*fast*Rise™ TC

Processing Guide

December 2024

Disclaimer:

This process guide is provided to users to assist in gaining an understanding of these materials and to quickly establish processes for PCB fabrication. It is assumed that the users will have a technical understanding and experience in the processes, equipment and standards related to PCB fabrication. The user will likely need to make adjustments to account for specific requirements and their production processes.

The following process recommendations are based on testing and production processes at several circuit board facilities. Each facility will have different product designs, equipment, or methods that will require modifications to these recommendations. For example, drilling parameters, routing parameters, and artwork compensation can vary dependent on circuit board thickness, design, processes, and equipment.

Adjustments should be based on the experience of each facility. Please contact your AGC representative if assistance is required.

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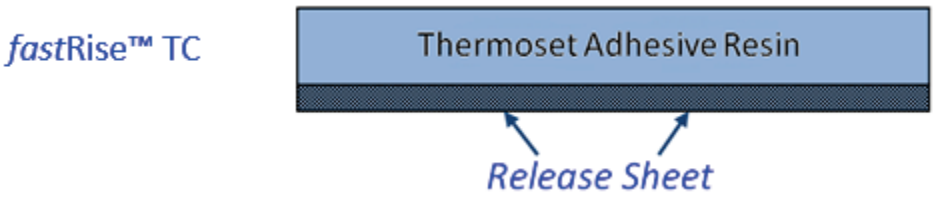
GENERAL INFORMATION

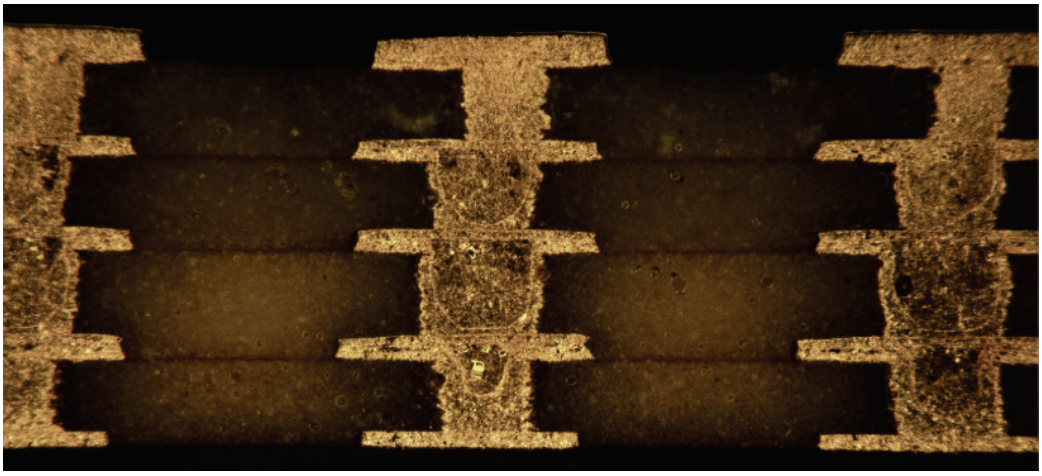
*fast*Rise™ TC

*fast*Rise™ TC prepreg is a variation on the basic *fast*Rise™ thermoset resin system designed to achieve both high thermal conductivity and thin dielectric spacing. These thin dielectrics are accomplished in part by removing the supporting PTFE film. Removing the PTFE eliminates some processing challenges for the PCB fabricator and improves compatibility with other laminate systems. Additionally, the thin, pure resin layer is well suited to HDI build-up designs with multiple layers of laser drilled microvias. *fast*Rise™ TC has a distinct advantage in this case owing to its coefficient of thermal expansion (CTE) being closely matched to copper. This, combined with its low elastic modulus, minimizes the stresses on the microvia connections during thermal cycling of the PCB.

*fast*Rise™ TC is available in both 1.2 mil and 2.5 mil thicknesses. Multiple plys can be used to achieve the desired finished thickness. The copper weight and circuit design on the adjacent layers will influence how much resin is needed. When calculating final pressed thicknesses to do an impedance calculation, please consult your technical service or technical sales manager for an approximate signal to ground distance.

