

Processing Guide

The processing guidelines contained in this document were developed through in-house testing and field experience. However, they should be considered to be starting points that will require further adjustment. Read the following review of processes for applicability to your particular Printed Wiring Board (PWB) fabrication environment. Remember that the suggestions contained herein can not account for all possible board designs or processing environments. Additional adjustments by the fabricator will be necessary. Isola can and will assist with this process, but the fabricator, not Isola, is ultimately responsible for their process and the end results.

Fabricators should verify that PWBs made using these suggestions meet all applicable quality and performance requirements.

Part 1: Prepreg Storage and Handling

Isola Group's prepreg bonding sheets for use in multilayer printed circuit board applications are manufactured to specifications that include physical and electrical properties and processing characteristics relative to the laminating application. Handling and storage factors have an important influence on the desired performance of the prepreg. Some parameters are affected by the environment in which prepregs are stored. They can also deteriorate over extended periods of storage. The prepreg received by the customer is a glass fabric that has been impregnated with a stated quantity of low volatile, partially polymerized resin. The resin is tack-free but somewhat brittle. Many lamination problems arise from resin loss off the fabric due to improper handling. The fabric used is based on the order and supplies the required thickness. In most cases the amount of resin carried by the fabric increases as the fabric thickness decreases.

Isola Group's FR406N is a proprietary multifunctional epoxy (170°C Tg typical by DSC) no-flow prepreg. It has been specifically formulated for optimal performance in bonding applications that require minimal resin flow and consistency in lamination. The material brings the fabricator specific characteristics appropriate for use in heat sink bonding, die cavity board (direct chip attachment) and multilayer rigid-flex applications. It meets IPC-4101C specifications as well as UL 94 V-0 specifications.

Handling Suggestions

Handle all prepreg using clean gloves. Use sharp, precision equipment when cutting or paneling prepreg. Treat all prepreg as being very fragile. Use extreme care when handling very high resin content prepreg (glass fabrics 1080 and finer).

Storage Suggestions

Upon receipt, all prepreg should be immediately moved from the receiving area to a controlled environment. All prepreg should be used as soon as possible using a First-In-First-Out (FIFO) inventory management system. No-flow prepregs should remain in their original bagging during storage and bags should be resealed if opened.

Prepreg should be stored at $\leq 23^{\circ}\text{C}$ and below 50% humidity. Prepreg packages should be allowed to equilibrate to layup room conditions before opening to prevent moisture condensation on the prepreg.

If stored @ 5°C (41°F), the unopened bag should be equilibrated for 8 hours in the layup area prior to opening and use.

Attention must be given to environmental conditions in the storage/layup areas to insure that the prepreg is not allowed to absorb moisture. FR406N prepregs are hygroscopic. Moisture absorption can lower minimum melt viscosity, resulting in a lengthening of the flow window. Further, excessive moisture absorption can also depress Tg and impact degree of cure. ***If excessive moisture is absorbed, desiccation procedures may NOT return prepreg performance to original specifications.***

Part 2: Prepreg Selection

Isola Laminate Systems offers no-flow prepregs in various glass styles. The resin content and flow characteristics of these items are tightly controlled to optimize consistency of flow and filling capability, plus provide precise thickness contribution. Actual thickness will be dependent on the prepregs selected as well as on the specific lamination set-up, including temperature, pressure, area under lamination and configuration of facing surfaces.

FR406N no-flow prepreg should be considered for use where UL94 V-0 flammability rating, high temperature reliability and chemical resistance are required.

Generally, two-plys of no-flow prepreg provide the best results. One ply of no-flow prepreg, style 1080 or thinner, is not generally

suggested. This is due to the lack of sufficient cushioning during lamination and may result in an increased potential for lamination voids and other defects. FR406N no-flow prepregs are typically available in 106 and 1080 glass styles in most regions (Asia, Europe and North America). Some regions may offer more than one combination of resin content and/or flow performance per glass style.

Prepreg selection should be based on the glass style and overall thickness requirement needed as well as the resin content and the flow characteristics of the specific prepreg product. The PWB fabrication process requirements as well as the end product's design and performance requirements should also be taken into account when choosing no-flow prepregs.

Consult your Technical Service representative for assistance with product selection as well as with general processing and press cycle adjustments. The processing suggestions contained in this document are generic or general in nature. Each fabricator should characterize FR406N No-flow prepregs in their specific applications.

Incoming Testing and Acceptance of No Flow Prepreg Materials

During the manufacturing of Isola no flow prepregs, Isola controls the prepreg rheology by performing "Circle Flow" (CF) tests. The test consists of punching 1" diameter holes in the prepreg, pressing 4 plys of the prepreg and then determining the reduction in the 1" circle diameters due to resin flow. This test method allows for Isola to control the prepreg flow (Circle Flow) to established CF ranges. Isola has established capability to three CF ranges identified as low, med and high spec ranges and has the necessary process controls in place to consistently manufacture to these spec ranges.

