# *fast*Rise™ TC

## Bond-Ply for Indestructible Stacked Microvias

AGC
Your Dreams, Our Challenge

### Benefits

- Df = 0.0023 @ 10 GHz
- Passes 200 reflow cycles @ 35 – 260°C
- Low ~ 22ppm/°C expansion closely matched to copper and aluminum
- Low modulus, surface conformal layer to prevent pad cratering
- High 0.94 W/M*K thermal conductivity
- High flow and fill for sequential lamination and filling layers of heavy copper

### Applications

- Semiconductor Pin Routing (HDI)
- Power Amplifiers
- Aviation
- Space
- Military

*fast*Rise™ TC is a free standing, non-reinforced resin system designed with extremely low X, Y, Z thermal expansion. *fast*Rise™ TC is a higher DK, non-flame retarded build-up film and has a coefficient of thermal expansion from 16 ~ 22 ppm/°C over the temperature range from 30°C to 260°C. This build-up film is close to the thermal expansion rates of copper (18 ppm/°C) and aluminum (24 ppm/°C) to minimize any stress that occurs during temperature excursions caused by the mismatched expansion rates of the metal and the dielectric material. *fast*Rise™ TC was designed to meet the current and future needs of:

1. High density (HDI) laser formed interconnects
2. Applications requiring critical thermal reliability such as space and avionics
3. Applications in need of thermal conductivity to spread heat away from hot spots

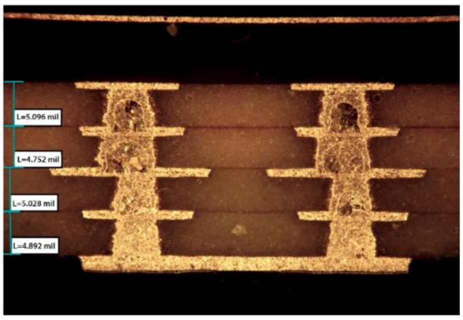
*fast*Rise™ TC has low dissipation values and is suitable for both high frequency microwave and digital electronics. To achieve high thermal stability, the following characteristics are important:

1. Low thermal expansion and contraction above and below $T_g$
2. A high $T_g$ (225°C) to minimize any accelerated expansion above $T_g$
3. Low modulus

Materials can have very low CTE values and be very brittle and prone to cracking with very little mismatched stresses. The ideal material has a low modulus, is conformable, and is capable of a limited amount of elongation and does not crack. *fast*Rise TC has been designed for low CTE, high Tg, and as low a modulus as possible and still retain other key properties.

Scan shows 4 stacks of microvias and the adjoining finely etched traces

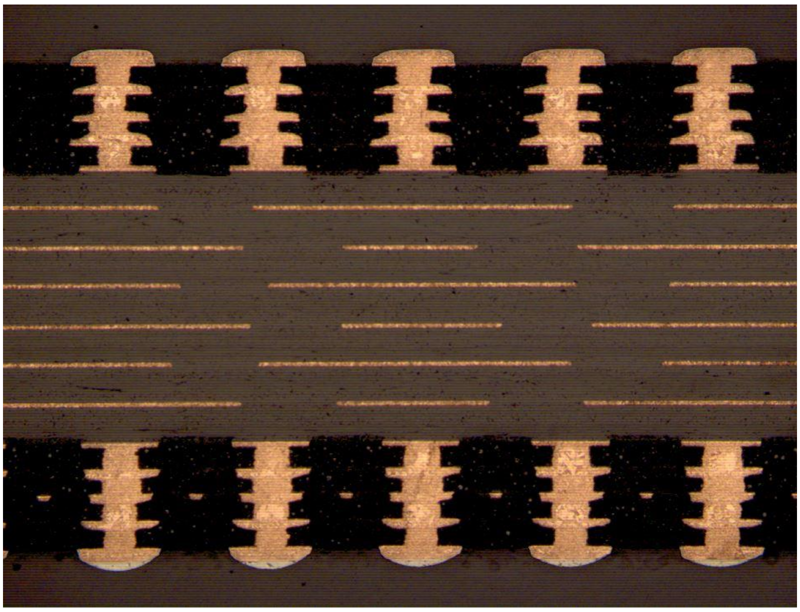
Scan shows consistent layer to layer thickness after each sequential lamination.