*fast*Rise™ TC is delivered as a b-staged pure resin cast onto a release sheet. Layup procedures should specify that the release sheet must be removed as each layer of bondply is added.





HDI build-up design using 4 layers of FastRise TC prepreg

STORAGE

Store the material in a cool dry area away from direct sunlight and high humidity, avoiding material contamination. *fast*Rise™ TC is certified to meet all requirements as agreed upon between the user and supplier for a given shelf life as defined by the storage conditions below.

Storage Conditions

Condition 1 (i.e. refrigeration): <4.5°C (40°F)

Condition 2 (i.e. room temp): <23°C (73°F), Relative Humidity <50%

When removing *fast*Rise™ TC prepreg from refrigeration, it should be allowed to acclimate to room temperature in the sealed bag. This will reduce the chance of moisture condensation on the prepreg and will also provide a more consistent start temperature for the lamination process. Bags should be resealed when not in use.

Shelf Life

For *fast*Rise™ TC, If material is stored under Condition 1 above, a shelf life of 180 days after receipt of shipment will apply. If material is stored under Condition 2 above, a shelf life of 90 days after receipt of shipment will apply. AGC will not ship *fast*Rise™ TC material with less than 90 days of remaining shelf life. Packaging will default to indicate shelf life based on storage Condition 2 unless end user notifies AGC that Condition 1 applies. In the event that the prepreg expires, please contact your AGC technical representative for assistance to coordinate re-testing the expired prepreg.

HANDLING

*fast*Rise™ TC resin is cast onto a release sheet and packaged with a slip sheet between each piece. The release sheet should remain in place until just prior to layup. To avoid damaging the resin during removal, best practice is to attach a piece of tape to both the release sheet and the resin, then pull apart. The resin can withstand some flexing and folding without cracking, though to minimize any potential cracking it is advised to handle by at least 2 edges at all times. The surface of *fast*Rise™ TC may be tacky, especially for freshly manufactured material. Although it is recommended to allow refrigerated prepregs to acclimate prior to opening a sealed bag, in some cases it may be advantageous to use the prepreg while it is cool* which will reduce the tackiness of the material and make handling easier. This recommendation is especially important when laying up two plies of prepreg on top of each other, as excessive tackiness can make it difficult to keep both pieces of material flat.

**do not allow condensation to form on the prepreg*

INNER LAYER PREPARATION

Laminate Preparation

*fast*Rise™ TC will bond well to most other materials. Inner-layers should be clean and dry before bonding. Oxide treatments of copper surfaces are recommended. As long as the uncured prepreg hasn't been exposed to moisture or high humidity, vacuum desiccating of the material is not required.

Flow Patterns / Thieving

Solid copper borders, 0.5-1.0" wide, are recommended and have been observed to allow the use of much higher lamination pressures without any negative effects or squeeze out. See Lamination section for more information. For thieving, retaining as much copper in between parts is preferred. Interlocking patterns such as offset diamonds, honeycombs, or other patterns which inhibit resin flow channels are ideal. Interlocking "star burst" flow patterns or other patterns which may promote resin flow channel formation should be avoided.

BAKING

As a general recommendation, *fast*Rise™ TC should be baked after exposure to moisture for 3 hours at 80°C (175°F). This can be substituted with a 1 hour bake at 120°C (250°F). For simplicity in this processing guide, all bake steps will refer to the 120°C process even though they are both acceptable. *The only heating of the bondply that should occur in its uncured state is a hot roll lamination (if required), do not bake the raw uncured sheets.*

LAMINATION

Excessive resin flow should be avoided as it can cause flow channels or other undesirable conditions.