While the CF testing allows for consistent manufacturing and control of the no flow prepreg rheology, the controlled CF ranges may not directly correlate and may result in different flow performance during the PCB fabrication lamination process over the various board designs and stackup configurations. Therefore, it is required that an incoming visual inspection and a CF test be performed through the PCB lamination process on every lot of no flow prepreg to approve the material for use.

Due to the different influences of each distinct board design and board stackup, the performance of the Isola no flow prepreg is required to be deemed acceptable via the incoming Circle Flow test. The customer incoming test must be correlated to the no flow prepreg material spec ranges, LSL and USL material samples, for the given CF material range identified to be supplied. Upon completion of the incoming test correlation to the Isola no flow CF product range, the incoming test is required to be performed on each production material lot received to determine if the material lot is acceptable for use.

Due to the high value add of finished product relative to the no-flow/low-flow prepreg, this incoming acceptance testing is a necessary and required control to eliminate the Isola no-flow prepreg as a potential contributor to any PCB process or quality problems. Please contact the Isola Technical Account manager to obtain assistance in establishing the incoming CF testing and correlation data to the Isola no flow CF product ranges.

Bond Enhancement

Bond strength and assembly reliability will be improved if the organic and metal surfaces to be bonded with no-flow prepregs are properly prepared prior to lamination using suitable procedures. Laminate surfaces (flex film or unclad laminate) should be clean and roughened (pumice scrubbed, plasma etched or similarly prepared). Metal or metallized surfaces should have the shininess broken and oxidation removed by pumice scrubbing, brushing, vapor honing or similar means. Copper surfaces are best prepared with oxide or oxide replacements for maximum adhesion. Shiny nickel is a particularly challenging surface to be bonded. Surface(s) must be dry, as moisture will affect adhesion, prepreg flow characteristics and disrupt the curing mechanism.

Each fabricator should conduct in-house testing to verify that their coating produces acceptable results with FR406N.

If reduced oxides are used, consult the chemical supplier for post oxide baking considerations as excessive baking may degrade the coating characteristics. It is generally suggested that post-oxide baking be performed vertically, in racks. Suggest mild bake of oxidized surfaces (15-30 minutes @ 80-100°C). For conveyORIZED oxide replacements, an efficient dryer at the end of a conveyORIZED oxide replacement line should remove all moisture from the innerlayer surface.

However, drying of layers for 30 minutes minimum @ 100°C or higher is considered a "best practice". Drying in racks is preferred.

If immersion tin adhesion treatments are used, the fabricator should test the coating to verify adequate bond strength develops with FR406N prepregs.

Part 3: Lamination

Standard Lamination

The amount of time at cure temperature, and to some extent the actual cure temperature of FR406N material, will be determined by

the thickness of the multilayer package being produced. Very thick boards will require a longer cure time to assure optimum material performance.

On rare occasions a customer will encounter a board design with highly unusual fill characteristics. In those cases, it is sometimes necessary to use very high pressures (400-500 PSI) to achieve complete resin fill with the prepreg in question.

Table 1: FR406N Lamination Pressure

Lamination Method	Suggested Pressure Range
Hydraulic Pressing (without vacuum assist)	350-400 PSI (25-28 kg/cm ²)
Hydraulic Pressing (with vacuum assist via vacuum frames or bags)	325-375 PSI (23-26 kg/cm ²)
Hydraulic Pressing (vacuum enclosure)	325-375 PSI (23-26 kg/cm ²)
Autoclave Pressing	175-200 PSI (12-14 kg/cm ²)

It is important to understand when higher pressure is the appropriate solution to the problem and when a different prepreg (thicker glass style, higher resin content or higher Circle Flow performance) is a more appropriate solution.

Table 1 outlines general suggestions for lamination pressure based on press type used.

Removal of FR406N flash should be performed by routing rather than shearing to minimize crazing along the panel edges.

Some designs and applications may require deviation from these guidelines. Consult with Isola Technical Service for assistance.

Single-Stage Press Cycle Lamination

The following page outlines the suggested lamination parameters for a single-stage lamination cycle. Dual-stage cycles that utilize “kiss” pressure during the initial stage of the cycle **are not suggested** for use with FR406N material.

The lamination cycle selected will be a function of board stackup, complexity and thickness as well as the lamination presses capability. Note that the following graph is for reference purposes only and may require adjustment depending on the board size, thickness and complexity. **Thicker boards may require additional dwell time at curing temperature to achieve full cure.** See “Standard Lamination” previously discussed.

The cycle includes a pressure reduction step, which facilitates stress relief of the package during the cure step. Further, the cycle assumes that vacuum is maintained throughout the heating cycle and that the book is cooled to a temperature well below the Tg of the material before the press is opened. All three conditions are considered to represent “best practice” conditions during lamination by Isola.

While use of both the pressure drop cycle and cooling well below Tg in the “hot” press are strongly suggested, these steps are considered to be “optional” and the PCB fabricator may have equipment or capacity limitations which prevent following these suggestions.

Also note that your Isola Technical Service representative may elect to utilize an “equilibrated” lamination cycle for some prepregs and some board designs. During this type of cycle the product temperature is held for 10-20 minutes in the product’s melting temperature range under full pressure to facilitate better flow and wetout of structures. Although this type of cycle is not specifically illustrated here, it is considered to be an acceptable practice for some designs.

