Application Note – Effect of Solder Reflow on Secure™ Adhesive

Overview:

Secure™ is a family of adhesive products developed for adhesion of dissimilar substrates. Secure™ are simple composites of silicone rubber, extending fillers, and functional additives supplied with or without a reinforcing substrate in rolls, sheets, pads, or die cuts. Secure™ adhesives may be used in electronic applications to bond printed circuit boards or electronic components to heat sinks and may be exposed to solder reflow processes during assembly manufacture.

In this application note Secure™ 1500FG is bonded between a fiberglass reinforced multilayer epoxy laminate and aluminum to simulated the bonding of an electronic printed circuit board to a heat sink. The assemblies are then subjected to solder reflow conditions by submerging them into a bath of molten solder at 288°C for 10 seconds. The high temperature of solder reflow and the mismatched coefficients of thermal expansion between the different substrates cause stress within the adhesive layer. The ability of Secure™ 1500FG to deal with this stress is determined as the difference in before and after values of adhesion strength, thermal impedance, and dielectric breakdown strength.

It is shown that Secure™ 1500FG had good resistance to two solder reflow cycles. No change was measured in the adhesion strength, thermal impedance, or dielectric breakdown strength.

Solder Reflow Cycle:

Samples were subjected to two concurrent 10 second solder reflow cycles at 288°C. This solder reflow cycle is called out in IPC-TM-650 2.4.8 to thermally stress the bond line for determining peel strength. The actual temperature at the bond line was determined by bonding a thermocouple between a 1.3 in. diameter fiberglass reinforced multilayer epoxy laminate disk and a 1.3 in. diameter T-6061 aluminum disk with 1.33 in^2 of Secure™ 1500FG 7 mil (Arlon part number 48A51R007) for 15 minutes at 120°C in a hydraulic platen press. The coupon was submerged in molten solder (40% lead / 60% tin) at 288°C for 10 seconds. Temperature recordings were taken every second for a total of 10 minutes. The cycle was then repeated. Only the first cycles is shown in Figure 1. Submerging the samples in the molten solder, rather than floating them on the surface, imparts the fastest heat

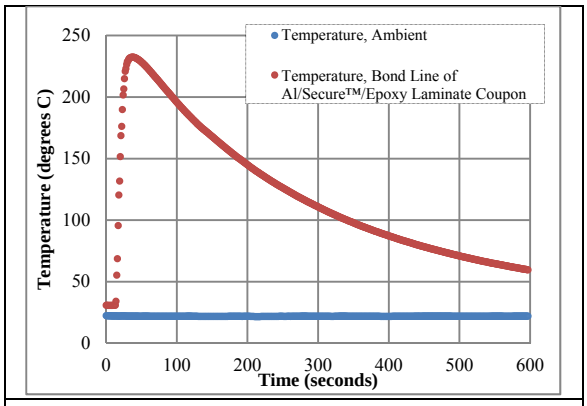

Figure 1 – Actual bond line temperature during solder reflow

rise possible and the greatest thermal shock. This method produced an initial temperature rise of 1,022°C per minute.

Adhesion Strength – lap shear strength per ASTM D1002 modified:

Single lap, FR4-to-aluminum, lap shear specimens were prepared by bonding one 1 in. x 6 in. x 0.062 in fiberglass reinforced multilayer epoxy laminate coupon to one 1 in. x 6 in. x 0.062 in. T-6061 aluminum coupon with 1 in^2 of Secure™ 1500FG 7 mil (Arlon part number 48A51R007) for 15 minutes at 120°C in a hydraulic platen press. One set of specimens were subjected to two concurrent 10 second solder reflow cycles in molten solder (40% lead / 60% tin) at 288°C. Specimens were allowed to cool to room temperature between solder reflow cycles. Specimens were tested to failure according to ASTM D1002 on a tensile testing machine equipped with a 1,000 lb load cell a crosshead speed of 0.085 inches per minute to determine their ultimate shear strength. Average shear strength normalized to the No Solder Reflow value is reported in Table 1.

Table 1 – Shear Strength

Condition	Average Shear Strength Normalized to No Solder Reflow Value
No solder reflow	1.00
Two solder reflow cycles	1.02

A 2-sample t-test on the shear strength data produces a p-value of 0.64 indicating that two solder reflow cycles has no effect on the shear strength of Secure™ 1500FG to FR4 and aluminum substrates.

Thermal Impedance – ASTM D5470 modified:

Thermal impedance specimens were prepared by bonding one 1.3 in. diameter fiberglass reinforced multilayer epoxy laminate disk to one 1.3 in. diameter T-6061 aluminum disk with 1.33 in^2 of Secure™ 1500FG 7 mil (Arlon part number 48A51R007) for 15 minutes at 120°C in a hydraulic platen press. One set of specimens were subjected to two concurrent 10 second solder reflow cycles in molten solder (40% lead / 60% tin) at 288°C. Specimens were allowed to cool to room temperature between solder reflow cycles. Specimens were tested according to ASTM D5470 at a pressure of 95 PSI to determine their thermal impedance. Average thermal impedance normalized to the No Solder Reflow value is reported in Table 2.

Table 2 – Thermal Impedance

Condition	Average Thermal Impedance Normalized to No Solder Reflow Value
No solder reflow	1.00
Two solder reflow cycles	1.02

- The thermal impedance is the sum of the thermal resistance of the FR4, aluminum, Secure™ 1500FG, and the interfacial contact resistances between the various layers and of the specimen to the fixture.

A 2-sample t-test on the thermal impedance data produces a p-value of 0.54 indicating that two solder reflow cycles has no effect on the thermal impedance of an assembly of FR4 / Secure™ 1500FG / Aluminum.

Dielectric Breakdown Strength – ASTM D149:

Dielectric breakdown strength specimens were prepared by bonding two 1.3 in. diameter aluminum disks with 4.0 in^2 of Secure™ 1500FG 7 mil (Arlon part number 48A51R007) for 15 minutes at 120^oC in a hydraulic platen press. One set of specimens were subjected to two concurrent 10 second solder reflow cycles in molten solder (40% lead / 60% tin) at 288^oC. Specimens were allowed to cool to room temperature between solder reflow cycles. Specimens were tested according to ASTM D149 with a 0.25 in. diameter electrode and an AC voltage ramp rate of 500 V/second to determine their dielectric breakdown strength. Average dielectric breakdown strength normalized to the No Solder Reflow value is reported in Table 3.

Table 3 – Dielectric Breakdown Strength

Condition	Average Dielectric Breakdown Strength Normalized to No Solder Reflow Value
No solder reflow	1.00
Two solder reflow cycles	1.04

A 2-sample t-test on the dielectric breakdown strength data produces a p-value of 0.25 indicating that two solder reflow cycles has no effect on the dielectric breakdown strength of Secure™ 1500FG bonded between two aluminum disks.

Conclusion:

The significance of differences in the adhesion strength, thermal impedance, and dielectric strength made before and after two solder reflow cycles was determined by testing the data sets with a 2-sample t-test. In all cases the calculated p-value is greater the chosen □-level (0.05). This condition indicates that the measured difference is insignificant or that the variable, over the range evaluated, has no effect.

Secure™ 1500FG has demonstrated good resistance to two solder reflow cycles. No change was measured in the adhesion strength, thermal impedance, or dielectric breakdown strength.