Quick Start

	***fast*Rise TC**	***fast*Rise TC High Temp**
Cure Temp / Time (measured at bondline)	120 minutes at 215°C (420°F)	120 minutes at 230°C (450°F)
Pressure	400 – 500 psi (see Pressure section page 7 for details)	
Heating Rate	2 – 3°C/min (3 – 5°F/min)	
Temperature Hold	30 – 40 minutes at 260°F recommended	
Critical Range	80°C – 150°C (175°F – 300°F)	
Cooling Rate	Less than 3°C/min (6°F/min)	
Breakdown	Breakdown or transfer to cold press when bondline is below 90°C (200°F)	
Vacuum	Full vacuum is recommended through entire cycle	
Vacuum Delay	Hold vacuum 10-20 minutes before applying heat or pressure	

Padding and Conformance Materials

Typical padding and conformance materials used for rigid, rigid-flex, or flexible circuit manufacturing can be used (pending temperature ratings of the materials).

Press padding (outside separator plates) is recommended. Use of conformance materials such as AGC's TacPad, PTFE skive film, clutch lamination, or others are often helpful to balance pressure variations induced from circuits. **Clutch laminations are recommended for foil lamination applications and when bonding plated up copper layers to achieve consistent dielectric thicknesses.**

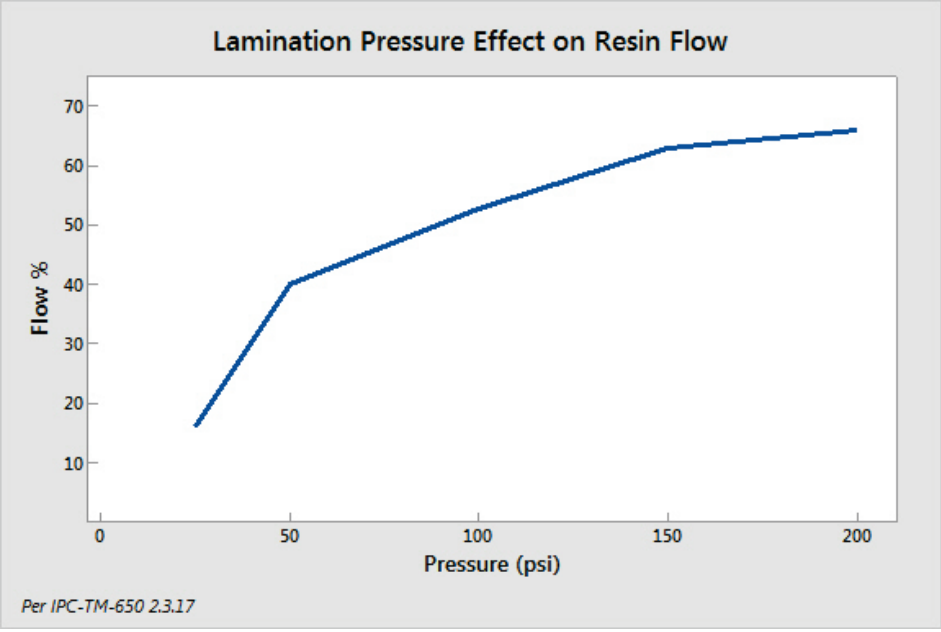
Pressure

Excessive pressure (500 psi +) should be avoided; it can distort circuit patterns, induce resin/filler separation, create flow channels, and impact phase shift in signals.

Full pressure should be achieved before the *fast*Rise™ TC reaches 80°C (175°F). *fast*Rise™ resin flow has been shown to be directly proportional to lamination pressure and higher pressures can increase resin flow when required.

HDI build-up designs and any foil lamination should be pressed at high pressure – 400-500 psi – to ensure good fill of the circuitry and uniform dielectric thickness. Other designs using fastRise TC will be able to achieve good results using lower pressures. Standard cap-core constructions with ½ oz or 1 oz copper should use a starting point of 200psi. Features such as cavities may necessitate a reduction in pressure down to 100psi.

Due to the absence of PTFE film in *fast*Rise™ TC, this product is especially prone to high flow rates at higher pressures. AGC has observed that a solid copper border around the inner layers, combined with the appropriate flow pattern, can prevent squeeze out and allow the application of pressures from 100 psi to as high as 500 psi. **Due to this observation AGC highly recommends a solid copper border for all inner layer artwork to achieve higher lamination pressures.** Approximate % flow vs. pressure for typical unsupported *fast*Rise™ resin products are charted below (per IPC standard flow test procedures).