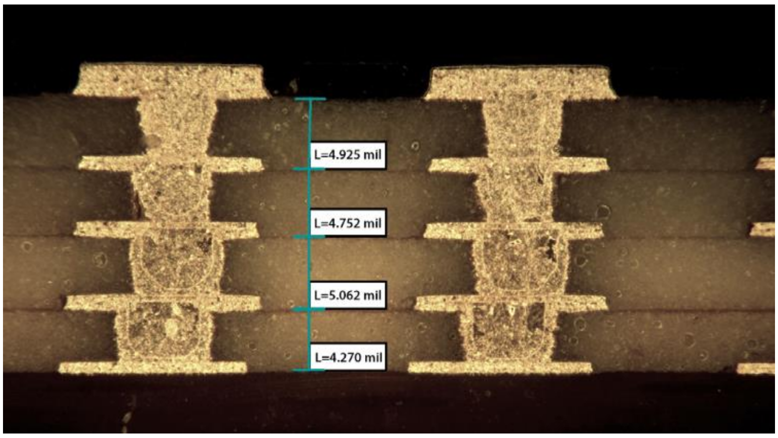
High Density Interconnects pose many material challenges. *fast*Rise TC addresses those challenges with the following features:

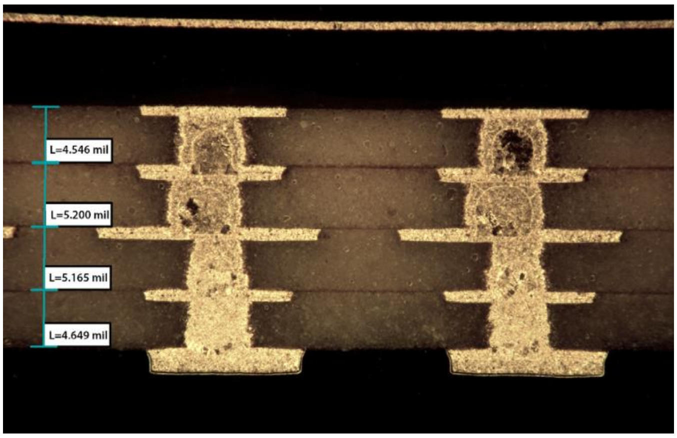
1. High flow and fill to encapsulate circuitry between sequential laminations to avoid any chemical infiltration.
2. Ideally enough flow with 1 ply of bonding material.
3. Sufficient copper adhesion to survive all PWB fabrication steps including planarization and routing.
4. Good lasability for via formation and a wide enough process window to account for varying thickness as a result of uneven copper distribution.
5. Temperature stability through many sequential laminations.

*fast*Rise TC acts as a leveling agent and will level off thickness variations in a subassembly. It is important that a subassembly be as flat as possible to achieve a uniform dielectric thickness of *fast*Rise TC during the first foil lamination. *fast*Rise TC is available in 1.2 to 2.5 mil in thickness, laser drills readily with a large process window and overcomes wide thickness variations from an underlying subassembly. It is a debated topic in the industry whether passing 6x reflow is a good enough indicator of thermal reliability of stacked vias. *fast*Rise TC passes 200 cycles 35 – 260° C of reflow with layers of 4 stacked microvias.



*fast*Rise$^{TM}$ TC D-coupon top to bottom



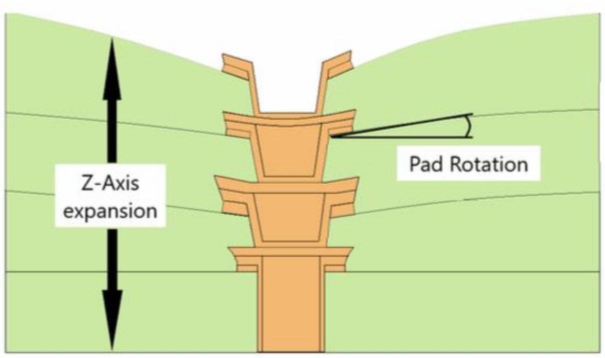



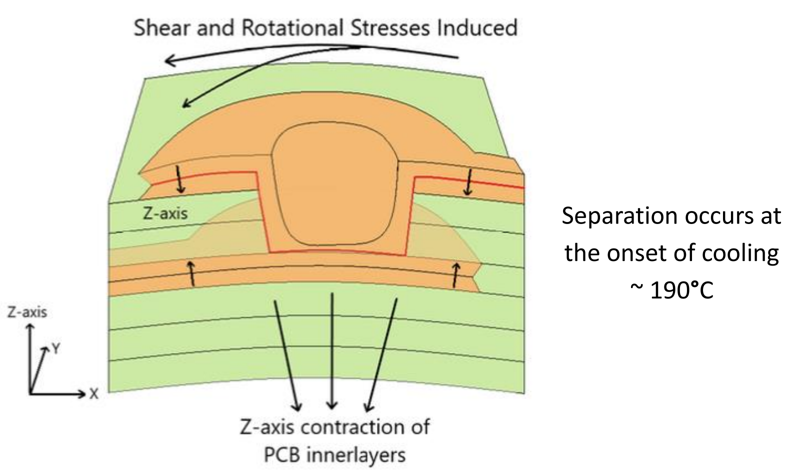

These two graphs show the respective dielectric thicknesses layer to layer when looking at the top and bottom of the FR4 subassembly.

