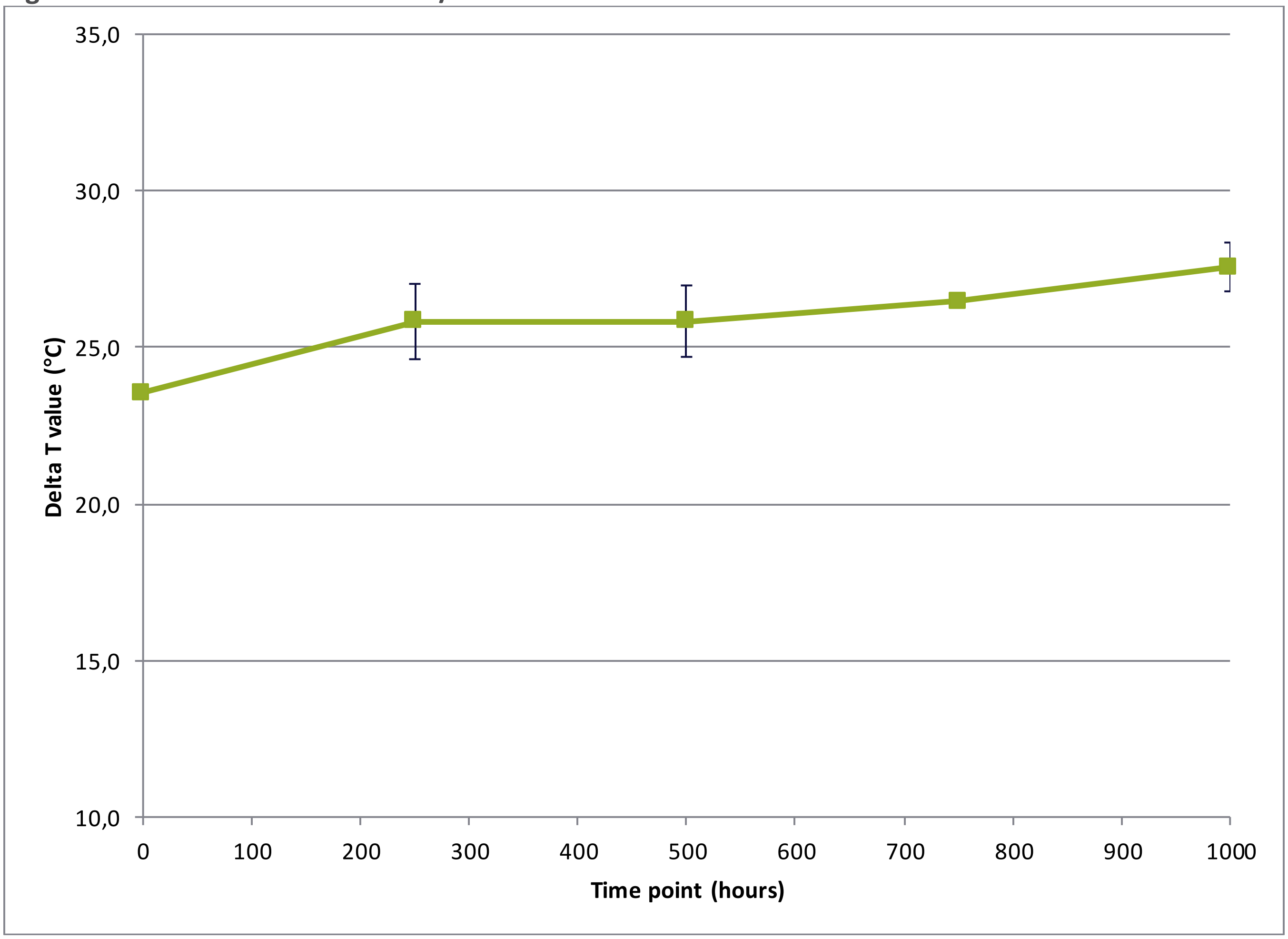