Single-Stage Lamination

Step 1:

Load/center the package as quickly as possible. **Pull vacuum for 20 minutes on lifters.**

Step 2:

Apply full pressure of 325-400 PSI (22.8-28.1 kg/cm²) on the panels. Suggest 350 PSI (24.6 kg/cm²) for initial pressure setting. See **Graph. NOTE: “Kiss” pressure cycles are not suggested with FR406N.**

Step 3:

Adjust heat rise to ~3.0-6.0°C/min (5.5-11.0°F/min), as measured between 79-135°C (175-275°F) by controlling the platen ramp rate and/or by using the appropriate amount of pressure padding.

Step 4:

Cure for a minimum of 80 minutes @ 185°C (365°F) once the package center reaches the specified set point. **NOTE:** An 60 minute cure cycle @ 185°C (365°F) may be used in some applications, but the product may not develop full Tg. Further, if the presence of components dictates a lower cure temperature, note that cure duration should be increased by 60 minutes for every -12.2°C (10°F) reduction in cure temperature below 185°C (365°F) to develop maximum Tg. **The use of unique press cycles should be validated by cure analysis. NOTE: Do not let the package temperature exceed 192°C (378°F).**

Step 5:

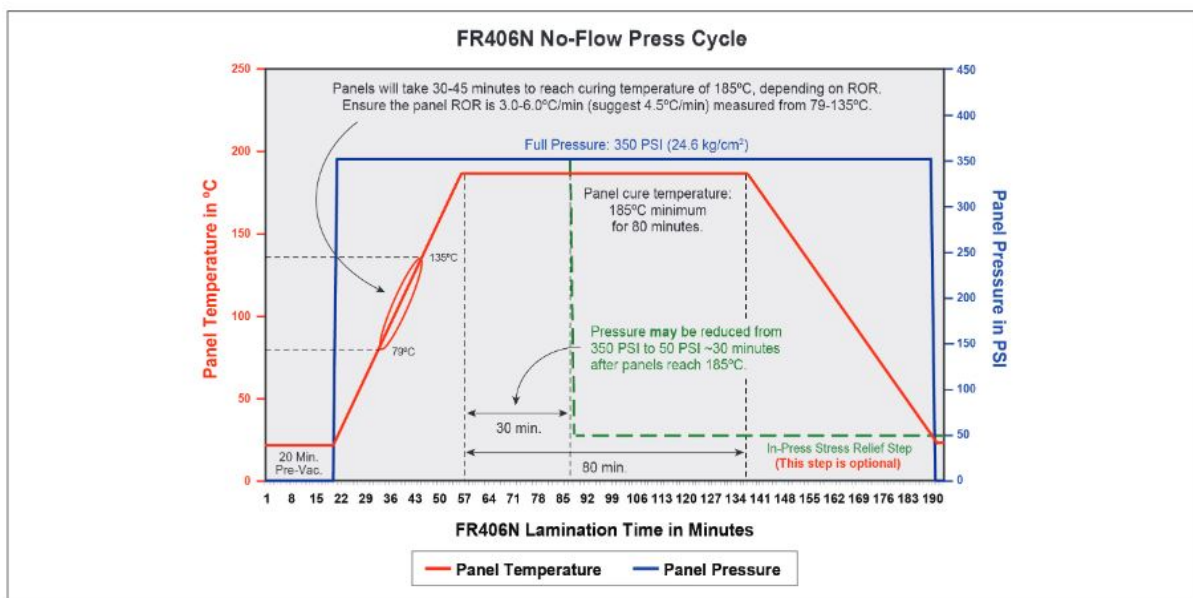
Reduce the pressure to 50 PSI (3.5 kg/cm²) after package has been at cure temperature for 30 minutes.

Step 6:

Cool material as slowly as possible or at 2.8°C/min (5°F/min) down from 185°C (365°F) through 135°C (275°F) or below.

Suggested FR406N Single-Stage Pressure-Temperature Profile

Please note: This is not a press control program! The graph represents the preferred pressure/temperature profile panels are subjected to during the lamination program cycle. **Note that the actual high pressure setting chosen may differ from the 350 PSI suggested in this graph. Press pressure and cure duration selected may depend upon board design as well as other factors.**



Part 4: Health and Safety

Always handle laminate with care. Laminate edges are typically sharp and can cause cuts and scratches if not handled properly. Handling and machining of prepreg and laminate can create dust (see FR406N Material Safety Data Sheet). Appropriate ventilation is necessary in machining/punching areas. The use of protective masks is suggested to avoid inhaling dust. Gloves, aprons and/or safety glasses are suggested if individuals have frequent or prolonged skin or eye contact with dust. Isola Group does not use polybromidebiphenyls or polybromide-biphenyloxides as flame retardants in any product. Material Safety Data Sheets are available upon request.

Part 5: Ordering Information

Contact your local sales representative or visit: www.isola-group.com for further information.

Or contact us at: info@isola-group.com

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Learn More

<https://www.isola-group.com/products/all-printed-circuit-materials/FR406N/>

NOTES

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