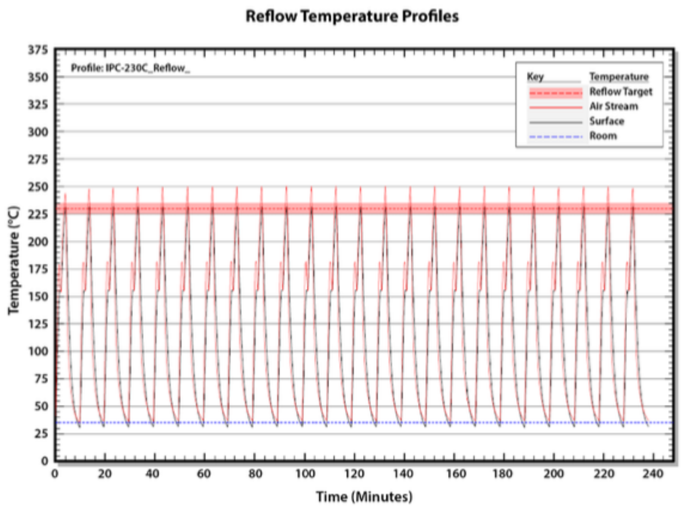
| Properties | Conditions | Typical Value | Unit | Test Method |
|---|---|---|---|---|
| **Electrical Properties** | | | | |
| Available Thickness | | 1.2 / 2.5 | mil | |
| Dielectric Constant | @ 10 GHz | 4.8 | | IPC-650 2.5.5.5.1 (modified) |
| Dissipation Factor | @ 10 GHz | 0.0023 | | IPC-650 2.5.5.5.1 (modified) |
| Volume Resistivity | After elevated humidy | 7.4 x $10^8$ | Mohm/cm | IPC-650 2.5.17.1E |
| Surface Resistivity | After elevated humidy | 1.8 x $10^8$ | Mohm | IPC-650 2.5.17.1E |
| **Thermal Properties** | | | | |
| Thermal Conductivity | | 0.94 | W/M*K | IPC-TM 650 2.4.50 |
| CTE (RT to 260°C) | X | 22 | ppm/°C | IPC-650 2.4.41/TMA |
| | Y | 22 | ppm/°C | |
| | Z | 22 | ppm/°C | |
| $T_d$ | 2% wt. loss | 357 (675) | °C (°F) | IPC-650 2.4.24.6/TGA |
| | 5% wt. loss | 402 (756) | °C (°F) | |
| $T_g$ | | 225 (437) | °C (°F) | IPC-650 2.4.41/TMA |
| **Mechanical Properties** | | | | |
| Peel Strength | After solder float | 0.61 (3.5) | N/mm (lbs/in) | IPC-TM 650 2.4.9E |
| Dielectric Strength | | 31.8 (808) | Kv/mm (V/mil) | ASTM D 149 |
| Tensile Strength | MD | 11 (1,595) | N/mm$^2$ (psi) | IPC-TM 650 2.4.18.3 |
| | CD | 11 (1,595) | N/mm$^2$ (psi) | |
| Young's Modulus | MD | 738 (107) | N/mm$^2$ (kpsi) | IPC-TM 650 2.4.18.3 |
| | CD | 814 (118) | N/mm$^2$ (kpsi) | |
| Elongation at Break | MD | 9.7 | % | IPC-TM 650 2.4.18.3 |
| | CD | 12 | % | |
| **Chemical / Physical Properties** | | | | |
| Moisture Absorption | | 0.07 | % | IPC-TM 650-2.6.2.1 |
| Dielectric Breakdown | @ 20 MIL | 18.3 | Kv | ASTM D 149 |
| Density | Specific Gravity | 2.22 | g/cm$^3$ | IPC-TM TM-650 2.3.5 |

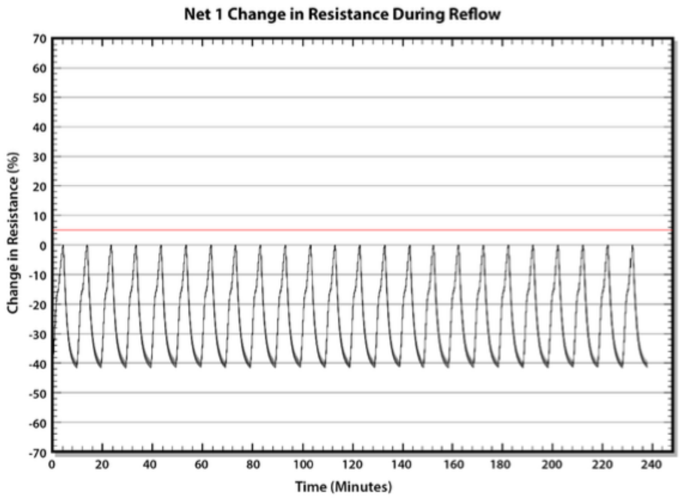
* All test data provided are typical values and not intended to be specification values. For review of critical specification tolerances, please contact a company representative directly.