Temperature

Resin Flow Window / Critical Range

*fast*Rise™ resins gel and flow between 80°C - 150°C (175°F – 300°F) and reaches their lowest viscosity between 100°C – 125°C (212°F – 260°F).

Heating Rate

A cold start of the press is desirable. Typical *fast*Rise™ heating rates are 2°C/min – 3°C/min (3°F/min – 5°F/min). In difficult to fill applications such as heavy copper or high layer count boards, a slow heating rate should be used (2°F/min – 3°F/min). It is also recommended that low heating rates be used if the process is to accommodate tight registration requirements or high layer counts. Past studies have shown that lower heating rates (i.e. <3°F/min) can provide substantial improvements in registration repeatability.

Curing

*fast*Rise™ TC resins cure at the same temperature as standard *fast*Rise™ but benefit from a longer time at temperature. It is recommended to hold the bondline at 230°C (450°F) for a minimum of 2 hours. If the conformance materials and laminates can handle higher temperatures, AGC has seen improved adhesion results with a cure temperature of 220°C (430°F) for 2 hours.

Cooling

A slow cool (<6°F/min) is necessary to avoid any issues associated with delamination. The hot press should be cooled below 90°C (200°F) before transferring to a cold press. In situations where mismatched CTE's may induce delamination or where warping may be an issue, slower cooling rates (<3°F/min) may provide better results.

Additional Notes

Multiple Ply Constructions

Resin flow can increase when multiple plies of *fast*Rise™ TC are used against each other. If higher-flow is not desired, pressure should be reduced to prevent excess resin flow, resin separation, or formation of flow channels.

Foil Lamination

Foil laminations may be achieved with *fast*Rise™ TC part numbers provided squeeze out and flow are minimized with the use of a solid copper border. In this case, the highest recommended pressures of 500psi may be advantageous to prevent pooling of resin in the center of the panel. Proper conformance materials are critical. Contact an AGC Technical Representative for process and design considerations that must be considered before using *fast*Rise™ TC in a foil lamination construction.

DRILLING

In most cases, the laminate cores will dictate drilling parameters. The following information is provided as a general suggested starting point where fastRise TC is combined with typical low-loss PTFE-based laminates.

Quick Start

	Imperial units	SI units
Entry Material	Phenolic (0.010" – 0.024")	Phenolic (0.25mm - 0.6mm)
Backer Material	Rigid Phenolic, Slickback, or comparable	
Cutting Speed (surface speed)	100 SFM	30.5 MPM
Chip Load	0.0010 in.	25.4 µm
Dwell	0-1000 ms (increase dwell time as speed and chip load deviate from above recommendations)	

Drill Bits

Sharp drill bits are critical to any PTFE drilling; new drill bits should always be used. Undercut drill bits are recommended, but past studies have shown that some drill bit brands may obtain better results using their standard drill bits.

Chip Load

A chip load of 1.0 mil (25.4 µm) is common with *fast*Rise™ combined with AGC's PTFE-based laminates. Increasing the chip load to 1.25 mils (31.8 µm) may provide acceptable hole quality and improved productivity.

Cutting Speed

Drill speeds of 100 SFM (30.5 m/min) or less will usually eliminate drill smear if it is present. The slower speeds allow generated heat to dissipate before smearing PTFE. Drill speed can be increased due to equipment limitations, but added dwell times may become more important.

Dwell Time

If smear is present and ideal cutting speeds cannot be obtained, a 250ms dwell is recommended for initial process setup in order to cool the drill bit between holes. Past AGC studies have shown that hole-wall quality in PTFE materials may improve as dwell times are increased to as much as 1000ms.

Peck Drilling

Peck drilling should be avoided where possible; it has been shown to increase drill bit wear as well as increase process time. Peck drilling may be required in some situations (e.g. bird nesting, hole plugging, chip extraction on thick panels, breaking thin drill bits, etc.).

If traditional peck drilling is not used, hole-wall quality in PTFE laminates may be improved with the use of a “clean” peck where the peck depth is set to equal that of the phenolic entry. In this, the entry material will effectively clean the drill bit, retract to clear phenolic debris and cool, and then reenter to drill the hole.