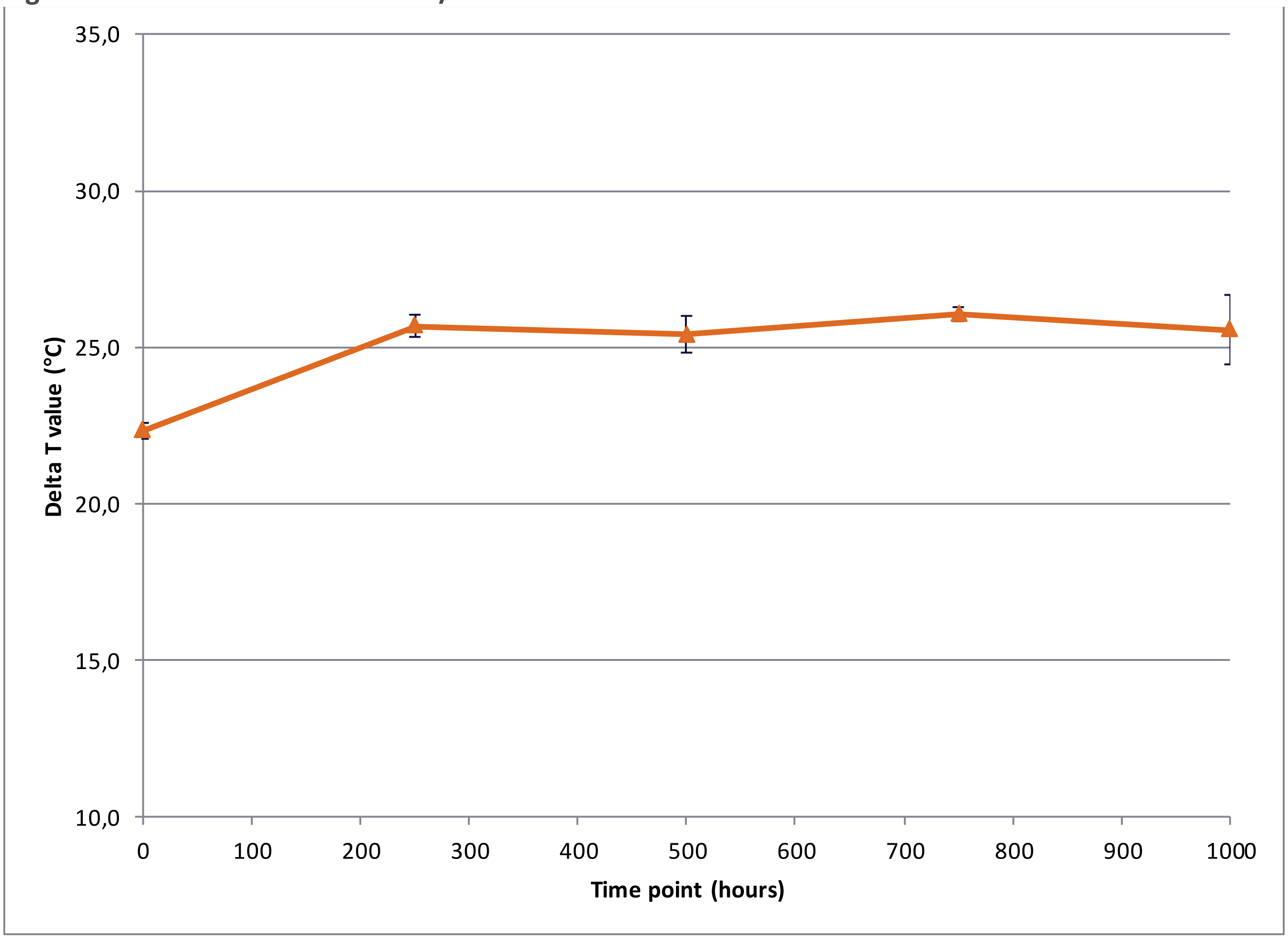