***Example part number: FR-TC-31 - 18" x 24" (457 mm x 610 mm)***






24 D-coupons passed 24 cycles 35 - 260 °C. The 24 coupons were divided: 8 coupons were solder floated at 270 °C, 8 coupons at 280 °C, and 8 coupons at 288 °C. The 24 D-coupons were then thermocycled another 24 times at an outside laboratory. All 24 coupons passed 48 cycles 35 - 260 °C with all of them being solder floated from 270 - 288 °C. Separately, an experiment was done thermocycling other coupons to 260 °C. The coupons passed 200 cycles 35 - 260 °C.

## Reflow Statistics

| Coupon Number | Nominal Resistance at Room Temperature (ohms) | | Reference Resistance at 230C (ohms) | | Cycles to 5% Change | | Change after 24 Cycles (%) | |
|---|---|---|---|---|---|---|---|---|
| | Net 1 - Lot #1 | Net 1 - Lot #2 | Net 1 - Lot #1 | Net 1 - Lot #2 | Net 1 - Lot #1 | Net 1 - Lot #2 | Net 1 - Lot #1 | Net 1 - Lot #2 |
| 1 | 0.981 | 0.943 | 1.621 | 1.581 | >24 | >24 | -0.1 | -0.4 |
| 2 | 0.952 | 0.987 | 1.599 | 1.693 | >24 | >24 | 0.0 | -0.3 |
| 3 | 0.916 | 0.983 | 1.554 | 1.671 | >24 | >24 | -0.0 | 0.2 |
| 4 | 0.893 | 0.972 | 1.509 | 1.655 | >24 | >24 | -0.1 | 0.0 |
| 5 | 0.908 | 0.978 | 1.538 | 1.671 | >24 | >24 | 0.2 | 0.1 |
| 6 | 0.910 | 0.959 | 1.530 | 1.615 | >24 | >24 | 0.1 | -0.0 |
| 7 | 0.899 | 0.936 | 1.511 | 1.561 | >24 | >24 | 0.1 | -0.1 |
| 8 | 0.911 | 0.995 | 1.560 | 1.685 | >24 | >24 | -0.1 | -0.2 |
| 9 | 0.942 | 0.940 | 1.601 | 1.601 | >24 | >24 | -0.1 | -0.2 |
| 10 | 0.913 | 0.961 | 1.571 | 1.635 | >24 | >24 | -0.1 | -0.2 |
| 11 | 0.911 | 0.927 | 1.587 | 1.569 | >24 | >24 | -0.1 | -0.1 |
| 12 | 0.891 | 0.949 | 1.542 | 1.593 | >24 | >24 | -0.2 | -0.2 |
| 13 | 0.895 | 0.920 | 1.538 | 1.565 | >24 | >24 | -0.2 | -0.2 |
| 14 | 0.911 | 0.936 | 1.581 | 1.614 | >24 | >24 | -0.3 | -0.2 |
| 15 | 0.883 | 0.965 | 1.518 | 1.661 | >24 | >24 | 0.0 | -0.2 |
| 16 | 0.910 | 0.918 | 1.567 | 1.588 | >24 | >24 | -0.1 | -0.4 |
| 17 | 0.887 | 0.903 | 1.532 | 1.564 | >24 | >24 | -0.0 | -0.2 |
| 18 | 0.904 | 0.909 | 1.551 | 1.554 | >24 | >24 | -0.1 | -0.4 |
| 19 | 0.908 | 0.934 | 1.545 | 1.598 | >24 | >24 | -0.1 | -0.2 |
| 20 | 0.905 | 0.922 | 1.546 | 1.592 | >24 | >24 | 0.1 | -0.1 |
| 21 | 0.899 | 0.925 | 1.531 | 1.598 | >24 | >24 | -0.1 | -0.1 |
| 22 | 0.901 | 0.888 | 1.523 | 1.528 | >24 | >24 | -0.0 | -0.1 |
| 23 | 0.899 | 0.939 | 1.523 | 1.617 | >24 | >24 | 0.1 | -0.1 |
| 24 | 0.896 | 0.975 | 1.487 | 1.687 | >24 | >24 | 0.1 | 0.1 |