Hit Count

Hit counts can vary widely and are usually determined by the laminates used, panel thickness, and hole size. Hit counts of 100-300 hits per bit are typical for ceramic/PTFE constructions. When paired with unreinforced and ceramic free laminates, little drill wear will take place and hit counts of 700-1000 are not unreasonable. When developing the process, the drill point edges should be periodically inspected to assess the level of drill wear and hit count should be adjusted accordingly.

Entry / Backer Materials

Rigid entry and exit material is usually beneficial in order to remove any debris or deposits from the drill bit. 10-25 mil phenolic entry is acceptable for most applications and 30-50 mil phenolic entry can be used if pressure foot clearance is substantial.

Like the entry, rigid backer is usually necessary to prevent burring and aid in obtaining good hole-wall quality. Thick phenolic is typical and lubricated rigid backers such as SlickBack® from L.C.O.A.® have also been successful.

Coolant Assisted Drilling

Some drilling equipment is now equipped to apply coolant/lubricant to the drill bit during the drilling process. This process has been shown to provide substantial benefit to the drilling process and should be used if available. If available, expect increased chip loads, cutting speed, and improved hit counts.

Laser Drilling / MicroVias

Microvias are best formed using a combination UV/CO2 laser. An initial UV pass to ablate the surface copper. A CO2 pass is recommended for formation of the actual microvia in the *fast*Rise TC, followed by a final UV pass to clean the capture pad. Capture pad cleaning is critical to forming a solid microvia connection, and AGC recommends an aggressive UV laser clean as opposed to a wet chemistry-based cleaning process.

HOLE WALL PREPARATION

*fast*Rise™ TC does not contain PTFE and therefore does not require an activation step prior to plating. The thermoset adhesive resins can be de-smeared / etched back as directed below.

Desmear

Plasma

If panels have been exposed to moisture, bake the boards at 120°C (250°F) for 1 hour to drive out moisture. Standard FR-4 CF_4/O_2 desmear processes should then be used. **The CF_4 cycle time is typically half that of standard FR-4 times because the *fast*Rise™ TC resin system tends to etch back quickly.**

Permanganate

A permanganate desmear IS NOT RECOMMENDED if the process contains glass etch chemistry. This is due to the high ceramic content of the *fast*Rise™ TC resin system and will result in excessive etchback. If glass etch chemistries must be used due to other materials in the stack up, consult with your AGC technical service representative for specific process recommendations.

Standard permanganate and glass etch baths as a part of the electroless copper process are OK. However, note that this alone will not sufficiently desmear the *fast*Rise™ TC resin. A plasma process as described above is required for good hole wall quality.

PLATING

*fast*Rise™ TC will readily accept any standard electroless copper or direct metallization plating. It is compatible with all copper plating and final finish chemistries.

IMAGE, DEVELOP, ETCH, STRIP

When copper surface preparation is required, chemical cleaning processes are preferred (e.g. microetch); mechanical scrubbing (e.g. pumice scrub) should be avoided due to possible mechanical

damage or distortion. Although *fast*Rise™ TC should be resistant to this type of damage, low loss materials typically used in conjunction with *fast*Rise™ TC may not be. Otherwise, standard processing should be used.

SOLDER MASK

Panels should be clean and dry. No other special treatment is required.

SOLDER REFLOW

A pre-bake cycle of 2 – 3 hours at 120°C [250°F] is recommended prior to thermal stressing. Longer pre-heat times and reduced cycle times may be advantageous depending on design and processes.

ROUTING / MILLING

*fast*Rise™ TC can be successfully machined using standard router bits or end mills. Rigid phenolic entry and a rigid backer should be used. In some cases, adding paper (white paper or craft paper) between the phenolic and the part allows better conformance to surface topography (e.g. circuits, soldermask, etc.) and may reduce burring. For tight tolerances or superior edge quality, a "rough cut" placed 0.005"-0.010" off the part edge may be run prior to the "finish" cut at the nominal part edge.