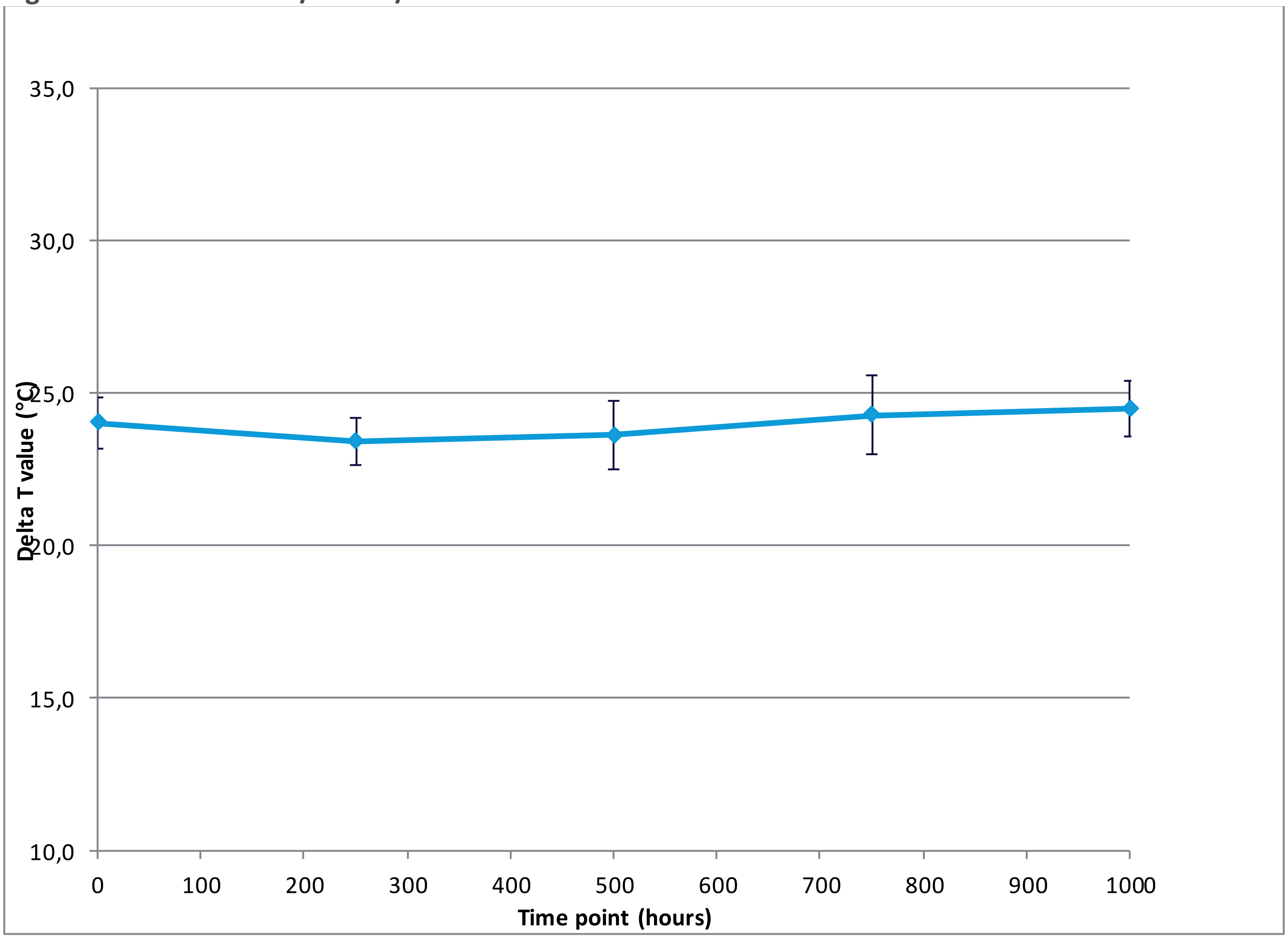
Figure 6: Isothermal Bake Results / +150°C



HAST

HAST was performed for 1000 hours at 85°C and 85% relative humidity. Two test fixtures were used in each condition and assemblies were kept in horizontal orientation. See figure 7 for HAST results.

Figure 7: HAST Results / +85°C/85%RH



Conclusion

In conclusion, Tflex CR607 showed little change in temperature differential (ΔT) in all aging conditions. The isothermal bake conditions showed approximately 10% increase in temperature differential. The trend in high heat and humidity was essentially flat. There was minimal increase in the more moderate thermal shock condition. The higher temperature thermal shock conditions showed more of an increase, similar to the high isothermal bake conditions. The change is generally less than 10% after 1,000 hours and meets the expectations of the industry. The results indicate that the material will be a reliable thermal interface material and will continue to perform well under rigorous conditions similar to those simulated in this report.